

needed. There seems to be ample ventilation even in the remote portions.

These mines are also well situated for drainage, as the water naturally accumulates in the lower levels. The water is led from each level to the level above by a double system of force pumps. The volume pumped out daily is immense, and does not vary much with the seasons.

The miners use small portable oil lamps which can be hooked on the cap. Each one supplies his own oil.

The losses in this mine are very slight, and are more the result of mechanical crumbling of the coal, which forms unsalable fuel; very little coal is left standing in the mine.

The Mt. Diablo mines have produced, up to 1877, about 1,875,000 tons of coal.

The Black Diamond mine is under the management of Mr. M. Morgans, and it is due to his kindness that I have been able to obtain the above facts.—*J. O'Callaghan, in Mining and Scientific Press.*

TRIANGULAR BLAST-HOLES.

To effect this the boring bar or jumper is partly turned on each side of its cutting alternately. No difficulty is experienced in boring the holes to this shape, and they are found more effective than round holes—the corners forming points at which the fracture of the material operated on appears to commence, the line of fracture usually forming a prolongation of the sides of the triangle.

AERIAL NAVIGATION.*

By F. W. BREAREY, Honorary Secretary to the Aeronautical Society, London.

ARTIFICIAL FLIGHT.

In the paper which I read before the Aeronautical Society at the general meeting in 1878, I stated that, with respect to those of my models which are actuated by wing-movement, I had found a difficulty of sustaining the weight which appertains to the living example. But from experiments which I have lately made I find that the weight to be sustained depends upon power and strength of material employed, and also upon the right application of that power. For instance, in the wing-action of the bird, that portion of the pectoral muscle which depresses the wing is considerably more powerful than that which elevates it, because its function is to sustain the whole weight of the bird by impact upon the air. In my models I attain that action by affixing India-rubber cord, more or less in tension (according to the power used), underneath the wings, so that when the wings are elevated there shall be a strong downward impetus. There is, however, a disadvantage not shared by the bird—the upward stroke in the model absorbs much power in working against the tension of the India-rubber underneath. Given that power, and with material to endure the pressure, considerable weight can no doubt be sustained. What immediately concerns us, however, is this: Can the weight equal to that of a man and the additional power necessary to propel him be sustained by any material which man can construct light enough and strong enough?

Mr. Wenham, in his paper read at the first meeting of the Aeronautical Society, says: "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 surfaces may be superposed, or placed in parallel rows, with an interval between them. A dozen pelicans may fly one above the other without material impediment, as if framed together; and it is thus shown how two hundredweight may be supported in a transverse distance of only 10 feet." But I think that the difficulty of actuating the wings of these twelve mechanically imitated pelicans would present as great a difficulty as the vibration and construction of wings of the dimension of "60 feet from end to end, and 4 feet across at the widest part," which in the same paper Mr. Wenham estimates as necessary to support the weight of a man. If to this we add the weight of motive power—for it is evident that man does not possess the necessary power—we might, but for other encouraging reasons, give up the hope of his ever being able to navigate the air, because its possibility, in the way that a bird flies, is held to rest either up in the necessary surface extended laterally or else superposed, and in either case—were the difficulty overcome—there would remain the important question of balance, which in the bird is maintained, I believe, similarly to that unconscious muscular action in the sole of the foot and leg, when a man stands in an upright position. Under such a surface, therefore, there would be, I maintain, no safety.

I grant that a light and very powerful motor would favorably alter some of these conditions, because the rapid vibration of a much smaller surface would effect the same result, but increase of strength of structure would be necessary.

I had hoped that some rotatory action, which would have presented to the air in rapid succession all the equivalents of light by wing-surface, would have solved the difficulty; but the only attempt hitherto made in that direction has been effected by Mr. Moy, at a cost of several hundred pounds. The velocity which was requisite in its preliminary run was fatal to the attempt, because it could not be attained even if the machine had been effective on leaving the ground.

Then what has man to propose to evade these difficulties, which appear insuperable? Need I mention that he resorts to balloon propulsion in one of the various forms which are always recurring to minds who take freshly to the subject, and which are always supposed to be new?

Is there any need for me to dwell upon this negation of all hope for those who desire to navigate, and not to float and stagger about, in the air?

There remain, therefore, the advocates of the screw-propelled plane. For the lecture-room this is a very pretty and effective experiment, and I have propelled such for years with screws both fore and aft; but I have failed to see safety to life under such a surface, even were there not another objection, and that a fatal one, to their use.

I have always said that any aerial machine, to be safe, should have sufficient power to rise from the ground. It will then possess power to control its descent. But no plane has hitherto been devised capable of rising from the ground with any preliminary run which could be imparted to it. I have watched such experiments with much interest. Mr. Linfield's ambitious attempt failed to afford any indication of rising power, although he has traveled upon wheels at somewhere about 20 miles an hour, with a surface overhead of about 300 square feet set at an angle originally. The

dimensions are: Length, 40 feet; width, 18 feet; height, 15 feet. The weight of all, including Mr. Linfield, is 304 pounds.

Mr. Moy also tried with a model weighing $1\frac{1}{2}$ lb., also upon wheels, the screws actuated by twisted India-rubber, but he failed in my presence to effect any rise at all. He succeeded in attaining only 10 miles an hour.

The preliminary run with the velocity requisite for success seems to me to be fatal to any attempt of this nature—equally so any descent from an elevation—to attain the initial velocity.

The bird with extended wings does not rise by passively holding out his wings as a plane, but during his preliminary run he either slowly waves his wings or else tremulously vibrates them, which enables him to feel the air, and gradually to obtain a fulcrum upon it.

There is yet another group of inventors who hope, by presenting a suitable supporting surface to an accommodating breeze, to be lifted thereby, and then, by the aid of gravity and this friendly breeze, to sustain themselves like a kite, and even to progress when they get accustomed to the position.

For the last three years I have myself been a continuous experimenter, and one can scarcely work in any field of science without advancing a step in knowledge. Much more likely is the investigator to be rewarded if the field has been almost abandoned. Many a nugget has been dug out of a deserted claim. I will remark, however, in passing, that experimenters in flight are placed at a great disadvantage. The laboratory, or anything of the dimensions of a laboratory, would suffocate flight. Space and privacy are two necessities. The absence of these greatly deters progress, because for experiments in flight the object must fly; and we are necessarily, most of us, confined to models of small dimensions, which upon an increased scale would have more than a proportionate effect.

There is a mode of progression adopted by some fishes which is not reproduced by any flying creature, and in observing that motion—which was an undulating one—I asked myself whether in the air it would act also as a support? The fish is about the same gravity as the water; but how would the undulating motion of a loose fabric support a weight in the air? The result of my experiment was so satisfactory that it seems to me to get over the great difficulties that always suggest themselves in all plans except our own. For instance, in some designs which possessed encouraging features, there seemed a want of provision for a safe and gradual descent, so that a parachute naturally suggested itself as a necessary adjunct. But the addition of a parachute means weight, and also an incumbrance. In the loose material, however, which I employ, both for support and propulsion, there exists the parachute, which acts upon cessation of the motive power, and brings the machine down with a gently gliding motion in the direction of its travel.

In none of the plans which have been submitted to the Aeronautical Society has there been the slightest hint that flight could be attained by imparting a wave-like action to a loose surface extended in the direction of its length; nor do I well see how it would occur to any one to try the effect, unless he had been experimenting with flying models, so that he could readily substitute one arrangement for another. Certain it is that this discovery enables us to make a very large surface effective for support, which with wings alone appeared to be impossible. Of course, like every machine intended to find support in the air, it must be balanced; but in the model which I have made, such is its stability that an inch more or less does not affect it. So that we are at liberty to contemplate the construction of an aerial vehicle whose dimensions would suffice to maintain in wave motion six or seven hundred square feet of canvas, actuated by steam-power, and capable of supporting the additional weight of a man, whose weight, together with the machine, would certainly not exceed 500 lb.; and we can contemplate the man as being able to move a few feet backward or forward without much affecting the stability of the machine. His descent under the parachute action can thus be graduated at will. This can also be effected by a cord attached to the tail, which by that means can be elevated or depressed at pleasure. Placed upon wheels it has, of course, yet to be ascertained what distance of preliminary run would be required, assisted by the action of the fabric, before it would rise from the ground.

In Mr. Linfield's construction I see the framework required. The alteration would be flexible arms, and I think a looser arrangement of the cloth. The treadle action might or might not be able to vibrate the wing-arms. These flexible arms I construct of a bundle of canes, about 12 or 14 feet long, bound tightly together with whipcord throughout their whole length, and cutting off a cane every 2 feet or so in order to taper them. The wing-arm then affords lightness combined with strength, for it is almost impossible to fracture it. In this case we should be spared the weight of the screw, which is something considerable.

It has to be determined by experiment what velocity and what arc of vibration are best suited to the weight to be sustained. There will be also some relation between the arc of vibration of the wing-arm and the amount of surface in undulation.

In the model which I have made there exists a strong illustration of the assertion that any device made in miniature which will fly, can, when constructed upon a scale of utility, perform not only all, but much more than all, the promises extracted from it in the model form. In the first place, the experimenter is greatly in want of some motive power which will last sufficiently long to allow of close observation. Now in the recoil of the India-rubber which I have employed to produce the revolution of the crank which vibrates the arms, there exists only power sufficient to give a dozen strokes or so. And were I to increase the throw of the crank so as to increase the arc of vibration at the end of the wing, I should require so much greater power that either I could not with my own exertions wind it up, or else the parts would fail to bear the strain. For want of that continuous power I cannot say what amount of weight the model which I have made will carry, but I know this to a certainty, viz., that the weight to be carried depends upon the power and the strength of material for a given surface kept in a state of vibration. The weight of the larger model is 3 lb. $1\frac{1}{2}$ ounces, of which 7 ounces is added weight, which it easily carries. The dimensions are 6 feet wide by 10 feet long, with about 16 square feet of surface. By this arrangement of loose waving surface I have had the smaller model (5 x 8) fly from my hand perfectly horizontally to the extent of 60 feet.

What has assured me that there is a necessary relation between the arc of vibration, the velocity, the weight, and the surface, is the fact that through breakage I had to review the parts, and I have never since regained that chance

relationship; but the model appears to descend until the loose fabric is seen to hold the air, so that if the ballast is behind the center of effort the surface is forced outward at an angle of perhaps 10° . Upon stoppage of the motive power there would then be no parachute action, but the machine would descend tail first. The ballast, however, properly arranged, the velocity of the model is increased, and the head being heavier, and power ceasing, onward motion continues under the concave extension of the surface.

All this would be at the command of a man with a power upon which he could depend. It is probable that if this wave-action were used in addition to a wing about a foot wide, a greater impact upon the air at starting might assist the supporting effort.

I perhaps need scarcely say that the judgment must be formed not upon the duration of flight or the distance traveled, but upon the effect observed in any part of its short flight which with my limited power I am enabled to give the model. It then becomes evident that we should only require a continuance of the power.

I think that after fourteen years' study of the subject by the members of the Aeronautical Society we are now in a far more favorable position than we have ever yet been to form a fair estimate of the probabilities of success.

The conditions necessary for flight are pretty well understood. There remain but the mechanical difficulties. How far those difficulties have now been minimized can only be satisfactorily determined by actual experiment upon a scale commensurate with the importance of the subject. And with respect to the model which illustrates this wave-action we may predicate for it that—largely constructed with power, strength, and surface—there would be as much difference in the effect as between a child's halfpenny toy, with four paper vanes pinned to the end of a stick, and the windmill whose larger vanes grind our corn.

FIREPROOF PILLARS.

THE plan which we gave in the *Review* for June, of a safe pillar for architectural purposes—an interior solid core of wood and an outer thick shell of cast iron—has brought us several communications from manufacturers of composite "fireproof" pillars. In each case of these the center is a hollow circular iron core, with divergent flanges—the spaces between the latter being in one instance filled with oak wood bound with bands, and in others with fireproof blocks of clay or cement, duly clamped on with iron bands; and such posts are generally intended to be finished by plastering. We are glad to see these evidences of attention to an important subject, especially as one comes from Chicago, where such attention is much needed. We wish the manufacturers success, but think they have not commenced at the right point in their protective efforts. They seem to forget that the iron hoop clamps may burn off, and that anyway the heat, always above 180°F. , must reach the interior pillar; then there will be expansion, throwing off the covering, or if not, the heat—without actual contact of flame—must weaken greatly the iron, and all the weight being upon it, the probability is it would bend and break.

We still hold that an interior solid wooden post, with an exterior cast iron shell of one inch thickness, would be safer than any of the composite patent pillars exhibited to us. The great danger in a fire is, that intense heat—we will not say flame—would reach the iron through even fireproof clay, for every one has seen that material red hot in cylinders of stoves; then, according to our views, as expressed in another article in this *Review*, intense molecular vibrations must ensue, which would weaken the iron, and the superincumbent weight of three, four, or more stories would aid to bear down the pillar.

In the pillar we suggested, the iron resisting fire would be supported against the weakness of its cohesion for a much longer time than if it were not assisted by the interior solid post of wood; and although the iron might become red hot, it would still shield the wood from the fierce flame. The outer pillar, if red hot, could but char the exterior of the wooden post, for there would not be air enough to support flame between the iron and wood. Meantime, in such a fire the outer iron pillar being red hot, and confessedly useless to bear great weight, the wooden post has assumed all the burden and upheld all the weight, which is what we claim it will do in any ordinary fire. The outer iron shell being thus relieved from pressure, remains in its place as a shield from flame, although it may become, as just stated, red hot, or even up to a white heat. The principle of no space left for air between the wooden post and the iron shell, is a point we strongly insist upon in suggesting this form of pillar.

As an evidence of how heat will penetrate terra-cotta ware, we will mention that a fire took place in a laundry on Marble street, above Tenth, Philadelphia, July 14th, where the shingle roof was set on fire and some damage done through a stovepipe surrounded by a terra-cotta pipe, which ran close underneath the bare rafters and shingles.

The difference between "fireproofing" a wooden and an iron support is this: Wood is strong against heat up to flammability; iron is weak against heat, but is fusible only at very high temperature, and not flammable, or very slightly so. The covering of the iron column admits the heat to the iron; the iron covering the wood largely keeps the wood from flaming.—*American Ex. and Review.*

FURNACE FOR THE COMBUSTION OF REFUSE MATTERS.

THE animal and vegetable refuse from markets, the débris from kitchens, sweepings, and other materials of a like nature, which go to make up the waste matters of large cities, are objects of which all municipalities strive to rid themselves. At Paris these matters are calcined and form what is known as "Paris charcoal."

The apparatus shown on next page is designed for the combustion of all such refuse. It is the invention of Mr. R. Foote, of Stamford, Conn., who proposes therewith to destroy, by burning them, the waste products which accumulate in the vicinity of large cities, and to use no fuel in the process but the matters themselves, and this too without the production of disagreeable odors. As a general rule, organic matters superabound in these waste heaps, and often constitute ninety-four per cent. of the material; so there is always more combustible matter than is necessary for producing a heat sufficient to melt the mineral constituents. In producing a high degree of heat through the combustion of these organic matters, by means of a blast furnace, the non-combustible elements are fused and form scoriae, which are entirely odorless, inoffensive, and capable of being utilized in different ways. The upper portion of Mr. Foote's furnace is of forged iron supported by refractory bricks. The whole is placed upon an iron quadrilateral supported by iron

* A paper read before the Aeronautical Society of Great Britain.