is doubtless due to the formation of eddies of air flowing over the rigid lip.

It is obvious that a bird's wing, both as a gliding and a propelling surface, is a beautifully efficient instrument. To test these conclusions, Mr. Frost and Dr. Hutchinson in co-operation with Mr. D'Esterre in 1902 arranged the apparatus which is illustrated herewith. The experimenters used a pair of natural dried wings with an area of approximately three square feet, in conjunction with a small electric motor and a reduction gear to flap them up and down. The apparatus was suspended by a spring balance from a balanced arm. The following are the best results that were obtained by this crude experiment:

Volts.	Amps.	Estimated loss in motor and gear transmission.	Estimated horse power on wings.	Number of flaps per minute.	Maximum lift.
24	12	75 per cent	$\frac{1}{10}$	350 to 400	5 lbs.

The effect was striking. The bird flapped itself round and round, although it fell between the down strokes. But against this must be set the fact that its rate of progression was only four or five miles an hour, no doubt due to air resistance and friction, which were considerable, for the apparatus was primitive, while the bird also weighed about 21 pounds, which would of course tend to pull down on the up strokes, and the primary feathers were stiff. The oscillations, however, diminished to a very marked extent when the tail was fitted.

It will be observed that the ratio of horse-power to weight was one horse-power to 50 pounds. This ratio coincides with that given by various authorities as that obtaining with birds, and is not in marked contrast with the ratio obtained with the large machine of Messrs. Wright in this country.

Owing to the highly successful results obtained with this primitive apparatus, the investigators resolved upon a larger model with which to continue their researches, and this is shown in another photographic illustration. For the purposes of future experiments, this car is to be run on a special trough section track, and it is intended to arrange in the frame four vertical guides, one at each corner, of stretched cord or wire. The machine is suspended from a spring balance. The model, although possessing certain crudities in the motive portion, will serve adequately for the purposes of the tests it is intended to carry out. It is only intended to act as a testing model, from which some reliable conclusive data may be obtained.

The wings are of special construction, designed in accordance with the principles described in this article. They have a total wing area of about 60 square feet, while the machine measures approximately 20 feet across from tip to tip.

The motive power is transmitted from a gasoline motor of from 3 to 3½ horse-power, through a coned friction clutch and chains in two stages to the connecting rod. The crank throw is adjustable for altering the size of angle or flap. The top sprocket of the second motion can be raised or lowered for altering the limiting positions of the wings (i. e., the position of the arc). The lower end of the connecting rod actuates the inner ends of the levers for wagging the wings by a simple device of two oscillating roller-carrying links attached to the crosshead, whose pin is constrained by vertical guides. Attached to the brackets below the wings are "pectoral cords" of elastic. These serve to store up the energy on the up stroke, and so obviate too violent alterations of load in the driving mechanism.

The wings are at present adjusted to flap one hundred times per minute. This is of course considerably less than proportionately corresponding to the increased area and horse-power. But increased area does not necessarily imply proportionally increased resistance.

Some satisfactory results have already been obtained by means of this apparatus. When suspended from the bough of a tree and set in action under power, at each down stroke the whole machine, apart from the carriage weighing 232 pounds, was lifted bodily up into the air, and at the same time propelled forward. It rises about two feet with each stroke. At the down stroke the suspending rope left the vertical, and became markedly inclined. The pull on the rope then hauled the machine back, so that even if it were capable of flight, it could not fly under these conditions. At the down stroke it appeared that if the rope were then severed, the machine would travel up and away with the powerful sweep of the wings.

The spring balance here is obviously fallacious so far as registering the lift is concerned, because the rope exerts a restraining or backward pull on the machine. However, at the rough test already carried out, the balance showed a diminution of reading of from 80 to 160 pounds at the down stroke when the machine springs upward and also forward.

At the preliminary trial with this apparatus, the wings described a diminished angle as compared with that obtained with the first and smaller model. But with this angle and a velocity of one hundred flaps per minute the wings were capable of evoking a resistance of about 100 pounds each, and the machine was raised about two feet at each stroke. The conditions, however, at this test were not favorable to the machine, as it was near the ground in eddying air, and was not free to get proper forward velocity.

The investigators are of opinion that a feathered wing made of a number of units can exert a greater resistance than a single wing such as that of the insect or bat type, or the various mechanical wings that have hitherto been adopted in wing flapping machines. They are also inclined to the contention that resistance is more dependent on periphery of an aeroplane than on its superficial extent. Furthermore, the primary feathers almost certainly act as a series of stepped aeroplanes, each acting on air from a different level, which has not had a downward velocity imparted to it by having had to sustain the weight of a previously acting supporting surface.

Considerable interest is being evinced in the experiments with this machine in aeronautical circles in England. It is anticipated that some highly interesting data concerning aerial flight will be gathered from the tests that will be carried out by these investigators with this apparatus.

Peat in the United States.

The peat industry can hardly be said to exist in the United States at the present time. A few small operations are now going on, however, and a great number of prospective schemes are being exploited, so that a paper by Mr. Henry H. Hindshaw entitled "Peat in the United States in 1904," which the United States Geological Survey brings out as an extract from the forthcoming volume "Mineral Resources of the United States, 1904," should find numerous readers.

A number of companies have been organized in the Middle and Northwestern States to produce peat fuel by various methods. Some of these are building plants to operate during the summer of 1905. Others do not seem to have advanced beyond the prospectus stage. Many of them promise extraordinary profits by the use of patented processes, often involving the use at some stage of electric devices.

Besides various plants in Canada and Mexico, Mr. Hindshaw makes particular mention of certain plants now in operation in the United States. The Pompton Fuel Developing Company is producing machine peat near Lincoln Park, N. J., and sells all its product to local consumers. Its success on a small scale will probably result in building a much larger plant this year. The machinery in use was imported from Germany and includes a Dolberg breaker and mixer. This company controls a large acreage of peat land in the vicinity of Pompton Plains, N. J. Another plant is in operation near New Rochelle, N. Y., by the Peat Koal Company, of New York, which uses a Schlickeysen machine. At Orlando, Fla., machine peat is manufactured on a machine designed by Mr. T. H. Leavitt, of Boston. A company has been organized in California to manufacture briquettes composed of peat and oil. Some tons of fuel have been made and tested, both for domestic and steam-raising purposes.

The many uses of peat are reviewed by Mr. Hindshaw. Persons interested in the subject on which he writes should procure a copy of his report from the Director of the United States Geological Survey. It will be mailed free of charge, on request.

Foundry Transportation Cables.

The Aumetz-Friede Company at Reutlingen has introduced, according to Stahl und Eisen, important improvements in the transportation of ore from the Aumetz mine to the Friede foundry. The capacity of the system (Pohlig) is five and a half millions of kilometric tons per year, or seventeen hundred tons per day of twenty working hours. There is a principal line from the mine to the factory, with two branches for the blast furnaces and the deposit of ore. The line is 10,750 meters in length and operated by electro-motors installed at the Friede factory. The motor of the principal line works directly a length of 22 kilometers of traction cable. The incline not being great and the line being quite direct, the expenditure of energy is low. The cost of transportation is only 25 pfennigs per ton as against 1.20 marks per ton by the ordinary railway.

The production of quicksilver in 1904 is estimated at 3,391 tons, not including the output of Mexico and Russia, of which no statistics have been received as yet. In 1903 these countries yielded 190 and 362 tons respectively. The production in 1904 of the United States, Spain, Austria, and Italy was 1,480 tons, 1,020 tons, 536 tons, and 355 tons respectively. Counting the output of Mexico and Russia, the world's production for 1904 will probably amount to 4,000 tons.—Richard Guenther, Consul-General, Frankfort, Germany, April 3, 1905.

Correspondence.

Do Animals Reason?

To the Editor of the Scientific American:

Under the above heading the Scientific American of June 3 told of a cat that had learned to open a door by climbing to the old-fashioned thumb catch, and pulling it down with its paw. I can confirm that story. My father had a cat that would open a similar door by jumping up, and while falling pull down the thumb catch with its paw. Afterward the door was changed to open by a turning knob, and, though he could not then turn the knob from the outside, he soon learned that his efforts to do so attracted attention, and he was let in; so he called for admittance in that way instead of mewing. But as a table was so near the door that he could mount the table and reach the knob on the inside, he would paw the knob to try to open the door from the inside, and occasionally succeeded. No one taught him to do these things.

Such cats must have observed how people opened doors, and to my mind they certainly possessed reasoning powers. C. W. Bennett.

Coldwater, Mich., June 5, 1905.

A Tornado's Freaks Explained.

To the Editor of the Scientific American:

I note with some interest and amusement the communication of your correspondent in your issue of May 27 relating to the experience of those caught in the Oklahoma tornado who had their shoes and hair removed by its action. Your correspondent hints at "phenomena which cannot be explained by our accepted physical laws." So far as relates to the shoes, this is in entire accordance with the general action of tornadoes in causing the explosion of receptacles containing inclosed bodies of air, which are suddenly brought into the immediate path of the tornado; and I do not doubt that such an explanation would serve equally well in the case of the hair, more especially if it may be taken for granted that, like the shoes, it was more ornamental than natural.

As relates to the other incidents mentioned by your correspondent, I would suggest the propriety of having these incidents properly authenticated before discussing the reasons for them. While the things which occur are undoubtedly wonderful, they are really nothing to the power of human imagination that is invariably displayed on like occasions. (See Hume "On Miracles.") George W. Colles.

Milwaukee, Wis., May 31, 1905.

Where Did the Photographer Stand?

To the Editor of the Scientific American:

The article in your issue of June 10, 1905, entitled "Where Was the Camera Set Up?" by Prof. William F. Rigge, has been of special interest to me.

I wish to thank the professor for his novel solution of a somewhat difficult problem; and at the same time I take the liberty of calling his attention to the fact that his last statement appears to be somewhat erroneous.

Were the picture plane parallel with the front of the observatory, the mortar lines in the front of the transit room would have retained their normal position in the photograph, but as near as I can tell from the reduced cut, accompanying the article, they vanish at a point on the horizon 347 feet to the right of *O*. This is the vanishing point of east-and-west lines, or *V R*. If a transit is set up at this point and trained on the optical center of the camera, the line will be found to be due east and west, or at right angles with the line from the camera to point *O*. Then train the transit on ●, and the angle will be found to be very nearly 10 deg. 45 sec. and the course will be N. 89 deg. 15 sec. W., showing that the plate in the camera formed an angle of about 10 deg. 45 sec. with the front of the observatory, instead of about 8 deg., as stated, and the entire front of the building would measure 9/416 inch instead of 4⅛ inches, as it does in the cut, showing that the lines are reduced a little more than 10 per cent. The angle of the picture plane with the front of the building also accounts for the apparent shortening of the wall space at the left of the door to the equatorial room, which, were they parallel, would show a trifle larger than that between the door and angle at the right. B. F. Crawford.

Pittston, Pa., June 13, 1905.

The British government has decided to secure and protect the ancient ramparts erected by Edward I. around the town of Berwick-on-Tweed for the nation. These ruins are of great antiquarian and historical value, since they form one of the most interesting monuments of the bitter strife that existed for centuries between England and Scotland, as they are situated right on the border. The walls include the old bell tower, from which a flaring beacon gave warning to the English farmers of the approach of the bands of marauding Scots. The ruins are to be inclosed and placed under the charge of a curator and guide.

Gardening under Glass in England and France.

A letter was recently written to a local paper suggesting that a trip be arranged to give the gardeners of Evesham, Worcestershire, England, an opportunity to see how the French gardeners cultivate vegetables by the means of glass and make their early produce so great a factor in supplying the London market. The suggestion was acted upon, and a short time ago a party of thirty vegetable growers, large and small, started for Paris. The Evesham growers saw the gardens at Vitry-sur-Seine and found these to consist chiefly of two-acre lots, practically all given up to the growth of early lettuce and other vegetables under glass. The Evesham men thought the soil not naturally better than that in the vale of Evesham, but found that it had been so carefully prepared for so long a time that practically there is not a bit of natural soil in a garden. The methods of preparing this soil and the general methods in use in raising the vegetables as reported by the Evesham men and printed in the Birmingham Daily Mail should be of interest to our Agricultural Department, and are as follows:

"The plan adopted is something of this kind: At the bottom of the seed bed, from which all the top soil has been removed, is a hard bed of clay, and upon this is placed a quantity of stable manure, the stronger at the bottom. Over this is spread about 3 inches of the prepared soil. The lettuce is planted in this in August, the frames are placed over the plants, and are now [February] coming into market. When the crop has been marketed the bed is cleared and the soil and manure mixed well together and built up in mounds to rot. This process takes one to two years, and then this soil is used again to place on the manure. As a consequence the soil is always of the very best and most fertile.

"The frames, which are 13 feet long by 4 feet 6 inches wide, are 9 inches high at the top and 7 inches at the bottom, so that they have a gentle slope to the south. There is no artificial heating except that provided by the manure, but the lights are covered with straw mats, which are very carefully made by elderly men, and which easily roll up. These mats would be very useful for Evesham radish beds, and would prevent a good deal of waste and loss. Water is laid onto nearly every frame by means of pipes from a raised tank, which is filled by a pump, generally driven by horse-power, but sometimes by a gas engine. Great care has to be taken in the ventilation of the frames or damping off may set in. The frames cost about 13s. ($3.16) if bought in large quantities, but they can be obtained for less money in England. They are only used for the raising of cabbage or flat lettuce, and these are planted in rotation, so that as soon as one lot has been marketed another is ready to come in.

"In addition to lettuce, carrots and radishes are planted in the frames, and these come in after the lettuce have been cleared off. Cos lettuce is grown under big glass globes or bells, which cost about a shilling [24 cents] each, and which can be supplied in Evesham at about 1s. 4½d. [33 cents]. About six plants are put under a bell, and when they have made a fair growth three of them are transplanted. After a little time another transplanting takes place, and only one is left under each bell, but so that no space may be lost flat lettuce are placed around each.

"The frames, again, are utilized for the raising of cabbage and cauliflower plants, but despite this help the plants seen this week were at least a fortnight behind those grown at Evesham in the open. This does not seem to show that the climate around Paris, at any rate in the winter, is any warmer than it is at Evesham.

"An asparagus bed was also seen in which a system of culture different from that in vogue at Evesham is used. The roots of this particular bed were exposed to the weather, but they will now be covered with a coating of stable manure and then the earth will be replaced a little at a time. The result is the production of some very fine 'grass.'

"This system is carried out round Evesham, in some instances, with excellent results. Covent Garden (London) was visited as the party passed through London, and the Paris market was also seen, with the idea of instilling into the local growers the necessity of paying more attention to the packing and grading of their produce."

The Mail states it is hoped to organize further excursions into the fruit-growing districts of France, Germany, Netherlands, and Belgium; and arrangements are already being made for another trip in May to France to see how black currants are grown there. The advantage of the French system is that it brings a crop every year, while in Evesham one is gotten only about every three years. The gardeners thought they could compete successfully with the French growers, though they would have to bring their manure from London or Birmingham, but could get it at from 5s. to 6s. 6d. ($1.21 to $1.57) per ton, while the French have to pay at least 5s. 6d. ($1.33) at Paris.

One of the French gardeners said that his working expenses were as heavy as those of the Englishman. To cultivate two acres of land his annual expenses were £600 ($2,919.90), but despite that he could send lettuce to London and compete successfully with the English gardeners.—Marshal Halstead, Consul, Birmingham, England.

The Current Supplement.

The current SUPPLEMENT, No. 1539, is opened by an article on the Cavite Floating Dock, which has recently been completed for the United States government in the Philippines. The dock is especially notable for the fact that it has the greatest lifting capacity of any similar mechanism ever designed. The article is excellently illustrated. Samuel S. Wyer writes instructively on Gas Producer Power Plants. The article on Glass Paving and Building Bricks is concluded. An entertaining description is given by Mr. Carnochan Douglas of the Curiosities of a Seed Warehouse. T. H. S. Escott contributes an interesting historical *causerie* on Social Pioneers. Dr. Howard D. Barnes writes on the physical properties of ice and water. The Manufacture of Briquettes is thoroughly described and illustrated. Prof. Ernest Ford Nichols, of Columbia University, recently lectured at the Royal Institution on the Radiation and Pressure of Light. An abstract of this lecture is published.

Tunnels Connecting Two Continents.

Of the three barriers to a continuous railway route from Great Britain to Africa through France and Spain, the Moniteur de l'Industrie et de la Construction expresses the satisfaction of the French people that two are prospectively broken down. The tunnel under the Pyrenees will soon be an accomplished fact. The problem of one under the Straits of Gibraltar will be successfully solved by the French engineer Bertier. The length of the latter will be forty-one kilometers, and the depth four hundred meters under the sea. It is difficult, says the Moniteur, to estimate its cost, but judging from the work under the East and North rivers at New York, it cannot be less than 425,000,000 francs. The third barrier to the continuous route, the Straits of Dover, is regarded as unsurmountable at present, in view of the conviction of the English people that safety depends on their insular position.

The rails on the Belt Line Road around Philadelphia are the heaviest rails used on any railroad in the world. They weigh 142 pounds to the yard, and are 17 pounds heavier than any rails ever before used. They are ballasted in concrete, and 9-inch girders were used to bind them. All the curves and spurs were made of the same heavy rails, and the tracks are considered superior to any railroad section ever undertaken. The rails were made especially for the Pennsylvania Railroad by the Pennsylvania Steel Company. An officer of the railroad company states that this section of roadbed will last for twenty-five years without repairs.

EXPLORING FOR FOSSILS.

So much prominence has been given by the local newspapers and periodicals to the opening of the new Dinosaur Hall of the American Museum of Natural History, that the interest of the general public in things palæontologic has been greatly stimulated. Particularly fascinating to the layman are the accounts of the field work of the scientific parties sent out to prospect for fossils or to collect those already discovered. The photographs show how fossils are excavated and forwarded to the laboratories of the museums for restoration, and illustrate in a more detailed manner how this branch of the work is conducted, than those accompanying the article on the *Brontosaurus* restoration in an earlier number of the SCIENTIFIC AMERICAN.

Fossil bones are found in various conditions and various kinds of matrices. Usually, the bones are smooth, hard, and brittle, but sometimes they are decayed, and then resemble "rotten" stone. Often they are discovered on the surface, entirely uncovered by the action of the elements, and then need only be collected and wrapped for shipment. Chiefly the jaws and hard, compact foot bones of small mammals are obtained in this way, as they stand weathering better than do other bones. Fossils occur in sand, sandstone, and limestone, but more frequently in a hard, brittle clay shale, and the difficulty encountered in excavating the specimens, of course, depends upon the character of the soil in which they are imbedded. Until the excavation closely approaches the bones, rough tools can be employed—hand picks, spades, and shovels, and, as one of the photographs shows, plows and scrapers. It is only in the case of quarries or of large specimens, such as Dinosaurs, that horses are employed at all, and as a rule the fossils are uncovered on such steep bluffs or hillsides that the use of the teams is impossible.

Fig. 1.—Part of the Skeleton in Its Original Bed, Bone Cabin Quarry.

EXPLORING FOR FOSSILS.

The bones are handled in the field in various ways. If they are delicate, badly mixed up, or crushed, the surrounding matrix is cut out in a block, packed in hay or straw, and boxed or crated. This method is also followed with the remains of the smaller animals. In many cases, as the excavation proceeds, the portions laid bare are covered with sheets of tissue paper or muslin and gum arabic. Over these, bandages of burlap and plaster of Paris are placed, enveloping the entire fossil, and the specimen is ready for crating. This is the procedure where the fossils are not in good condition, if they are "rotten," rough, or cracked by weathering. If they are smooth and hard, the plaster bandages are applied directly, paper or muslin being placed only over such portions as may be in poorer condition. The plaster envelopes of the large bones are sometimes strengthened by wooden ribs or braces. The whole is then bound with wet rawhide strips, and the consequent shrinkage of these on drying binds the whole firmly together. If possible, it is so arranged that no crate or case shall weigh more than 500 pounds.

Sometimes, particularly in the case of smaller, more delicate specimens, flour paste is used instead of plaster. The advantage of this is that the flour is easier to handle and pleasanter to work with, and the envelope is easily removed from the bone by moistening it. Moreover, a pound of flour goes further than a pound of plaster. The latter consideration is of great importance when we consider that the supplies for these expeditions must frequently be transported hundreds of miles into the wilder parts of some of our western States.

It is of vast importance for the work of restoration that the bones be excavated and shipped to the laboratories as nearly as possible in the relative positions in which they were found. Especially is this true where the remains of various animals are commingled, or the single bones are broken and scattered, for to separate the bones properly or to segregate the skeletons requires more care and time than the field party can devote to it. For this reason a large part of the matrix is often not removed until the specimen reaches the museum. Here the plaster envelope is cut away on one side, all the matrix that can be reached is removed, and the bones or fragments freed and separated while still firmly held in their relative positions by the remaining part of the envelope. A plaster bed or layer is now made for the freed side, which is first covered with tissue paper, that the bones may be held in place without adhering to the bed. The specimen is then turned over, and the envelope and matrix are removed from the other side, leaving the entire fossil free for the work of restoration and mounting, but in its original position. In the case of the large fossils, such as those of the gigantic Dinosaurs, where the bones are unbroken, this procedure is usually unnecessary, as the size of the individual fossils is so great that they must be transported separately. Here, how-