men continue to beat about the bush when they know exactly where the real quarry is?

A few years ago the pressure for a reformation in the management grew to considerable proportions and it was shrewdly met by the Navy Department in the scheme for an astronomical director. Many hopeful people without much experience rejoiced at this which they thought was a great step in the right direction. When a year or two ago the continued dissatisfaction had grown to the extent of demanding the appointment of committees by the American Association for the Advancement of Science and the Astrophysical Society, it was again as shrewdly encountered by the appointment, by the Secretary of the Navy, of the Board of Visitors whose report is unhappily meeting with criticism fore and aft. A distinguished statesman whose loyalty to the interests of the Navy Department has long been known was made chairman of this Board and it is an open secret that he peremptorily cut off all suggestions looking to the real emancipation of this great institution.

The scientific members of the Board, all most excellent astronomers, but possibly not well informed as to the methods sometimes resorted to by great statesmen, were restricted in the recommendations to proposals for repair rather than reconstruction. In spite of their limitations they succeeded in getting in a most interesting and valuable report—one in which symptoms are admirably set forth, although there is 'much silence' as to the real nature of the complaints. Is it not perfectly true that the Naval Observatory, as such, has been of little value to astronomical science, although *astronomers* attached to the establishment have contributed greatly to the glory of American science? But this is in spite of, not on account of the character of the administration of the Observatory. This administration is and must always be, and properly so, while it is under the Navy Department, military in its character. The utter incompatibility of this sort of control and direction with the best interests of scientific research needs no demonstration. The very existence of a comfortable retiring pension for astronomers who survive their sixty-second year has been unfortunate in its results, in that it has led to the appointment, through the use of influence, other than that of merit, of men whose principal ambition was old age under these conditions. Why should a regularly appointed astronomer be detailed as inspector of apparatus for fire protection at the Navy yards? What would be thought of a civil establishment which detailed one of its best paid professors of astronomy to the duties of superintendent of grounds and buildings? M.

REPRODUCTION OF DIFFRACTION GRATINGS.

To the Editor of Science: The communication of Professor R. W. Wood in your issue of January 4th (p. 33), concerning diffraction gratings, is of interest to me. I have, during the past year, made some experiments on the reproduction of gratings. Obtaining through the kindness of Professor Rowland and Mr. Schneider, a fine flat glass grating, it was silvered on its face in a silvering solution, then electroplated with silver and afterward with a heavy coat of copper. With care it could be readily removed from the glass especially if warmed. I had used the process to make concave mirrors from lens surfaces about six or seven years ago and the results were excellent, even the most minute scratches or imperfections of the glass appearing in the silvered surface with the utmost fidelity, while the polish and brilliancy was such that one could scarcely believe that the surface was not one of glass instead of polished metal. With the glass grating the experiments gave excellent reproductions of the ruling and great brilliancy, but the surface of the metal grating was not optically flat but slightly warped. This condition varied in different trials and the result would probably have been more perfect if the temperatures during the electro-depositing had been maintained rigorously the same.

It is possible that had the glass been convex the resultant concave grating would have been without distortion. Lack of time has so far prevented my trying another expedient which ought to give good results. It is to first silver the glass grating as before, then, having coated a flat glass surface with a thin layer of adhesive cement, like hard pitch or shellac warmed, or with a cement like glycerine and litharge which

sets firmly, apply this to the silver surface and allow it to harden. It should then be easy to remove the silver grating from the glass grating and the reproduction should have all the gloss and accuracy of the surface serving as the matrix. My interest in the matter was the possibility of easily and rapidly obtaining fairly good gratings without great expense, so that students in laboratories might use them without restraint. From one good glass grating numerous reproductions could be had at any time.

ELIHU THOMSON.

SWAMPSCOTT, MASS.,
Jan. 5, 1901.

THE FRICTIONAL EFFECT OF RAILWAY TRAINS ON THE AIR.

AN interesting and in some respects exceptionally important paper, read by Professor F. E. Nipher before the St. Louis Academy of Science has just been published by that Society in its transactions.* In this paper, the results of an experimental investigation of the effect of railway trains in the production of air-currents, and in causing the motion of adjacent bodies, are given with tabulated and diagrammed data. The effect of a rapidly moving express-train in producing strong air-currents is familiar to all who have seen anything of that kind of train-service, and the results of action of these fast-moving currents in overturning and in transporting objects near the track are hardly less familiar; but this is the first investigation conducted in a scientific and satisfactory manner to determine the quantitative measures of such effects. The stimulus to this particular research seems to have been the denial, by the Supreme Court of Missouri, that such effects are or can be produced.†

The station agents of all the great trunk-lines of railway over which fast trains are operated are invariably cautioned regarding this danger and are careful to warn people against standing near the track when an express train passes. Small articles, and especially bulky and light merchandise, may often be seen to move under the 'suction' so produced, and, in the case referred to, a boy standing near the track, awaiting the passing of the coming fast train, and about to cross, was overthrown and rolled under the wheels and killed. The evidence showed that he was not struck by the train and the upper part of his body was not bruised. 'He fell after part of the train had passed.' The Court, however, repudiated the evidence of two scientific men of recognized attainments and distinction, testifying to the existence of known facts and to the probability of the claim of the plaintiffs in the case. The outcome of this doubt of the evidence was the employment by Mr. Nipher of a large part of the succeeding summer in the investigations here recorded, which were carried on, on the various roads leading out of St. Louis to Burlington, Chicago and Cairo. The Illinois Central Railroad finally fitted up a special car for the work; this was employed in securing the larger part of the information published.

The difference of pressure was taken between the interior of the car and some one point, selected by the observer, in making a series of observations from contact with the side of the car to a stratum several feet from the side, and the successive differences of pressure constitute measures of the varying tendency to carry along loose bodies near the track and of the tendency, also, to rotate them. A cup-shaped collector was used and the Newtonian equation was adopted. The coefficient, for pounds per square foot and miles per hour, was found to be 0.0025, very nearly, without wind. Still air is only reached at distances of sometimes many feet from the side of the train. The curve of varying pressures relatively to the car was found to be, as plotted, approximately hyperbolic, the vertical asymptote finding its position a short distance inside the car. The pressures measured range from 3.4 to 6 pounds on the square foot, at distances of 0 to 30 inches from the side of the car; the mean speed being 38 to 46, usually about 40, miles an hour; at which speed the

* The Frictional Effect of Railway Trains upon the Air; Francis E. Nipher. *Trans. Acad. of Science of St. Louis;* Vol. X., No. 10. Issued Nov. 12, 1900.

† "When the case was tried a second time, and again resulted in a verdict against the company, the Supreme Court attacked the experts it had approved in the first reversal and threw out their uncontested evidence. * * * The Supreme Court of Missouri decides that the physical laws of the universe do not exist, so far as that august assemblage is concerned." —*St. Louis Mirror*, November 29, 1900.