and taking Fort Assinaboine as a starting-point, we obtain the following lines of advance: —

HOURS FROM FORT ASSINABOINE.

10.	20.	30.	40.	50.
St. Vincent, Minn. Huron, Dak. North Platte, Neb. Cheyenne, Wyo.	Duluth, Minn. St. Paul, Minn. Leavenworth, Kan. Fort Sill, Tex. Santa Fé, New Mex.	Marquette, Mich. Milwaukee, Wis. Chicago, Ill. Memphis, Tenn. Denison, Tex. Concho, Tex.	Erie, Penn. Pittsburg, Penn. Knoxville, Tenn. Vicksburg, Miss. Brackettville, Tex.	Rochester, N.Y. Washington, D.C. Charlotte, N.C. Augusta, Ga. Mobile, Ala.

This shows that in November, 1881, the cold waves were about two days in travelling from Fort Assinaboine to Washington. It would be an interesting comparison if a like investigation were undertaken for waves of heat, also, during other months of the year. A similar method may be applied to the advance of waves of high and low pressure, with the great advantage that clouds would not interfere with the determination of the time of passage.

This subject has attracted much attention from time to time, and recently it has been taken up by Mr. A. N. Pearson of India (*Nature*, Aug. 9, 1883).

The chief signal-officer has kindly permitted this publication in advance of a more extended investigation. H. A. HAZEN.

TISSANDIER'S ELECTRIC BALLOON.[1]— I.

IN describing recently the new hydrogen-gas apparatus which we had constructed in our workrooms at Paris-Auteuil, we mentioned that the governable electric balloon, which has been in preparation since the electrical exposition, was ready for trial. This took place the 8th of last October.

The arrangement of the controllable electric balloon consists of three distinct pieces of apparatus, — the air-balloon, properly so called; the gas apparatus to inflate it; and the electric motor to supply freedom of motion by means of a screw.

The construction of an elongated aerial ship presented serious difficulties. We were aided by two experiments, — that of Mr. Henri Giffard in 1852, and that of Mr. Dupuy de Lôme in 1872. In the model which we tried at the time of the electrical exposition, we arranged for the suspension of the little boat a low rod, running longitudina similar to that of the air steamship of Mr. Giffard. We afterward concluded that it would be better to place the screw behind a large parallelopiped-shaped boat, high enough to protect the propeller against the danger of a shock on descent. The boat, in this case, is connected to the balloon by suspension-cords running obliquely; and the deformations of the arrangement are escaped by means of a flexible shaft fixed at either side of the balloon. The balloon was constructed by my brother, in the rooms of Mr. H. Lachambre, to whom was intrusted the making of the new air-ship. A model 15 cubic metres in capacity was first made; and, after studying the action of this in a captive state, the construction of the large balloon (fig. 1) was begun. Its shape was like that of Mr. Giffard's and Mr. De Lôme's balloons: it was 28 metres long, and 9.2 metres in diameter through the middle. On its lower surface, there is a cone with an automatic valve: it is made of a thin cloth, rendered impermeable by a new varnish prepared by Mr. Arnoul of Saint-Ouen-l'Anmône. The capacity of the balloon is 1,060 cubic metres.

The netting over the balloon is formed of ribbons woven with longitudinal spindles, which keep them in their proper geometric positions. The ribbons thus easily adapt themselves to the inflated material, and do not form projections, as do the meshes of a net. The netting is connected on the sides of the balloon with two flexible shafts, which perfectly conform to its shape, passing along the centre of each side. The shafts are made of thin walnut laths fitted with bamboo: they are connected by silk belts. At the lower end of the netting are intersecting rods, at the ends of which are twenty suspension-ropes connected in groups of five to the four upper corners of the car. This latter is in the form of a cage made of bundles of bamboo rods, strengthened by cords and threads of copper covered with gutta-percha. The lower part is made of walnut cross-pieces, which support the willow basket. The suspension-ropes entirely cover the boat: they are woven into the basket, being previously sheathed in caoutchouc, which, in case of accident, protects them from the acid liquid centained in the boat to feed the batteries. The suspension-ropes are connected horizontally by rigging about two metres above the boat. The guide and anchor ropes are attached to this rigging, which also serves to equally distribute the traction during the descent. The rudder, a broad surface of unvarnished silk supported by bamboo, is also arranged behind. The weights of the different parts are as follows: —

[1] Translated from *La Nature*.

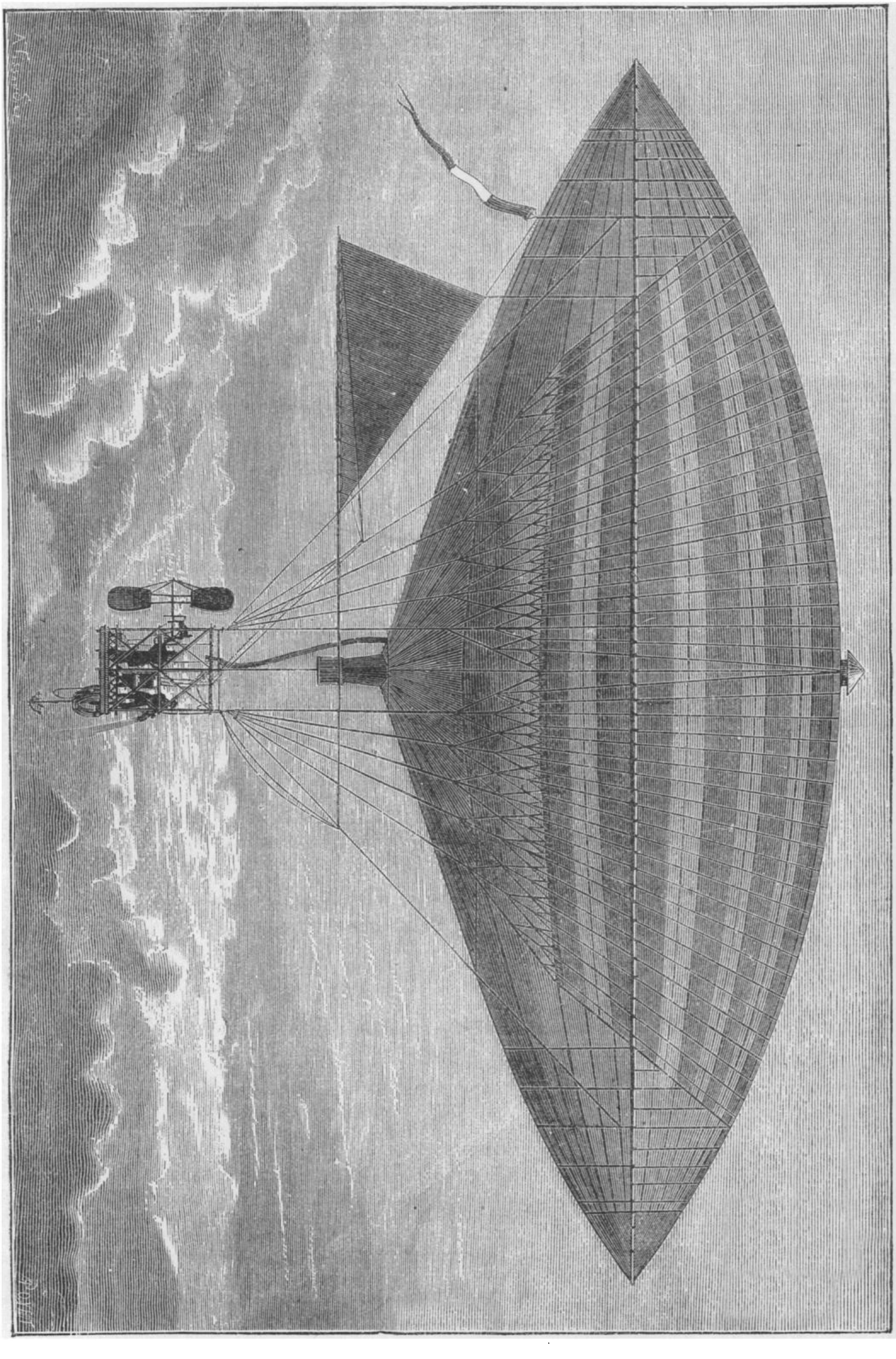

FIG. 1.—TISSANDIER'S FLYING BALLOON AS USED OCT. 8, 1883.

	Kilograms.	
Balloon, with the valves	170	
Cover, with rudder and suspension-ropes	70	
Flexible side-shafts	34	
Car	100	
Motor, screw, and batteries, with liquid for 2 h. 30 m.	280	
Stopping-machinery (anchor and guide rope),	50	
Weight of material	——	704
Two passengers, with instruments		150
Ballast		386
Total weight		1,240

Allowing 10 kilograms, the lifting-force was 1,250 kilograms. The capacity of the balloon being 1,060 metres, the gas had a lifting-force of 1,180 grams per cubic metre, — a result not hitherto obtained in the production of large quantities of hydrogen.

By the end of September the gas apparatus was ready for trial; the balloon was stretched out on the ground under a long tent, in order that it might be immediately inflated; the boat and the motor were stowed under a cart-house; and my brother and I were only awaiting good weather to make the trial. On the 6th of October there was a rise of barometer; on the 7th the weather was fine, with light wind; and we decided to make the experiment the following day, Oct. 8, 1883.

The inflation of the balloon began at eight o'clock in the morning, and continued, without pause, till half-past two in the afternoon. This operation was expedited by means of the equatorial ropes hanging at the right and left of the balloon, and to which were attached the ballast-bags. (The ropes are shown in fig. 2, which also presents the spindle-shaped balloon as seen from one end.) The inflation completed, we proceeded to arrange the boat and the ebonite tanks, each of which contains thirty litres of the acid solution of bichromate of potassium. At twenty minutes past three, having heaped in the ballast and obtained equilibrium, we were slowly raised into the air, a light east-south-east wind blowing. On the ground there was almost no wind; but, as frequently happens, it increased with the altitude; and we found, when the balloon had risen five hundred metres, that it attained a velocity of three metres a second.

My brother was especially engaged in regulating the ballast, in order to keep a constant low altitude. The balloon was kept very regularly at a height of four or five hundred metres. It remained perfectly inflated; and the superfluous gas escaped by opening, under its pressure, the automatic valve, the action of which was very uniform.

Several minutes after the departure, I tried the bichromate of potassium batteries, composed of four troughs with six compartments, making twenty-four elements in circuit. A mercury commutator enabled us to use at pleasure six, twelve, eighteen, or twenty-four elements, and thus to obtain four different speeds of the screw, varying from sixty to a hundred and eighty revolutions per minute. With twelve elements, we found that the speed of the balloon was insufficient; but above the Bois de Boulogne, when our motor was working with great speed, with twenty-four elements a very different effect was produced. The movement of the balloon became suddenly appreciable, and we felt a fresh breeze produced by our horizontal motion. With the balloon head to the wind, pointing toward the belfry of the church of the Auteuil, near our starting-point, we remained

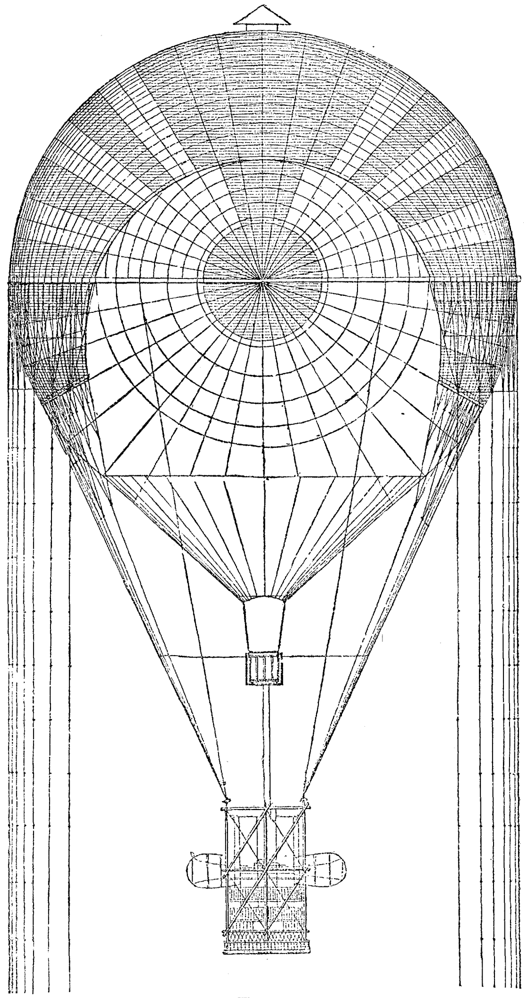

FIG. 2.

motionless, as we proved by noting conspicuous points beneath our car. Unfortunately it did not long maintain this position; but, after acting well for several instants, it suddenly began gyratory motions which the rudder was powerless to completely control. In spite of the rotations which in later trials we were able to prevent, we tried the same experiment for more than twenty minutes, during which we could perceive that we were over the Bois de Boulogne. When we tried to change our position by cutting the wind perpendicularly to its direction, the rudder became inflated like a sail, and the rotations were produced with much greater violence. From this we assume that the position which an air-ship ought to occupy should be such that its major axis may make with the line of the wind an angle of several degrees.

After the experiments we have just described, we stopped the motor, and the balloon passed over Mont-Valérien. Once, when it had taken the direction of the wind, we began again to turn the screw, proceeding this time with the current. The speed of the balloon was increased, and by means of the rudder we were now easily able to turn to the right or left from the line of the wind. We proved this by taking, as before, some point on the surface; and several spectators also verified it.

At thirty-five minutes past four we made the descent in a large plain near Croissy-sur-Seine. The operation of landing was conducted by my brother with great success. We left the balloon inflated over night, and the next day it had not lost the least gas. Painters and photographers were enabled to obtain views of our air-ship, which was surrounded by a numerous and sympathetic assembly which the novel sight had attracted from all sides.

We had intended to make a new ascent on this day: but, on account of the cold of the night, the bichromate of potassium in our ebonite tanks had crystallized; and the battery, which was by no means exhausted, was on this account, however, incapable of action. We drew the balloon to the shore of the Seine, near the bridge of Croissy; and there, to our great regret, we were obliged to discharge the gas, and to lose in a few instants what had required so much care in its preparation.

Without describing in greater detail our return, we have concluded from this first trial that, 1°, electricity furnishes a balloon with the most convenient power, the management of which in the car is remarkably easy; 2°, in our own case, when our screw, 2.8 metres in diameter, made a hundred and eighty revolutions per minute, we were able to keep head to a wind moving three metres per second, and, when proceeding with the current, to deviate from the line of the wind with great ease; 3°, the mode of suspension of a car from an elongated balloon by means of bands running obliquely, and supported by flexible side-shafts, insures perfect stability to the whole.

We ought to say that our ascent of Oct. 8 should be considered only as a preliminary trial, which will be repeated with the alterations which our experience commends. In addition, we would mention that there was in the car a considerable excess of ballast, and that eventually it will be possible for us to use a much more powerful motor. Aerial navigation will not be made practicable through a single attempt: it will require many trials and efforts and great perseverance under every ordeal.

(*To be continued.*)

THE DISCOVERY OF THE GERM OF SWINE-PLAGUE.

IN a communication read before the Paris academy of sciences, Nov. 26, 1883, by M. Pasteur, the following paragraph occurs: —

"As soon as I received his [Thuillier's] first letters from the commune of Peux, in the department of Vienne, it was certain that he had perceived in the blood and humors of the dead hogs a new microbion which it seemed should be the author of the disease. This microbion had escaped the observation of Dr. Klein of London, in the course of a long and remarkable account of autopsies and experiments published three years before in the report of the English sanitary office. Dr. Klein stated that a microbion was the cause of the affection; but he committed an error, for the microbion that he described has no connection with the cause of *rouget*. Thuillier by his observation had overcome the principal difficulty to a knowledge of this disease of the hog. Historic truth, however, obliges me to declare, that in 1882, and also in the month of March, the microbion of *rouget* was signalled at Chicago, in America, by Professor Detmers, in a paper which does great honor to its author. Thuillier could not have been acquainted with this paper, and I myself only learned of its existence very recently. The observation of the microbion of *rouget* of the hog by Thuillier dates from the 15th of March, 1882."[1]

It is so very seldom that investigations on this side of the water receive any notice whatever abroad, and particularly in France, that it seems a pity even to call attention to the very great injustice done to American work in the above statement, since any recognition at all is so much better than being quietly ignored. There is, however, so much of general interest in regard to the gradual development of our knowledge of the germ of this disease, so much of interest in the success and failures of those who have worked upon it, that, aside from our desire to see history correctly written, there is sufficient incentive for tracing the progress of this study, which commenced when the first real light was breaking upon the germ-theory of disease.

Dr. Klein deserves more credit for his share in the discovery of the micrococcus of swine-plague than M. Pasteur seems inclined to grant. In 1876 he published one of the first, if not the very first, reliable microscopic studies of this disease. The care and skill shown in this investigation are more apparent to-day than when the details were first published; and, although he subsequently made the unfortunate mistake of attributing the cause of the disease to a bacillus, this fact should not be allowed to weigh against his former and really valuable researches.[2]

In his account of the microscopic appearances of the intestine, the following sentence occurs: —

"From and even before the first signs of necrosis of the mucosa, viz., when the epithelium begins to break down and be shed from the surface, there are found masses of micrococci, which in some ulcers occupy a great portion of the *débris*."[3]

A little farther on he says, —

"There is one more point which I believe deserves careful attention. In the ulceration of the tongue just mentioned, and at a time when the superficial scab has not become removed, I have seen masses of micrococci situate chiefly in the tissue of the papillae, but at some places reaching as far deep as the inflam-

[1] *La vaccination du rouget des porcs à l'aide du virus mortel atténué de cette maladie.* PASTEUR et THUILLIER. *Comptes rendus*, xcvii. p. 1164.

[2] Report on the so-called enteric or typhoid-fever of the pig, by DR. KLEIN. In Reports of the medical officer of the privy council and local government board. New series, No. VIII. Report to the Lords of the council on scientific investigations, etc., 1876, pp. 91–101.

[3] Loc. cit., p. 98.