have ascended in the balloon from Alexandria itself, when the observers could have seen, not merely fourteen, but fifty or sixty miles easily.

The CHAIRMAN said the business of the evening was now closed. They were not able to congratulate themselves as yet on the art of flight, but they were able to say that a great number of them were working at it, many of them in the dark in more than one sense. The Meeting was not so large that night as usual, but they had the satisfaction of knowing that they had workers always about them. He was asked to mention that Mr. Linfield's apparatus for aëronautics on a large scale would be exhibited at the approaching Engineering Meeting at the Agricultural Hall. They might now consider the Meeting closed.

On the motion of Mr. Frost, seconded by Mr. Simmons, a vote of thanks was given to the Chairman, who briefly acknowledged the compliment, and the Meeting terminated.

"MEMOIR OF THE LATE JOHN STRINGFELLOW."

By FRED. W. BREAREY.

On the 13th December, 1883, passed away the life of one whose later aspirations were fixed more upon the attainment of success in a special mechanical problem than upon the acquisition of wealth. Yet, though in comfortable circumstances, John Stringfellow, of Chard, in Somersetshire—like some of his Sheffield contemporaries, whose now familiar names we have heard him mention as schoolfellows—had his pursuit been wealth, might have vied with many in its attainment.

He was born at Attercliffe, near Sheffield, the 6th December, 1799.

He was in the foremost ranks of that army of observation which had studied the conditions of flight with a view to its imitation. But despairing apparently of accomplishing the end by the adaptation of wing action, he strove with Henson to obtain a bearing upon the air by the propulsion of a plane of dimensions deemed suitable to sustain a given weight per square foot of surface. The difficulty recorded in their experiments arose in the attempt, upon a large scale, to preserve a rigid plane surface. In 1844, he and Henson commenced the construction of a model, the former undertaking the manufacture of a steam engine for propelling purposes, whilst Henson constructed the model. Their combined efforts sufficed for its completion in 1845. The model measured 20ft. from tip to tip of wing by 3½ft. wide, giving about 70 square feet of sustaining surface in the wings, and about 10 more in the tail. The weight of the model, provided with its engine, fuel, and water, was from 25 to 28 pounds. This is a very large sustaining surface in proportion to weight, but in this respect all was tentative. Mr. Stringfellow, in his efforts to determine this question upon some well ascertained basis, had frequently availed himself of the express train, taking with him an arrangement for testing the resistance of various angles against the air at high speeds, but he said that those experiments only tended to prove that any guess work was better than the calculations made by writers upon the subject.

However, to give the model a fair trial, a tent was erected on the Downs two miles from Chard, and for seven weeks these two continued their experiments, though greatly annoyed by lookers on. As it was necessary to provide initial force, an inclined plane was constructed, down which

the machine was to glide, and the velocity was to be maintained by the steam engine working two four-bladed propellers, each 3ft. in diameter, at 300 revolutions per minute. It was found, however, that they could not maintain a rigid surface with the silk. Sometimes it was saturated with moisture, and the framework was altogether too weak. The steam engine was the best part. The absence of success was not for want of power, but for want of proper adaptation of the means to the end. Many trials by day showed a faulty construction, and its lightness proved an obstacle to its successfully contending with the ground currents.

Shortly after this Mr. Henson left for America, and Mr. Stringfellow, not disheartened, and in possession of his steam engine, renewed his experiments.

In 1846 his new model was shaped like the wings of a bird, 10ft. from tip to tip, feathered at the posterior edge, and curved a little on the under side. The surface was two feet across at its widest part, and contained seventeen square feet. The propellers were 16in. in diameter, with four blades three-fourths the area of circumference set at an angle of 60 degrees.

The cylinder of the steam engine was three-fourths of an inch in diameter; length of stroke 2 inches; level gear on crank-shaft giving three revolutions of the propellers to one stroke of the engine. The weight of the entire model and engine was 6 pounds; and with water and fuel it did not exceed $6\frac{1}{2}$ pounds.

The room which he had available for experiments did not measure above 22 yards in length, and was rather contracted in height. In this room he fixed a horizontal wire down the centre for part of the distance, and so contrived that the model suspended whilst traversing it, should be

released automatically upon reaching a certain point. He found upon setting his engine in motion, that in one-third the length of its run the machine was enabled to sustain itself, and upon reaching the point of self-detachment, it gradually rose until it reached the further end of the room where there was a canvas fixed to receive it. It frequently rose as much as one in seven. The experiments were afterwards repeated at the solicitation of the manager, at Cremorne. There, when it reached its liberation point, it appeared to meet some obstruction, and threatened to come to the ground, but it soon recovered and darted in fair flight to a distance of about 40 yards, further than which it could not proceed. Finding but pecuniary loss and little honour attaching to these experiments, nothing further is heard of him until the year 1868. The announcement of the intention of the Aëronautical Society to hold an Exhibition at the Crystal Palace, of which he was informed by circular, aroused his old enthusiasm. In the meantime, by the perusal of an early number of the Society's Annual Report, he had become impressed with the value of Mr. Wenham's suggestion of superposed planes, conveyed in a Paper read at a General Meeting of the Society. It reads as follows:—"Having remarked how thin a stratum of air is displaced beneath the wings of a bird in rapid flight, it follows, that in order to obtain the necessary length of plane for supporting heavy weights, the surface may be superposed, or placed in parallel rows with an interval between them. A dozen pelicans may fly one above another without mutual impediment, as if framed together; and it is thus shown how two hundred-weight may be supported in a transverse distance of only 10ft."

This hint was sufficient for Mr. Stringfellow, and the result was seen at the Society's Exhibition in 1868, about which opinions differed. The effect of the superposed planes

was certainly not overwhelming, but Mr. Stringfellow's opinion was given to the author in the following words:—

"With respect to the superposed planes, I consider they are the most practical arrangement hitherto proposed for machines on a large scale, but I had always my doubts if they would be effective in a small model on account of their nearness to each other."

Here then was the true reason. It contained in its three planes a sustaining surface of 28 square feet in addition to the tail.

Its weight with engine, boiler, fuel, and water was under 12 pounds. In its steam engine it possessed one-third the power of a horse, whilst its weight was only that of a goose.

The sustaining surface was more than 2ft. to the pound, always supposing the limited space between the planes admitted of an independent effect of each plane upon the air. Whilst running suspended from the wire in the central transept at the Crystal Palace, its liberation was not permitted by the Company, but it had been observed by several Press Reporters to show a decided tendency to an upward course in its often repeated journeys.

However, in the basement afterwards, the author assisted to hold a canvas with which to break the fall of the model when liberated. When freed, it descended an incline with apparent lightness until caught in the canvas; but the impression conveyed was—that had there been sufficient fall, it would have recovered itself. In the author's experience, however, with every description of models, it is not sufficient to provide suitable surface to weight, even if accompanied with the motive power best calculated to convey it.

The balance must be found, and this means *repeated trials* under a condition of freedom of action. A model,

https://doi.org/10.1017/S2397930500001417 Published online by Cambridge University Press

especially in the air, is subject to varying conditions, which alter the equilibrium, and the balance can only be secured by intelligent control in the large machine which the model is constructed to represent. It was intended at the last to set this model free in the open country, when the requirements of the Exhibition were satisfied, but it was found that the engine, which had done much work, required repairs. Many months afterwards, in the presence of the author, an experiment was tried in a field at Chard, by means of wire stretched across it. The engine was fed with methylated spirits, and during some portion of its run under the wire, the draught occasioned thereby invariably extinguished the flames, and so these interesting trials were rendered abortive

The best of Mr. Stringfellow's Exhibits at the Aëronautical Exhibition, and which gained him the prize of £100, was his light steam engine for aerial purposes.

It was entered in the Catalogue thus "Light Engine and Machinery for Aërial Purposes, about half-horse power. Cylinder 2in. diameter, 3in. stroke, generating surface of boiler 3½ft., starts at 100lbs. pressure in three minutes, works two propellers of 3ft. diameter, about 300 revolutions per minute. With 3½ pints of water, and 10ozs. of liquid fuel, works about ten minutes. Weight of engine, boiler, water, and fuel, 16¼lbs.

The Council of the Aëronautical Society were announced as the adjudicators of the £100 prize for light engines, and upon this occasion it was represented by Mr. F H. Wenham.

The following is taken from the Report of the Exhibition:—

"The Engine No. 4, by Stringfellow, from its size and power, may be considered something more than a mere model. The cylinder is 2in. in diameter, stroke 3in., and works with a boiler pressure of 100lbs. per square inch, the engine

making 300 revolutions per minute. The time of getting up steam was noted; in three minutes after lighting the fire, the pressure was 30lbs., in five minutes 50lbs., and in seven minutes there was the full working pressure of 100lbs. When started, the engine had a fair amount of duty to perform in driving two four-bladed screw propellers 3ft. in diameter, at 300 revolutions per minute.'

"The data for estimating the power are taken as follows:—Area of piston 3in., pressure in cylinder 80lbs. per square inch, length of stroke 3in., velocity of piston 150ft. per minute, 3 × 80 × 150 = 36,000 foot-pounds; this makes rather more than one-horse power (which is reckoned as 33,000 foot-pounds). The weight of the engine and boiler was only 13lbs., and is probably the lightest steam engine that has ever been constructed. The engine, boiler, car. and propellers together were afterwards weighed, but without water and fuel, and were found to be 16lbs.

"At a Meeting of Council, held at Stafford House on the 20th of July, it was agreed that this engine, as a complete working machine, met with the condition of the Society's award, for 'the lightest engine in proportion to its power from whatever source the power may be derived.' The Prize of £100 was accordingly allotted to Mr. Stringfellow."

Although for some time after this period, the subject of this Memoir pursued his experiments according to his expressed determination, for which purpose he erected, out of the prize-money, a building over 70ft. long, he found his labour of love greatly aggravated by impaired sight, and it became painful for a looker-on to witness his distress when engaged in anything requiring minute investigation. It was easy to see that his work was done, and he knew it.

Three months before his death, he felt that the work he was executing for its improvement was a mistake, and to his

son he said "I've hung it up, Fred, I shall touch it no more. I hope I have not spoiled it for you."

Had his cunning not departed from him, many a light engine would have been turned out in satisfaction of the enquiries and demands of Aëronautical Inventors. But in that case nearly all would have been manufactured with his own hands, because he would never allow a workman to prosecute any part of his mechanical labour without taking the tool from his hands and completing it himself. This was a perpetual source of amusement to his sons, who were all practical mechanics. This may be an answer to enquirers as to the utility of the prize awarded to Mr. Stringfellow for his light steam engine. As far as the author knows, none have followed his initiative.

We who survive to pass judgment upon the results of a man's life, should be very careful how we exercise that judgment. It is much too solemn a retrospect for the toleration of a flippant analysis. All that we are justified in concluding, is that John Stringfellow considered that aërial navigation was capable of accomplishment, and that he gave much of time and means to its elucidation. In the future years, when this end is accomplished as it surely will—his name will be included in the roll of fame.

https://doi.org/10.1017/S2397930500001417 Published online by Cambridge University Press