terially in length, breadth, outline, or latitude, during four years' time. A slow retrograde drift in longitude has, however, taken place quite uniformly. The summary of mean results of Professor Hough's micrometric measures of the spot is as follows: —

	1879.	1880.	1881.	1882.
Length	12.25″	11.55″	11.30″	11.83″
Breadth	3.46	3.54	3.66	3.65
Latitude	−6.95	−7.14	−7.40	−7.52

While the spot has remained thus nearly stationary in latitude, the south edge of the great equatorial belt has gradually drifted south during the late opposition, until it is nearly co-incident with the middle of the spot. But, what is remarkable, the two do not blend together, but are entirely distinct and separate, seeming thus to indicate that they are composed of matter having repellent properties, similar to two clouds charged with the same kind of electricity.

In the years 1664, 1665, 1666, a great spot, with a diameter of some eight thousand miles, or about one-tenth that of Jupiter, was observed by Hook and Cassini, and situate in latitude 6″ south of the planet's equator. The spot re-appeared and vanished eight times between 1665 and 1708, was invisible from this latter year until 1713, and the longest period of its continuous visibility was three years, and of its disappearing, five. Professor Hough suggests the possible identity of that great spot with the present one, taking much the same ground with Russell of Sydney, — that it is a portion of the solid body of the planet, or *Jupiter firmus*, so to say, and is ofttimes rendered invisible by a covering of clouds. Professor Hough does well to call attention to the incorrect statement, so universally made in the astronomical text-books, that new belts are formed on the disk of the planet in the course of a few hours' time. The appearance of the disk changes from hour to hour, owing to the rapid axial rotation of the planet; and, as we pass from the equator to the poles, the apparent transit of an object across the disk becomes slower and slower. Observers, even at the present time, not always realizing that they are looking at a globe, and not at a plane surface, make statements regarding rapid changes in size or shape of objects on the planet's disk that are not legitimate deductions from the actual observations.

Regarding other configurations of the disk of Jupiter, Professor Hough notes the drifting south of the great equatorial belt nearly two seconds of arc during the late opposition. Small oval white spots were observed to be quite numerous. They were difficult to observe, and their identification is somewhat uncertain; but they appear to have a general retrograde drift at the rate of seventy miles per hour. Great numbers of minute white spots and markings near the equatorial regions were also observed, the discussion of which is reserved; but it is a curious fact that these spots should drift for years with the enormous velocity of two hundred and sixty miles per hour, if they are nothing more than clouds in the planets' atmosphere. The series of micrometric measurements on all these belts and spots appears to have been sufficiently elaborate, and the results derivable from a complete discussion of them will surely possess much of interest. Four sketches accompany the report, which show the salient features of the disk merely, no attempt having been made to represent the minute detail of the equatorial markings.

About the average success is reported in the contact-observations of the transit of Venus, of December, 1882. Mr. Burnham assisted in taking a number of dry-plate photographs of the planet on the sun, which present very sharp outlines of the disks of the sun and Venus. The method of insuring a minimum exposure, ordinarily in use by photographers, was employed; the equivalent exposure for any part of the sun's disk being as short as one sixteen-hundredth part of a second. Professor Hough regards these experiments as showing conclusively that astronomical photography will be most successful when the time of exposure becomes a minimum.

DAVID P. TODD.

A NEW MOTOR.

THE pneumatic tramway engine company of New York has recently issued a prospectus, in which it presents the claims of compressed air as a motor for short lines, with statements of the results of experiments with a motor built for them by the Baldwin locomotive-works. The engine was used, experimentally, on the Second-Avenue elevated railroad in New-York City, with what would seem to have been very satisfactory results.

The locomotive has four driving-wheels, two working cylinders of twelve inches and a half diameter and eighteen inches stroke of piston, with running-gear like that of the standard steam-locomotive of small power. In place of the boiler there are four air-reservoirs, each three feet in diameter, of Otis steel, half an inch thick, having a tenacity of seventy-five thousand pounds per square inch of section, and made up with the spiral seam introduced by Root. These reservoirs are tested to eight hundred pounds per square inch, and are filled with air at six hundred pounds. A small steam-boiler inside the cab is used as an air-heater, and raises the temperature of the air leaving the reservoirs, and on its way to the cylinders, to about 240° F. A reducing-valve causes the pressure to fall, at the cylinders, to a hundred pounds per square inch, the working-pressure for the engine. The cylinders are lubricated in part by the water taken up in the heater, where the air bubbles up through the confined liquid, and in part by oil, introduced for that purpose. The main valve is worked in full gear, and expansion is obtained by the use of an independent 'cut-off valve' on its back.

The 'braking system' is as novel as it is ingenious and effective. The engines are reversed, as in the method of Le Chatellier; and they thus become pumps, taking in air, which is forced into the main reservoirs to replace that expended in propulsion.

The system is made still more effective by taking this air, not from the exhaust-pipe, but from the air-brake cylinders beneath the cars, and thus operating the continuous brakes on each car as well as the same work is done by the common Westinghouse system.

The experimental engine has drawn trains of three and four loaded cars from Harlem to the Battery, New-York City, a distance of nine miles, in two minutes and a half less than schedule time, — forty minutes, — making all stops, and on three-fourths of a single charge of air. The engine will handle well, alone, with a pressure of twenty-five pounds.

It is impracticable to cover long distances without refilling the reservoirs, and it is not proposed to attempt doing so. The reservoirs are to be filled at every ten-miles run, or every forty or fifty minutes; and filling-stations are to be provided at proper intervals along the line of the road. The reservoirs are so well made, that the engine stands all night, under a pressure of one hundred pounds, without appreciable loss of pressure.

The obvious and unquestionable advantages of this method of transportation are: safety from the dangers of explosion, which, aside from simple pressure, are unavoidable with steam and water; perfect cleanliness, not only on the engine, but along the line and on the train, in consequence of the avoidance of dust and smoke, and sparks from the engine; freedom from gas from the locomotive; less noise than with the steam-engine; freedom from the annoyances from dripping hot water, soiling the clothing, and half scalding the unfortunate pedestrian beneath; permanence of the reservoirs, which cannot be burned out, as can the steam-boiler, and which cannot be injured by the corrosion, due to leakage of water and steam, which is so serious a cause of injury to the steam-boiler. The engineer appreciates the latter points particularly, as well as the comfort of having no fire or fireman to look after and to distract his attention from his duties at the throttle, and ahead of the train. He is even saved the responsibility and taxation of 'looking out for the water' in the boiler, which is no small matter on the steam-locomotive.

Comparing the commercial sides for the two motors, the air-locomotive will undoubtedly be found to cost much less for repairs, to lose vastly less time in the shops, and to demand very much less of the time of the engineer and of the master mechanic, when off the road. Whether the cost of running will be so small as to permit the adoption of the system on our elevated railroads, and other railroads to which it may be as well adapted, cannot, as a matter of course, be certainly known until the experiment shall have been tried under all the best conditions for its operation. This is, in fact, the question to be determined. The experiment on the New-York lines is evidently very encouraging; and it is to be hoped that the very favorable estimates offered by its promoters may be confirmed by long trial, and the successful introduction of the motor. So far as we are aware, the compressed-air locomotive has hitherto been used only where, as in the longer lines of tunnels, there existed peculiar reasons for its introduction. The experiment is a perfectly legitimate one, and the new company are entitled to every favor that can be properly accorded those who attempt in any way the amelioration of the annoyances and the dangers of railway travel. R. H. THURSTON.

DANIELL'S PRINCIPLES OF PHYSICS.

A text-book of the principles of physics. By A. DANIELL. London, *Macmillan*, 1884. 20+653 p. 8°.

MANY of those who have been engaged in teaching physics to undergraduates during the last ten years have felt the want of a text-book more in accord with the present condition of the science than the majority of those accessible to the English-reading student. It is doubtless a fact, and a curious one, that those most generally in use in this country are, or perhaps it is better to say were, originally translations from the French; and this in spite of the generally admitted leadership of English-speaking people in this department of science.

Although, perhaps, the best attainable up to the present time, these English translations of French text-books have certainly fallen short of perfect adaptability to the work, and more and more so as the years passed by. It is true that an attempt has been made by the editors and publishers to keep pace with the rapid growth of the science, but this attempt has met with but doubtful success.

Any system or design or scheme which may have existed in some of these books in the beginning has been pretty effectually destroyed by the numerous additions which have been made from time to time, in the placing of many of which the convenience of the printer seems to have been oftener consulted than any thing else.

Although one may find a brief account of the very latest discovery or invention up to the time of going to press, he is likely to find it in a most unexpected place; and, although here and there will be found detailed fragments of modern theory, they are often so purely fragmentary as to be quite unintelligible to the student. In fact, the book comes to resemble a conglomerate in its structure; and the student, in attempting to 'go through it,' meets with sudden and remarkable changes in hardness and density. The fact is, the change which has been going on in the science of physics during the last fifteen or twenty years does not consist alone in the series of brilliant discoveries and inventions which have brought it glory and renown: along with these there