friction of the collar of the eccentric, a rolling friction, by means of friction rollers.

When this wheel is at rest, owing to its floats being able to pivot, the wheel becomes a kind of lee-board, when the directing curve has been so adjusted as to cause the lower floats to assume a position in a line with the keel of the vessel. This much facilitates the progress of the vessel under sail, especially if it is not provided with a high keel, and draws but little water.

M. Segulier's vessel, (the lines of which were laid down by M. de la Morinière, ex-engineer in chief of the Navy,) may be propelled either by the wind and steam combined, or by either separately.—*Bulletin de la Société d'Encouragement.* Lond. Journ. Arts & Sci.

On an Easy Method of Measuring the Distance and Height of an Elevated Point, Accessible or Inaccessible, Fixed or Movable, by Means of a Single Instrument, and by taking the Observation from only one Station. By M. ELIE WARTMANN, Professor of Physics in the Academy of Geneva.*

Geodesical and astronomical operations very frequently require the knowledge of the distance of a remote object. If the object be fixed, the ordinary processes of trigonometry readily lead to the desired result. It is only necessary to determine a base, and to measure, from each of its extremities, the angle between the other extremity and the object; we thus obtain the value of two angles and of the adjacent side, from which the triangle is easily resolved.

But for the case in which the distant object is in motion—a case of great importance, and which occurs in several strategical and cosmological problems, the operation is by no means so simple. It would be necessary first to measure a straight line, more or less extended, and to station at its extremities two observers, who at the same instant should direct the telescopes of their theodolites to the same point of the object. When the point is simultaneously visible from the two stations, and the chronometers compared, and when, above all, the object preserves exactly its form, or only changes it imperceptibly, it is conceivable that this method may succeed; and the result will be more exact as the readings are repeated at shorter intervals, in order to lessen the probable errors by means. But when these different circumstances do not exist, when there is only a single observer, or the object varies in appearance, or is not visible at the same time from both extremities of the base, then the execution of the process becomes impossible.

Such are the objections which may be made to the method proposed by M. Pouillet† for estimating the *height of the clouds*, a problem which

* Bulletin of the Sitzings of the Vaudois Society of Natural Sciences, tome i. p. 21. (Sitting of February 2, 1842.) See also Pogg. Ann., tome lvi. p. 635; and Gehler's Physikalisches Wörterbuch, tom. xi. p. 700.

† Note on the Height, Velocity, and Direction of the Clouds; Comptes Rendus de l'Académie des Sciences, Paris, tom. xi. p. 717, (Nov. 9, 1840.)

has already attracted the attention of several eminent philosophers, such as James Bernoulli,* Brice,† Lambert,‡ and more recently M. Arago.§ The following is the method which I propose for its solution.

Let us select in a motionless cloud, or in one which does not move with too great velocity, any point N, fig. 1, distinguishable by its color

or peculiar form. Let us place ourselves on an elevated point P, on the summit of a hill or tower, or even at the window of the upper story of a house. Let us have under us a reflecting plane MM', such as a tranquil surface of water or mercury, or a large horizontal glass. The angle of incidence of a luminous ray which strikes a mirror being equal to the angle of reflection, it will suffice to determine the angle d formed by the ray which reaches the eye directly from the point N, with the ray PI which reaches it by reflexion in I, and to estimate the length PI, in order to solve the problem.

In fact, calling e the angle formed by the reflected ray PI with the vertical PS, which passes through the centre of the instrument with which the angle is taken, it is evident that the angle l contained by the incident and reflected rays $= 2e$. The two angles d and l being known, it only remains to measure PI. As it might be difficult to determine precisely the point I of the reflecting surface, we may turn the telescope round the vertical, keeping the angle e constant, and seek the length PL or PE of the line joining the point P with the object L or E situated on its margin, (fig. 2.) If the observer is on the top of a vertical wall, or on a tower or house, he will only have to measure its height above the reflecting plane $PS = h$ to deduce

$$PI = \frac{PS}{\cos e} = \frac{h}{\cos e}$$

* Acta Eruditorum, 1688.

† Philosophical Transactions, 1766.

‡ Memoirs of the Academy of Berlin, 1773.

§ Comptes Rendus, tom. xi. p. 323, (August 24, 1840.) Annual of the Bureau on Longitudes, 1840, p. 316.

This value being known, we deduce from it

$$h = PI \cos e.$$

In like manner since the incident ray

$$IN = PI \frac{\sin d}{\sin (d + l)},$$

therefore the vertical height $NQ = H$ of the cloud above the mirror is

$$H = IN \cos e = h \frac{\sin d}{\sin (d + l)},$$

and its height $\Delta = H - h$ above the observer

$$\Delta = h \left\{ \frac{\sin d}{\sin (d + l)} - 1 \right\}.$$

It is sufficient in practice to employ a circle placed vertically and furnished with a tube without lenses. A metallic plate, blackened, and pierced at its centre with a small hole, serves instead of an eye-glass. The tube, the interior of which is likewise black, is furnished with cross wires, and a sufficient length is given it to admit only the useful rays, and not those which are reflected by objects surrounding the point which is observed. The reflecting surface may be a pond, a lake, a large sheet of water, or mercury, &c.

Besides its simplicity, the process which I have described, and which evidently applies in the same cases as the other methods which have been proposed, appears to me to offer some advantages over them.—It is absolutely independent of the presence of the sun above the horizon. The larger the base to be measured PI , the greater will be the approximation. If the point N is only slowly moved, we may employ Borda's method for the repetition of the angles, and thus limit more nearly their exact value: we may, moreover, observe at short intervals of time, and determine the velocity of translation of the object,—a circumstance which it is often useful to ascertain. We remark, lastly, that there is no longer any possibility for a single observer to confound the point of vision with other surrounding points. Now this confusion frequently occurs in the case of a fleeting cloud, and which requires less time to lose its form than is required, in M. Pouillet's method, for two observers to regain their post and observe, after having met to make their arrangements.

If the wind or any other cause prevents the employment of a liquid as the mirror, a very smooth silvered glass might be substituted, of as large dimensions as possible, and be placed horizontally by means of levels or screws, or thin wedges.

Professor Whewell has very recently proposed* to ascertain the height of the clouds, or of a mountain, by means of the formula

$$H = h \frac{\sin (\alpha + \beta)}{\sin (\alpha - \beta)},$$

in which

H is the height of the cloud above a horizontal mirror,

h the vertical height of the observer above this mirror,

* Reports of the British Association for 1846; Transactions of the Sections, p. 15.

α the angle of depression of the image of any point of the cloud below the horizontal plane passing by the eye of the observer,

β the angle of elevation of the same point above this plane.

It is evident that this formula is identical with that* which I published four years ago, and which has been reproduced in the scientific journals of Germany. The learned Master of Trinity forgot that, at the time when he made his communication to the Section of Physics of the British Association, at Southampton, I informed him that what he proposed as new was already in print.

Lond. Edin. & Dub. Phil. Mag.

Account of the Cost and Durability of Banks's Patent Steel Tyres for Railway Wheels.

Mr. Fothergill read the following paper before the Institution of Mechanical Engineers, Birmingham. The statement of facts relative to Mr. Thomas Banks's patent plant of steeling the tyres of Railway wheels, is the result of nearly five years' trial, and shows the cost and durability of Staffordshire tyres, steeled on his plan, as compared with Low Moor tyres.

The present cost of Low Moor tyres, for 3-foot wheels, will be—

Four tyres of 3 cwt. each—12 cwt., at 22s.	£ 13 4 0
Putting on the tyres ready for work,	8 0 0
Twice turning up, after wearing hollow,	1 0 0
Total cost,	£22 4 0

Suppose these tyres to run 50,000 miles on an average—that is, 50,000 miles at a cost of £22 4s.

The present cost of Staffordshire tyres will be—

Four tyres of 3 cwt. each—12 cwt., at 12s.	£7 4 0
Putting on the tyres ready for work,	8 0 0
Steel for steeling one set—1½ cwt., at 42s.	3 3 0
Man's wages, for turning grooves in the wheels,	0 10 0
Smith's wages, for inserting the steel,	0 10 0
Man's wages, for turning up after steeling,	0 10 0
Men's wages, for drilling and rivetting,	0 7 6
Total cost,	£20 4 6

These tyres are proved to run, before steeling, 18,000 miles, and after steeling, 100,000 miles—making a total work of 118,000 miles, at a cost of £20 4s. 6d. Now subtracting 50,000 miles—the work of Low Moor tyres—from 118,000—the work of Staffordshire tyres steeled—we have 68,000 miles, which the latter will run more than the former, and at a cost of 39s. 6d. per set less. From the above statement, we see the cost of Low Moor tyres per 1000 miles, is 8s. 10½d.; whilst the cost of Staffordshire tyres, steeled, is only 3s. 5¼d. per 1000 miles. The truth of this statement is proved by a test of nearly five years' trial, on those lines on which the plan has been most used. We are

* Reports of the British Association for 1846; Transactions of the Sections, p. 15.

† For the specification, See Journ. Frank. Inst., 3rd Series, Vol. vi, p. 212.