take place. The pseudoscope being directed to an object, and adjusted so that the object shall appear of its proper size and at its usual distance, the distances of all other objects are inverted; all nearer objects appear more distant, and all more distant objects nearer. The conversion of relief of an object consists in the transposition of the distances of the points which compose it. With the pseudoscope we have a glance, as it were, into another visible world, in which external objects and our internal perceptions have no longer their habitual relations with each other. Among the remarkable illusions it occasions, the following were mentioned. The inside of a tea cup appears a solid convex body; the effect is more striking if there are painted figures within the cup. A china vase, ornamented with colored flowers in relief, appears to be a vertical section of the interior of the vase, with painted hollow impressions of the flowers. A small terrestrial globe appears a concave hemisphere; when the globe is turned on its axis, the appearance and disappearance of different portions of the map on its concave surface has a very singular effect. A bust regarded in front becomes a deep hollow mask; when regarded *en profile*, the appearance is equally striking. A framed picture, hung against a wall, appears as if imbedded in a cavity made in the wall. An object placed before the wall of a room appears behind the wall, and as if an aperture of the proper dimensions had been made to allow it to be seen; if the object be illuminated by a candle, its shadow appears as far before the object as it actually is behind it.

The communication concludes with a variety of details relating to the conditions on which these phenomena depend, and with a description of some other methods of producing the pseudoscopic appearances.

On a Method of Obtaining a Perfect Vacuum in the Receiver of an Air Pump. By THOMAS ANDREWS, M. D.*

By using the necessary precautions, a vacuum may be obtained by the following process, with very little trouble, in the ordinary receiver of an air pump, so perfect that the residual air exerts no appreciable elastic force. Even after this limit has been reached, the exhaustion may be pushed still further, till it must become at last not less complete than the Torricellian vacuum; while at the same time, by suppressing the manometer, the existence of mercurial vapor may be altogether prevented. The manipulations required to arrive at this result will not interfere with the presence of the most delicate instruments in the receiver.

Into the receiver of an ordinary air pump, which is not required to exhaust further than to 0.3 inch, or even 0.5 inch, but which must retain the exhaustion perfectly for any length of time, two open vessels are introduced, one of which may be conveniently placed above the other; the lower vessel containing concentrated sulphuric acid, the upper a thin layer of a solution of caustic potash, which has been recently concentrated by ebullition. The precise quantities of these liquids is not a matter of importance, provided they are so adjusted that the acid is capable of desiccating completely the potash solution without becoming itself notably diminished in strength, but at the same time does not expose so

* From the London, Edinburgh, and Dublin Philosophical Magazine, February, 1852.

large a surface as to convert the potash into a dry mass in less than five or six hours at the least. The pump is in the first place worked till the air in the receiver has an elastic force of 0·3 or 0·4 inch, and the stop-cock below the plate is then closed. A communication is now established between the tube for admitting air below the valves and a gas-holder containing carbonic acid, which has been carefully prepared so as to exclude the presence of atmospheric air. After all the air has been completely removed from the connecting tubes by alternately exhausting and admitting carbonic acid, the stop-cock below the plate is opened and the carbonic acid allowed to pass into the receiver. The exhaustion is again quickly performed to about the extent of half an inch or less. If a very perfect vacuum is desired, this operation may be again repeated; and if extreme accuracy is required, it may be performed a third time. It is not likely that any thing could be gained by carrying the process further. On leaving the apparatus to itself, the carbonic acid which has displaced the residual air is absorbed by the alkaline solution, and the aqueous vapor is afterwards removed by sulphuric acid. The vacuum thus obtained is so perfect, that even after two operations it exercises no appreciable tension.

To give a clear conception of the progress of the absorption, I will describe in detail one observation in which the tension was measured simultaneously by a good syphon-gauge and by a manometer, formed of a barometric tube 0·5 inch in diameter, inverted in the same reservoir of mercury as a similar tube communicating with the interior of the receiver. The barometer had been carefully filled, and the depression of the mercury estimated by the method already described at less than $\frac{1}{100,000}$ th of an inch.

Previous to the admission of the carbonic acid, the exhaustion was carried only to 0·4 inch; it was again carried to 1 inch; and a third time to 0·5 inch, after which the apparatus was left to itself. The manometer indicated a pressure in—

15' of 0·25 inch.
 30' " 0·17 "
 80' " 0·10 "
 200' " 0·02 "

In twelve hours the difference of level was just perceptible, when a perfectly level surface was brought down behind the tubes till the light was just excluded. In thirty-six hours not the slightest difference of level could be detected. The vacuum has remained without the slightest change for fourteen days.

It is evident that the only limit to the completeness of the vacuum obtained by this process, arises from the difficulty of preparing carbonic acid gas perfectly free from air. This may be very nearly overcome by adopting precautions which are well known to practical chemists. When an extreme exhaustion is required, the gas-holder should be filled with recently boiled water, and the first portions of carbonic acid that are collected in it should be allowed to escape.

The substitution of phosphoric for sulphuric acid would remove the possibility of either aqueous or acid vapors being present even in the smallest amount, but such a refinement will rarely be found necessary.

In the experiment just described, the theoretical residue of air would be $\frac{1}{4500}$ th part of the entire quantity in the receiver, which would cause a depression of $\frac{1}{4500}$ th of an inch. This result must have been nearly realized. If the exhaustion had been carried at each time to 0.2 inch, the residue by theory would have been only $\frac{1}{37500}$ th part. But the experimental results will not continue to keep pace with such small magnitudes.

Queen's College, Belfast, January 7, 1851.

Chemical Report on the Cause of the Fire in the Amazon. By Professor GRAHAM.*

In reply to the questions arising out of the disastrous loss of the *Amazon* by fire, which are proposed to me for a Chemical opinion, I beg to submit to your Lordships the following statements and conclusions:

The practice of mixing together the various stores of the engineer, consisting of oils, tallow, soft-soap, turpentine, cotton waste, and tow, and placing them in heated store-rooms contiguous to the boilers, must be looked upon as dangerous in no ordinary degree, for several reasons. Although oil in bulk is not easily ignited, particularly when preserved in iron tanks, still, when spilt upon wood, or imbibed by tow and cotton waste, which expose much surface to air, the oil often oxidates and heats spontaneously, and is allowed to be one of the most frequent causes of accidental fires. The vegetable and drying oils used by painters are most liable to spontaneous ignition; but no kind of animal or vegetable oil or grease appears to be exempted from it; and instances could be given of olive oil igniting upon sawdust; of greasy rags from butter, heaped together, taking fire within a period of twenty-four hours; of the spontaneous combustion of tape-measures, which are covered with an oil varnish, when heaped together; and even of an oil-skin umbrella put aside in a damp state. The ignition of such materials has been often observed to be greatly favored by a slight warmth, such as the heat of the sun. I am also informed by Mr. Braidwood, that the great proportion of fires at railway stations have originated in the lamp store, and that in coach works also, when the fire can be traced, it is most frequently to the painter's department, the fire having arisen spontaneously from the ignition of oily matters. Lamp-black and ground charcoal are still more inflammable, when the smallest quantity of oil obtains access to them, and should not be admitted at all among ships' stores.

The stowing metallic cans or stoneware jars of either oil or turpentine in a warm place is also attended with a danger which is less obvious, namely, the starting of the corks of the vessels, or the actual bursting of them by the great expansion of the liquid oil which is caused by heat. These liquids expand in volume so much as one upon thirty by a rise of not more than 60° of temperature, or by such a change as from the ordinary low temperature of 40° to a blood-heat; the latter temperature may easily be exceeded in an engine room. It is remarkable that the burning a few years ago of a large steamer on the American lakes, which

* From the Journal of the London Chemical Society, April, 1852.