except in apparent contradiction to the principles of Free Trade.

"That the foundation by the late John Owens of Professorships of Arts and Sciences in the midst of this great city was not thought by Cobden to be subversive of his principles is proved by the fact that he himself was one of the original trustees, yet this conclusion does not appear equally clear to all of his disciples.

"We are, in sober truth, utterly at a loss to conceive how the higher education of the country can be efficiently carried on without a moderate endowment of its Professorships. The necessity for such an education you yourself admit.

"A single example from our own staff, which, more or less, applies to other places and subjects, will render our argument clear. It is evidently of very great importance that in a place like Manchester the citizens should be taught by a master mind the principles of political economy, and they have been fortunate in being able to avail themselves of the services of such a man as our colleague, Professor Jevons. But, although here both elements of pecuniary success might appear to be present in an intelligent public and a first-rate teacher, the fact remains that without the (misguided !) endowment of our founder the few who attend his lectures could not have benefited from the teaching of Professor Jevons unless the fees of attendance had been enormously increased. Indeed, we question whether the great apostle of Free Trade himself would have ultimately met with success had he not first of all received some sort of protection and support.

"We are naturally led by the instance we have quoted to remark that endowments really tend to diminish the expenses of education, and, looking around us, we see that in University College and King's College (London), where there are no endowments, they cannot afford to give their education at so low a figure as is possible at Owens College and in the Scotch Colleges, where endowments exist.

"In the German Universities, again, where all the important Chairs are well endowed, the expenses of education are almost nominal. In Scotland the education is in some branches of a very high standard, and in others great improvements have recently taken place, chiefly in the direction of relieving the head Professors from the duty of teaching junior classes which pay, and of enabling them to devote their energies to senior classes which do not pay. Such, in Scotland, have been the effects of endowments. Again, with regard to Germany, we have never heard any complaints made of the inefficiency of the German Professors.

"We must candidly own that we were much surprised by your statement as to the advisability of simply founding Scholarships and Exhibitions, coming, as it does, from a distinguished Oxford man well acquainted with the present state of feeling in the older Universities. Is it not true that this feeling is strongly against the extension of the already too numerous Scholarships, Fellowships, and other incitements to study, and in favour of the application of these funds to increase the paltry salaries of the Professors ?

"The excessive endowment of Scholarships appears to us to be objectionable, as an instance of unnecessary protection, where, by means of a hotbed regimen, young men are induced to enter a profession for which there is no subsequent career.

"While we admit that in a perfect state of society (unhappily still far distant) the laws of supply and demand may perhaps be applicable to all knowledge, yet we must point out that the teachers of the higher branches have too often now to create a taste for the commodity which they supply, and hence we believe that the moderate endowment of Professorships, such as exists in our own case, is essential to the progress of civilisation in this country.

"In conclusion, Sir, we cannot understand why endowment naturally tends to make teaching inefficient in the case of a Professor of science or arts more than it does in that of a minister of religion or a statesman.

"Are they not all servants of the nation administering to its higher needs ? The teacher of science or of the arts will, we venture to say, be no less conscientious and faithful to the true interests of a noble cause in teaching his class than the minister of religion in addressing his congregation, or the Minister of State in addressing his constituents.

"We are, Sir, your obedient servants,
"HENRY E. ROSCOE, B.A. (Lond.) F.R.S.
"BALFOUR STEWART, LL.D., F.R.S."

"11, Downing Street, Whitehall, May 23, 1872

"Gentlemen,—The speech which I made at the annual meeting of the London University occupied three-quarters of an hour, and was reported in a few lines. I never alluded to Professors, but spoke only of teachers, meaning those who do the drudgery or hard work of teaching, not those who are devoted to the investigation and inculcation of higher and more refined knowledge. I have the greatest respect for Mr. Jevons, and do not doubt that the endowment of his Chair is money well laid out.

"I also agree—indeed, I said—that the endowment both of Fellowships and Scholarships at Oxford and Cambridge is excessive ; but I pointed out how hard the competition was for the London University, with strict examinations and hardly any endowment, against Oxford and Cambridge, with rich endowments and easy examinations. I added that in my judgment money was better spent in giving Exhibitions to young men, leaving them free to choose the place of their education, than in paying persons to teach them ; since in the one case the inducement to the teacher to work was diminished, while in the other the student with money in his hand was sure to find the best teacher for himself.

"I am, Gentlemen, your obedient servant,
"ROBERT LOWE.

"I am an older Freetrader than Mr. Cobden, and am by no means prepared to assent to his views in all respects."

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*GLAISHER'S (HALL'S IMPROVED) RAIN GAUGE**

IN the first paragraph of my "Notes on the Rainfall of 1871," which recently appeared in NATURE (vol. v., p. 481) your readers will probably have noticed certain reference to the above.

The improvement to which I refer consists of an *inverted rim* (similar to the rim or flange in which the receiver stands) fixed to the outside cylinder of the receiver, and made sufficiently large to admit of its dropping over the rim or flange, sometimes called "channel," fixed to the lower cylinder, *id est*, the one just mentioned in parenthesis.

The *inverted rim* is shown by a thick line on the right of the accompanying half-sectional diagram.

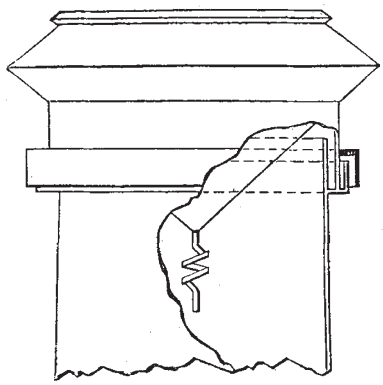
The reason that I suggested this addition was, that on one occasion, while registering the daily rainfall at Twickenham, during the winter of 1869-70, I was unable to take the receiver off, owing to the already existing channel being partly filled with water, which had frozen hard during the night.†

It is intended that water should be collected in the flange (Glaisher's) I have spoken of, and thus close the gauge against evaporation, scarcely a good idea theoretically, *certainly not practically*, inasmuch as the water

* Vide *Scientific Opinion*, vol. iii. pp. 449, 450.

† In order to avoid the interference of houses and trees, my gauge was supported at this time on a bracket carriage, running in vertical slides from a staircase window to a point a few feet above the roof of my residence.

collected therein so soon evaporates, especially in hot weather; *vide* "Symon's British Rainfall, 1868;" "Rain Gauge Experiments at Strathfield Turgiss, Reading," by the Rev. C. H. Griffith, F.M.S., &c., p. 23, which further establishes my remarks. The absence of outlet for confined air here spoken of, might be remedied, if indeed needed, by drilling small air-holes in the bottom of the receiving cylinder and upright flange, *but not facing each other*. I have two Glaisher's gauges fitted with the inverted flange arrangement, both of which answer remarkably well. I believe the improvement which I have adopted is more effectual against loss by evaporation (during all weathers) than the present (Glaisher's) system.



One of my gauges has been further improved at my suggestion by being fitted with a spiral or *helical* pipe in the place of the J-shaped pipe, thereby presenting no direct opening for evaporation, at the same time offering little or no hindrance to the speedy descent of the rain-water; but this is a matter I hope to enlarge upon in a paper (as yet unpublished) which I hope to communicate to you shortly, "On a Proposed New Form of Rain Gauge (the Atmospileometer)," in which a similar, but more extensive, idea, is shown.

The particulars mentioned in paragraphs 1 and 3 of this letter were long since communicated to and approved by the Secretary of the Rainfall Committee of the British Association (G. J. Symons, Esq., F.M.S., &c.) one of the highest authorities in matters relating to rainfall.

JOHN JAMES HALL

WATER ANALYSIS

I.

IT is now upwards of twenty years since the inhabitants of this country, and especially of the metropolis, were awakened, by a succession of virulent attacks of epidemic cholera, from the profound indifference with which they had regarded all matters connected with the public health for the hundred and eighty years which had succeeded the Great Plague. During that interval builders had been allowed to cover land with hundreds of acres of dwellings built without regard to ventilation, drainage, or water supply. In all the towns and villages of the country the ground was honeycombed with cesspools and wells, the latter deriving their supply of water at least in part from the former, and in all riverside towns the river either received the town sewage at once or after it had passed through the cesspools. Attention once being drawn to the matter, it became the duty of the chemist to detect the various polluting matters introduced by the sewage into the different sources of water-supply, and to discover, if he could, waters that were free from this pollution; and a still greater field was opened up, for the two first inquiries naturally led to the allied questions—How can sewage be rendered harmless? and Can slightly polluted water be rendered safely drinkable by the removal from it of the contaminating matter introduced by sewage? We propose in this article to look only at the first of these questions, the one on the successful solution of which depend all the others—Can organic contamination be detected and estimated with accuracy? As soon as the question was approached it was found to be one of extraordinary difficulty, and in 1856 Hofmann and Blyth drew attention to the inaccuracy of the then existing processes, especially of the one known as "loss on ignition" obtained by igniting the solid residue on the evaporation of the water. This loss, then generally looked on as affording a measure of the organic matter present in the water, they proved to consist of a loss of carbonic anhydride, nitric acid, ammonia, and moisture, &c., and they proposed to render the determination more accurate by the addition of a known weight of sodic carbonate, which, while it drove off the ammonia (usually a very small fraction of the loss), retained the acids and prevented the aqueous magnesic chloride from losing hydrochloric acid. The same chemists pointed out the necessity of determining the amount of nitrogen present, but were unable to recommend any process for its estimation. The methods for estimating the ammonia were also very unsatisfactory, for we find Dr. Dundas Thomson in 1855 distilling as much as fifty gallons of the metropolitan water-supplies in order to estimate the ammonia, which was done by titration with standard acid; and this when some of the metropolitan supply was taken from the Thames at Vauxhall, and "Fibrin from Fæces" could be distinctly recognised in the Southwark Company's water. Another process, devised by Forchhammer, was also in use for the determination of the organic matter, which consisted in adding a standard solution of potassic permanganate until no further loss of colour occurred. This process had been improved from time to time, and was and is largely used. The only other test was that for hardness, invented by Dr. Clark, and which is still in use, with but slight modification from the original method.*

If these processes are considered but shortly, the defects they possess are at once apparent. Take, for instance, Hofmann and Blyth's improved solid residue process. On ignition there was great danger of decrepitation and consequent loss, notwithstanding the high temperature (120° to 130° C.) to which the residue had been exposed. Frankland and Armstrong have shown that portions of the nitrogenous matter were liable to remain fixed in the ignited residue as cyanogen compounds. Again, in the case of some artificial residues prepared by treating dilute solutions of urea as in the above process, from 44 to 59 per cent. of the urea used was found to have been lost during the preliminary evaporation, the sodic carbonate having expelled it as ammonic carbonate. And on the treatment of similar residues by ignition, from 58 to 85 per cent. of the organic matter was left in the residue. It was usual also to restore the lost carbonic anhydride to the ignited residue by evaporating a solution of that gas on it and weighing until a fresh treatment did not increase the weight; but to still further increase the difficulty of this unhappy process, it was shown that some residues seemed to have the power of taking up such quantities of carbonic anhydride, that they weighed more after this treatment than they did before ignition. The estimation of ammonia by titration with acid needs no argument against it; the enormous quantities of water necessary for the determination sufficiently condemn it; and it has been long superseded by the admirable quantitative form of the Nessler process invented by the late Mr. Hadow, of King's College. The permanganate process, however, being an easy one to perform, still survives in the laboratories of many analysts. Indeed, not content with giving the results of this determination as "oxygen required to oxidise the organic matter present," the lively imagination of some led them to the remarkable conclu-