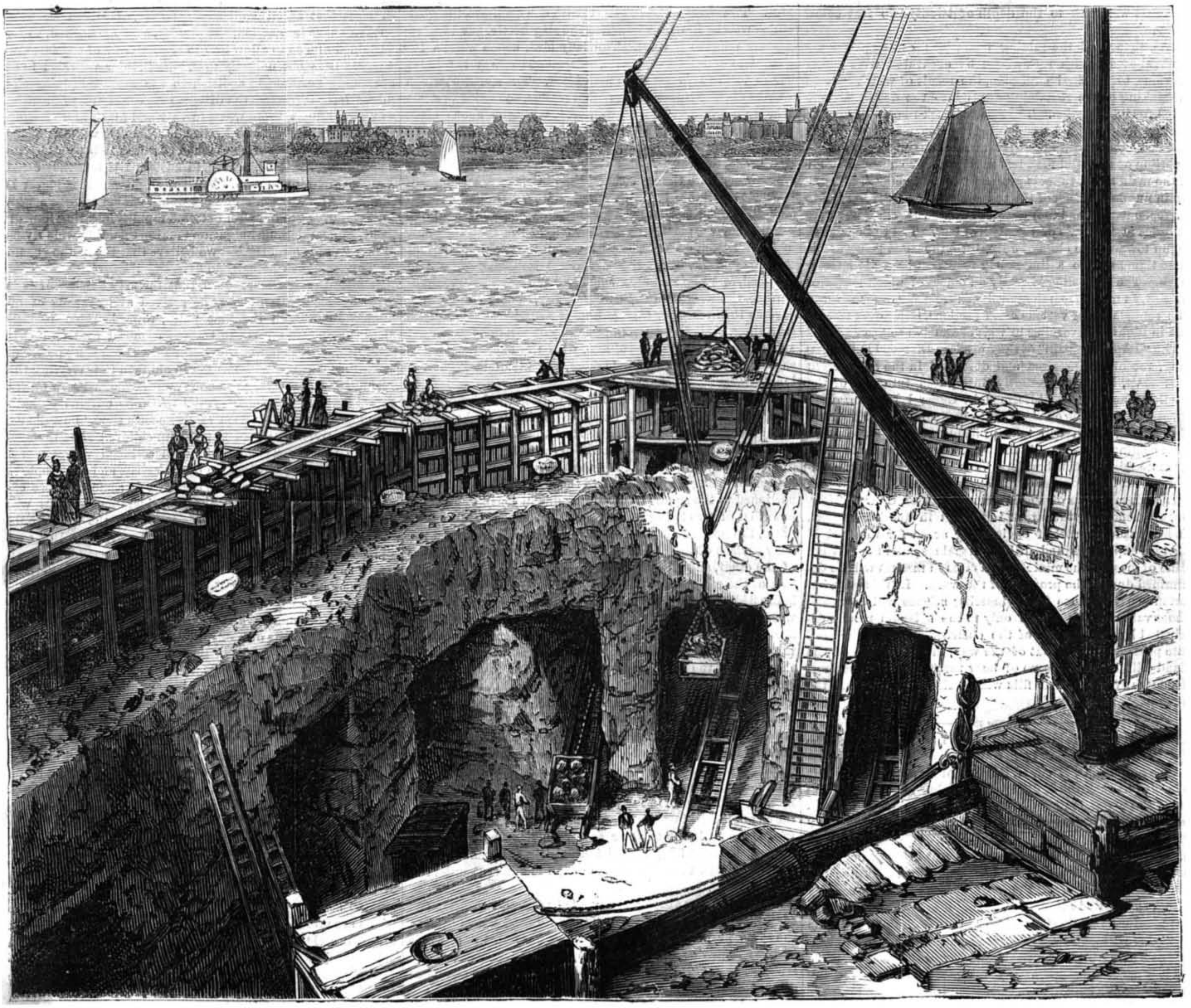
SCIENTIFIC AMERICAN

A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.

Vol. XXV.--No. 26. [NEW SERIES.] | NEW YORK, DECEMBER 23, 1871. | $3 per Annum. [IN ADVANCE.]



COFFER DAM, MAIN SHAFT, AND ENTRANCE TO HEADINGS, HELL GATE, EAST RIVER.

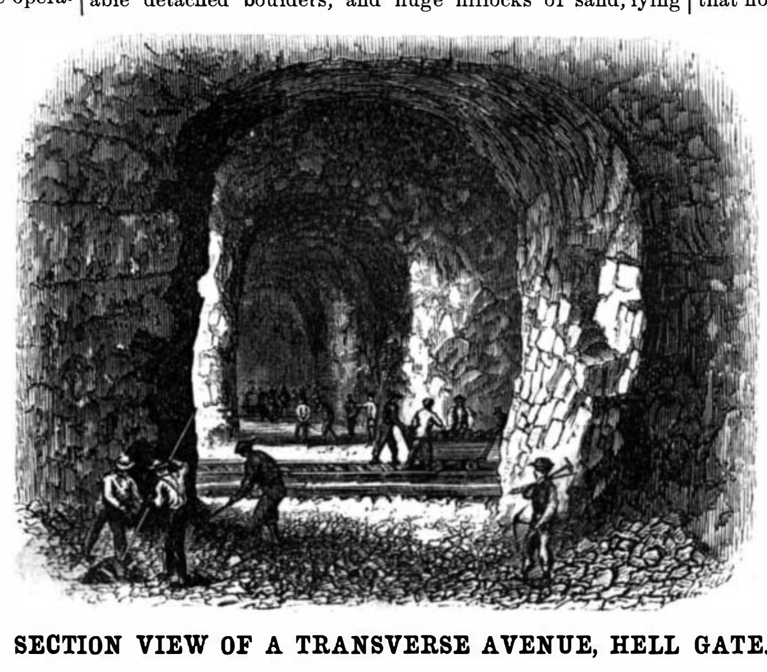
THE TUNNELING AND BLASTING OPERATIONS AT HELL GATE, EAST RIVER NEW YORK.

We give this week some engravings illustrating the operations now in progress for the removal of the obstructions at Hallett's Point, East River. Having often referred to this great work, our present notice will be rather historical and general than technical.

HISTORY OF THE WORK.

The following sketch of the origin and progress of the work is from the New York *Times:*

"Complete surveys of New York harbor have been made at different periods, as is well known, with the object of removing the obstructions to navigation, by Admirals Porter and Davis, Commodore Craven, and the present able and successful topographical engineer, General John Newton, of the United States army. In September, 1870, experimental blasts were made by General Newton, which proved to him beyond a doubt that the work he had undertaken, though a task of immense magnitude, could be accomplished, and at a comparatively trifling cost to the Government. Last May, General Newton commenced work with the steam drills on the dangerous rocks, in mid stream between Governor's Island and the Battery, known as Diamond Reef. After laboring assiduously for over five weeks, and making repeated blasts, between 700 and 800 yards square of the reef were blown away. Surveys were made of three blasts, which disclosed at the bottom of the river a mass of crushed rock, innumerable detached boulders, and huge hillocks of sand, lying around, and over which was once Diamond Reef. A contract was soon made to have the *débris* removed, a work which has almost been finished, and which has demonstrated the fact that no additional blasts will be required, and that the dreaded Diamond Reef is no more. Soon after the work of the drills upon Diamond Reef was concluded, the drill scows were securely moored over Coenties Reef, and immediately commenced operations. The number of cubic yards of rock to be removed at Coenties Reef is roughly estimated at over 3,000, and much of this has already been blasted out by General Newton's indefatigable workmen. Besides at Coenties Reef, General Newton's drills are now at work on the Shell Drake, Way's Reef, Hog's Back, Pot Rock, at the Hell Gate, or Horll Gatt as the old Dutch navigators termed it, and at Willett's Point. The operations at the Hell Gate are the most extensive, the most important, and decidedly the most interesting. The Hell Gate, as every New Yorker knows, is a narrow, rocky passage in the East River, and in the old Knickerbocker times its raging current was the terror of the Dutch skippers and their heavy and unwieldy craft. Of late years, many improvements have been effected by blasting away the surface rock, and the most salient points of the jagged ridges; but only since August, 1869, has the United States Government commenced to deal with the dangers of Hell Gate in a measure corresponding with their importance.



SECTION VIEW OF A TRANSVERSE AVENUE, HELL GATE.

The operations undertaken by General Newton at Hallett's Point, for the Hell Gate, involve the solution of an important problem of engineering as regards the most effective and economical process of submarine blasting. The *modus operandi* employed at Hallett's Point is entirely different from the manner in which the work of removing the obstructions has been accomplished at Diamond and Coenties Reefs, and is what is technically termed tunnel blasting. At Hallett's Point, in August, 1869, a coffer dam was commenced under the superintendence of General Newton, and was completed in October.

The dam is an irregular polygon in shape, having a circumference of 443 feet and a mean interior diameter of about 100 feet. The dam is built between low and high water marks. The excavation of the shaft immediately followed the construction of the dam, and during the spring of 1870 the shaft was sunk to the depth of twenty-two feet below water.

The theory of the mining operations contemplates the removal of as much rock as can be excavated with safety previous to the final explosion, the result of which will be the sinking of the remaining mass into the deep pit excavated for its reception. The mass of rock remaining for the final explosion will be supported by piers, each of which will be charged with nitro-glycerin. These piers are simply a portion of the solid rock left standing. From the bottom of the main shaft, tunnels proceed in all directions, and are ten in number. Each of the tunnels extends from 150 feet to 350 feet outward, and they are all connected together by cross-galleries at intervals of twenty-five feet. The tunnels were begun towards the close of July, 1870, the shaft being at the same time sunk to a line nearly forty feet below low water mark. The tunneling is really an object of a great deal of interest, as much from the novelty as from any other feature. The tunnels are of various cross sections, some over twenty feet in hight, and varying in width from ten to fifteen feet."

The "Improved Drill" of the American Diamond Drill Company, recently illustrated and described in the SCIENTIFIC AMERICAN, has been recently introduced into one of the headings, and, we are informed by General Newton, gives prospect of affording efficient aid in hastening the completion of the work, which will take probably two or three years more continuous labor. As the work advances, room is made for more miners, and therefore the rate of advance may increase with the progress of the excavation.

The liberal views of the Engineer in Chief, General Newton, are rendering this work important in another respect. He has made it a sort of engineering arena for the trial of different explosives and drilling machines; and the relative value of most of the mining appliances in market will be determined during the progress of the work. In this way, important contributions to engineering science will be made, whose value will be second only to the splendid results anticipated by the removal of the obstructions from the Hell Gate passage. These out of the way, the upper end of the island will become a scene of busy thrift, scarcely less prosperous than that which fills with unintermitting hum the lower part of the city.

The Holly System of Hydrants for Extinguishing Fires.

A correspondent, Mr. J. H. Balsley, of Dayton, Ohio, writes to inform us that the Holly system has been adopted in that city. Twenty-one miles of pipe have been laid, and the propelling power is a stationary engine, capable of producing a water pressure of 130 lbs. on the inch. A pressure of 80 lbs. on the inch will throw water 100 feet high, through 100 feet of hose, out of a one inch nozzle. With iron pipes to stand this pressure, all the connections must be equally strong, especially in buildings, as the bursting of a pipe under that pressure will flood a building in a few minutes. This apparatus will throw six or eight good fire streams when running at a safe speed. As the supply of water for domestic and manufacturing purposes is taken from these pipes, the engine must be kept always in motion to keep up a pressure sufficient for fire extinguishing purposes; in any other case, two sets of engines and pipes would be needed. The bursting of a four inch pipe will destroy the fire streams, and a large consumption for domestic or manufacturing purposes will have the same effect. The consumption of fuel in proportion to the water raised is considerable, and the expenses of the fire department, and the insurance premiums have not decreased in consequence of the introduction of this system.

THE ECLIPSE OF THE SUN.—In the number of our journal for October 21. of the present year, we informed our readers of the preparations being made, at home and abroad, for obtaining accurate and detailed accounts of the solar phenomena visible during the eclipse taking place on December 11; and we are glad to be able to report that the most favorable conditions existed during the critical period, and that perfect photographs of the corona were obtained. A party of astronomers, English, French, and Italian, journeyed to the East for the purpose of observing the eclipse, the most approved instruments having been forwarded in advance; and we hear, by telegraph *viâ* the Red Sea, that the desires of the party were fully satisfied, and that the settlement of several disputed facts as to the sun's composition, atmosphere, and luminosity may be looked for on the publication of the report. Mr. Norman Lockyer had charge of the expedition, Italy being represented by Signor Respighi, and France by M. Jannsen.

THE Russian Grand Duke, Prince Alexis, has contributed $5000 for distribution among the poor of New York city.

NOTES ON FLYING AND FLYING MACHINES.

[From the Cornhill Magazine.]

NUMBER II.

We owe to M. de Lucy, of Paris, the results of the first actual experiments carried out in this direction. The following account of his observations (made in the years 1868, 1869) is taken from a paper by Mr. Brearey, the Honorary Secretary to the Aëronaut cal Society. "M. de Lucy asserts," says Mr. Brearey, "that there is an unchangeable law to which he has never found any exception, amongst the considerable number of birds and insects whose weight and measurements he has taken—namely, that the smaller and lighter the winged animal is, the greater is the comparative extent of supporting surface. Thus in comparing insects with one another—the gnat, which weighs 460 times less than the stag beetle, has 14 times greater relative surface. The lady bird, which weighs 150 times less than the stag beetle, possesses 5 times more relative surface, etc. It is the same with birds. The sparrow, which weighs about ten times less than a pigeon, has twice as much relative surface. The pigeon, which weighs about eight times less than the stork, has twice as much relative surface. The sparrow, which weighs 339 times less than the Australian crane, possesses 7 times more relative surface, etc. If we now compare the insects and the birds, the gradation will become even more striking. The gnat, for example, which weighs 97,000 times less than the pigeon, has 40 times more relative surface; it weighs 3,000,000 times less than the crane of Australia, and possesses relatively 140 times more surface than this latter, which is the heaviest bird M. de Lucy had weighed, and was that also which had the smallest amount of surface, the weight being nearly 21 lbs., and the supporting surface 137 inches per kilogramme (2 lbs. 3¼ oz.). Yet of all travelling birds the Australian cranes undertake the longest and most remote journeys, and, with the exception of the eagles, elevate themselves highest, and maintain flight the longest."

M. de Lucy does not seem to have noticed the law to which these numbers point. It is exceedingly simple, and amounts in fact merely to this, that instead of the wing surface of a flying creature being proportioned to the weight, it should be proportioned to the surface of the body (or technically, that instead of being proportioned to the cube, it should be proportioned to the square of the linear dimensions). Thus, suppose that of two flying creatures one is 7 times as tall as the other, the proportions of their bodies being similar, then the body surface of the larger will be 49 times (or 7 times 7) that of the other, and the weight 343 times (or 7 times 7 times 7) that of the other. But instead of the extent of wing surface being 343 times as great, it is but 49 times as great. In other words, relatively to its weight, the smaller will have a wing surface 7 times greater than that of the larger. How closely this agrees with what is observed in nature will be seen by the case of the sparrow as compared with the Australian crane; for M. de Lucy's experiments show that the sparrow weighs 339 times less than the Australian crane, but has a relative wing surface 7 times greater.

It follows, in fact, from M. de Lucy's experiments that, as we see in nature, birds of similar shape should have wings similarly proportioned, and not wings corresponding to the relative weight of the birds. The same remark applies to insects; and we see, in fact, that the bee, the bluebottle, and the common fly—insects not unlike in their proportions—have wings proportioned to their surface dimensions; the same holding amongst long bodied insects, like the gnat and the dragon fly, and the same also among the different orders of flying beetles.

So that, setting apart differences of muscular capacity and adaptation, a man, in order to fly, would need wings bearing the same proportion to his body as we observe in the wings of the sparrow or the pigeon. In fact, the wings commonly assigned to angels by sculptors and painters would not be so disproportioned to the requirements of flight as has been commonly supposed, if only the muscular power of the human frame were well adapted to act upon wings so placed and shaped, and there were no actual inferiority in the power of human muscles (cross section for cross section) as compared with those birds.

So far as the practicability of actual flight on man's part is concerned, these two points are, indeed, among the most important that we have to consider. It was to Borelli's remarks on these points, in his famous treatise, *De Motu Animalium*, that the opinion so long entertained respecting the impracticability of flight must be referred. He compared the relative dimensions of the breast muscles of birds with those of corresponding muscles in man, and thence argued that man's frame is altogether unadapted to the use of wings. He compared also the relative muscular energy of birds and men, that is, the power of muscles of equal size in the bird and the man; and was yet further confirmed in the opinion that man can never be a flying animal.

But although the reasoning of Borelli suffices perfectly well to show that man can never fly by attaching pinions to his arms, and flapping these in imitation (however close) of a bird's action in flying, it by no means follows that man must be unable to fly when the most powerful muscles of his body are called into action to move suitably devised pinions. M. Besnier made a step in this direction (towards the close of the last century) when he employed, in his attempts to fly, those powerful muscles of the arm which are used in supporting a weight over the shoulder (as when a bricklayer carries a hod, or when a countryman carries a load of hay with a pitchfork). But the way in which he employed the muscles of the leg was less satisfactory. In his method, a long rod passed over each shoulder, folding pinions being attached to both ends of each rod. When either end of a rod was drawn down, the descending pinion opened, the ascending pinion at the other end closing; and the two rods were worked by alternate downward pulls with the arms and legs. The downward pull with the arms was exceedingly effective; but the downward pull with the legs was altogether feeble. For the body lying horizontally, the muscles used in the downward pull with the legs were those by which the leg is carried forward in walking, and these muscles have very little strength, as any one will see who, standing upright on one leg, tries, without bending the knee of the other, to push forward any considerable weight with the front of his leg.

Yet even with this imperfect contrivance Besnier achieved a partial success. His pinions did not, indeed, serve to raise him in the air; but when, by a sharp run forward, he had brought that aërial supporting power, of which we have spoken above into action, the pinions, sharply worked, so far sustained him as to allow him to cross a river of considerable width. It is not unlikely that, had Besnier provided fixed sustaining surfaces, in addition to the movable pinions, he might have increased the distance he could traverse. But, as regards flight, there was a further and much more serious defect in his apparatus. No means whatever were provided for propulsion. The wings tended to raise the body (this tendency only availing, however, to sustain it); but they could give no forward motion. With a slight modification, it is probable that Besnier's method would enable an active man to travel over ground with extreme rapidity, clearing impediments of considerable height, and taking tolerably wide rivers almost "in his stride;" but we believe that the method could never enable men actually to fly.

It may be remarked, indeed, that the art of flying, if it is ever attained, will probably be arrived at by means of attempts directed, in the first place, towards rapid passage along *terra firma*. As the trapeze gymnast avails himself of the supporting power of ropes, so the supporting power of the air may be called into action to aid men in traversing the ground. The following passage from Turnor's *Astra Castra* shows that our velocipedists might soon be outvied by half-flying pedestrians:—"Soon after Bacon's time," he tells us, "projects were instituted to train up children from their infancy in the exercise of flying with artificial wings, which seemed to be the favorite plan of the artists and philosophers of that day. If we credit the accounts of some of these experiments, it would seem that considerable progress was made that way. The individuals who used the wings could skim over the surface of the earth with a great deal of ease and celerity. This was accomplished by the combined faculties of running and flying. It is stated that, by an alternate continued motion of the wings against the air, and of the feet against the ground, they were enabled to move along with a striding motion, and with incredible speed."

A gymnast of our own day, Mr. Charles Spencer ("one of the best teachers of gymnastics in this country," says Mr. Brearey), has met with even more marked success, for he has been able to raise himself by the action of wings attached to his arms. The material of which these wings were made was too fragile for actual flight; and Mr. Spencer was prevented from making strong efforts because the wicker work, to which the apparatus was attached, fitting tightly round his body, caused pain, and obstructed his movements. Yet he tells us that, running down a small incline in the open air, and jumping from the ground, he has been able, by the action of the wings, to sustain flight for a distance of 150 feet; and when the apparatus was suspended in the transept of the Crystal Palace (in the spring of 1868), he was able, as we have said, to raise himself, though only to a slight extent, by the action of the wings. It should be remarked, however, that his apparatus seems very little adapted for its purpose, since the wings are attached to the arms in such sort that the weak breast muscles are chiefly called into play. Borelli's main objection applies in full to such a contrivance; and the wonder is that Mr. Spencer met with even a partial success. One would have expected rather that the prediction of a writer in the *Times* (calling himself Apteryx, or the Wingless) would have been fulfilled, and that "the aëronaut, if he flapped at all, would come to grief, like the sage in *Rasselas* and all others who have tried flying with artificial wing."

The objection founded on the relative weakness of the muscles of man as compared with those of birds (without reference to the question of adaptation), seems at first sight more serious. Although there can be little question that the superior strength of the muscles of birds has been in general enormously exaggerated, yet such a superiority undoubtedly exists to some degree. This gives the bird a clear advantage over man, insomuch that man can never hope by his unaided exertions to rival the bird in its own element. It by no means follows, however, that because man may never be able to rival the flight of the eagle or the condor, of the pigeon or the swallow, he must therefore needs be unable to fly at all.

It should be remembered, also, that men can avail themselves of contrivances by which a considerable velocity may be acquired at starting; and that when the aëronaut is once launched with adequate velocity, a comparatively moderate exertion of force may probably enable him to maintain that velocity, or even to increase it. In this case, a moderate exertion of force would also suffice to enable him to rise to a higher level. Te show that this is so, we need only return to the illustration drawn from the kite. If a weight be attached to a kite's tail, the kite, which will maintain a certain hight when the wind is blowing with a certain degree of force, will rise to a greater hight when the force of the wind is but slightly increased.

Kites afford, indeed, the most striking evidence of the ele-