Correspondence.

The Air Resistance Question.

To the Editor of the SCIENTIFIC AMERICAN:

I have read with much interest Mr. Cleveland's criticisms and conclusions concerning the Air Resistance Question, and while he, in a seemingly correct manner, obtains results absurdly large, a few facts borne in mind will, I think, tend to reduce these figures to a more reasonable size.

Nearly all formulas for the determination of wind pressure at different speeds are based on the assumption that the resistance encountered (other things being equal) is directly proportional to the area, or to express it mathematically: $P = KSV^2$ in which P = pressure in pounds, S = surface in square feet, V = velocity in miles per hour, K = some constant. Experiments, however, seem to show that as S increases, K would have to decrease, in order that the equation should hold true, and that therefore either P does not vary directly as S, or that K has been given too large a value in the experiments, which have usually been performed with comparatively small areas. Prof. Kernot says: "Experiments at the Forth Bridge showed that the average pressure on surfaces as large as railway carriages, houses, or bridges never exceeded two-thirds of that upon small surfaces of one or two square feet, such as have been used at observatories, and also that an inertia effect, which is frequently overlooked, may cause some forms of anemometers to give false results enormously exceeding the correct indications."

If the first of our conclusions, viz., that P does not vary directly as S, be correct, then Mr. Cleveland's figures are too large, and probably exceed the right number by at least one-third of their value. If the second conclusion, viz., that K is too large, be true, then, Mr. Editor, your results are too big. A little calculation shows that to obtain the pressure of 15 pounds per square foot at 60 miles an hour, the value of K would be about 0·004. As a number of authorities make K less than 0·004, it is quite possible that this figure is too large. Whipple and Dines made it to be 0·0029, and it has been placed as low as 0·0014. Moreover, the fact that you obtained such large results in your computations of the air resistance of a bicycle and rider goes to prove that the formula is too large for even small areas, and hence that K should be reduced. Of course, if the air resistance of the bicycle and rider were made too high, that encountered by the train was also correspondingly large.

Tiffin, Ohio. HARRY F. STRATTON.

Air Resistance to Moving Bodies.

To the Editor of the SCIENTIFIC AMERICAN:

Everyone is familiar with the spectacle of brakemen, in the performance of their duties, walking or running along the tops of swiftly moving box cars; and it is also a matter of common knowledge that empty cars of this type, when released on moderately descending grades, in spite of the large surfaces presented to air resistance, and with no propelling energy except that generated by their own gravity, yet attain enormous velocities, and in numbers of cases with men riding in this same exposed position on their tops. The air pressure against a surface equal to that of an erect human body in such a position, if it amounted to a fraction of the commonly accepted estimates, would sweep these men with the violence of a tornado to the ground.

To put one's head out of a car window, moving at a speed of 80 miles an hour, does not even involve the danger of losing a properly adjusted hat or cap, much less that of losing the scalp or the head itself. During the test of a high speed locomotive on the Intercolonial Railway, a few months ago, the writer was standing on the steps of the rear car of the train, moving at a speed of over 90 miles per hour, and, in order to watch a danger signal in front, it was necessary to lean far outward, but no air currents sufficient to remove a light summer hat were encountered, although some drops of rain, which were falling at the time, would occasionally sting the skin with the sharpness of a whip lash. Evidently the larger ones did not attain the full velocity of the air currents in falling through them. Even at a distance of 10 feet from a swiftly passing train the writer has often noticed a current of air fully equal to that experienced on a train moving at the same speed, and everyone has noticed the herbage by the roadside, waving in the air currents at considerable distances from the train. These facts show conclusively that a large body of air, extending many feet in all directions, but moving at gradually decreasing velocities at increasing distances therefrom, is disturbed by the passage of a train. We must therefore conclude that a thin stratum of air immediately enveloping the train, as, indeed, we may all know from personal observation, is moving at practically the same velocity as the train itself. The eddying currents of air between the ends of the cars must of course exert an equal pressure against both surfaces, and therefore add nothing to the load of the engine. How much power is required to continuously disturb such a large body of air is the question that should interest railroad managers, rather than that of determining the frictional resistance against the walls of the train.

It is probable that the greatest exertion demanded of Murphy, in his race behind the locomotive, was for the rapid movement of his legs. The air resistance was removed by the train, and the frictional resistance must have been very small indeed, and, aside from the work of speed acceleration, it is therefore probable, if he had used a more highly geared wheel, that he could have duplicated any pace set by the locomotive, at his leisure.

Wind currents cannot be regarded as wholly analogous to those generated by moving bodies, because the entire atmosphere within their zone of disturbance must be subjected to a considerable degree of condensation, and therefore the pressures, against stationary objects exposed to their action, must be correspondingly increased. W. F. CLEVELAND.

Moncton, N. B., Canada.

An Improved Method of Studying Underground Insects.

BY PROF. JOHN B. SMITH, SC.D.

Concerning the life habits of underground insects we are yet greatly in the dark, and much of our supposed knowledge is really inference from observations made upon the insects when at the surface or from such excavating as has been done in attempting to follow out the burrows of diggers. This method is satisfactory in soils which are tough like clay, or hardened like the "dobe" of the Southwest; but it fails almost completely on lighter soils, even when assisted by a straw or grass guide. Concerning insects that make a straight burrow we have some information that is reliable; but as soon as lateral galleries or chambers are involved we begin to infer and direct observation becomes difficult if not impossible.

During part of the summer and fall of 1897 and the spring and summer of 1898 a large number of experiments were made with plaster of Paris of the finest obtainable quality, pouring it mixed with water into insect burrows and digging out the cast after it had set. This method was originally proposed by Mr. J. Turner Brakeley, of Bordentown, N. J., and a great number of experiments were made by him before the best mixture was finally decided upon. Subsequently Mr. Brakeley and myself made careful studies of several species of digging bees, of burrowing spiders and of the underground larvæ of certain Coleoptera. The results of these investigations were very interesting and proved that some of the forms had a much more complicated life history than had been supposed; also particularly as to certain digging bees, that what had been published about their habits was almost entirely erroneous.

The method of work, after the experiments had once developed it, is very simple. Having located the burrow which is to be studied, the first point is to clear out the edges at the surface so as to give a clean mouth into which there is no danger of running sand or other material that will obstruct the free flow of plaster. The amount of material needed is, of course, a matter of estimate and it depends upon the experience of the operator as to how nearly he hits it. The dry plaster is first measured into a large tumbler or other receptacle with a pointed lip and water equal in measurement is then added; that is, equal parts by measure of water and plaster are mixed together. The mass must be rapidly stirred and thoroughly mixed, so that it pours evenly and as smoothly as water itself. The pouring must be careful so as not to obstruct the opening, and a little experience is necessary to enable the operator to run a small steady stream into an opening less than ¼ of an inch in diameter. The liquid plaster sinks at once to the lowest depths of the burrow and fills up, entering every lateral and every cell that is not actually closed; while the water soaks into the soil, leaving a cast that becomes hard enough to dig out in half an hour at the latest. I have poured 8 ounces of plaster into an opening about ¼ of an inch in diameter, reaching depths fully 5 feet below the surface, filling cell clusters made by digging bees, and all laterals of any kind connected with the main burrow. Anything in the way of insect life within the burrows is, of course, embedded in the plaster, and in that way we can get information concerning the actual food habits of predatory species. Thus, in the case of spiders, the owner will usually be found in the cast at the end, and around it will be fragments of the insects that have been devoured, giving a perfect representation of food habits. The plaster fills the burrow completely, and when dug out we have the opportunity of studying individual peculiarities, where there are any, and of getting at the general type by a comparison of a large number of examples. Thus it is found that some burrowing spiders have a distinct enlargement toward the middle of their tube, while others narrow it at some point near the middle and have a large chamber at or near the bottom. Where there is a silk lining this is held by the plaster and can be taken out completely with the cast.

Taking out a cast requires experience and sometimes much hard work. It is astonishing how deeply some of the bees go beneath the surface and how many lateral chambers or burrows they will make. One of the species studied by Mr. Brakeley and myself, not half an inch and no more than ⅛ of an inch in diameter, makes burrows in the course of its lifetime which will foot up to between 12 to 15 feet of ¼-inch tubing. Weighing less than a grain, it moves many thousand times its own weight in the course of its work, besides providing for from six to twenty descendants. This method also gives us the possibility of following out the history of a species at different periods of its life; and making casts at intervals during the season, the actual progress made by the insects can be ascertained and the order of their work definitely established.

The results of this sort of continuous observation are very prettily illustrated in the life history of one of the Andrenid bees. Andrena, according to published accounts, makes a vertical burrow extending down a variable distance from the surface; then makes a lateral cell, fills it with food, lays an egg, seals the cell, and digs another at some distance below it; continuing this until a sufficient depth has been reached. The idea is, of course, that the upper cell being first loaded will develop first; that the adult bee will come out through the burrow left by the parent; that the lower one comes out in its turn and so on, each finding a free passage made for it. Now the actual facts are almost the direct opposite. In the first place the parent bee digs down just as far as it intends to go—in one case over 40 inches—then sends off an oblique lateral and constructs a cell, which agrees fairly well with the published accounts. Having filled this cell the mother bee begins another lateral some 6 inches or more above the first, and uses the material excavated out of it to fill up the burrow below, thus saving herself the trouble of carting sand to the surface and at the same time closing completely the entrance to the cell below. When this second lateral has been loaded with a cell a third is started still nearer to the surface, and the second lateral is filled up. When the bee has completed as many laterals as she thinks it desirable to fill, she simply breaks the burrow down altogether, so nothing is visible except perhaps a discolored heap of sand at the surface, which is beaten down by the first heavy rain that comes. All the bees from these underground cells mature at about the same time and each one must, in order to reach the surface, dig through the layer of sand resting upon it, be it only 6 or as many as 40 inches.

Concerning other insects our knowledge has also been materially added to by this method of study, and it is one that adapts itself, particularly to lighter soils, where following a burrow in any other way becomes difficult or almost impossible. Ant hills offer more difficulties than any other kind of underground workings, and this for several reasons: the chambers are, first of all, so terribly irregular; they are often connected by very narrow passages; they are on different planes and two or three roads into or out of a chamber is nothing unusual. The galleries are also well populated, and a few specimens at one time in a narrow gallery will obstruct the flow of the plaster, particularly toward the end of the pour when setting is about ready to begin. Taking out a cast of that kind also offers innumerable difficulties and is an exercise in patience and perseverance. The results, however, are astonishing, and incomplete as the method is for this purpose, it yet gives us a much clearer conception of an ant hill than we can get in any other possible way.

To the entomologist's collecting outfit there must be added in the future a can of dental plaster, some graduates, a funnel or two, a good shovel, at least two trowels and two or three knives with flexible blades to dig around the casts without breaking them.

After the casts have been removed from the ground they must be thoroughly dried in order to harden them, and they can be then brushed clear of unnecessary sand and earth and preserved in any way desired for further reference and study.

Wireless Telegraphy Experiments at New York.

Signor Marconi has postponed his trip to this country until the fall and he may not come at all this year. Experiments are being conducted at Tompkinsville, Staten Island, by Mr. W. J. Clarke, under the inspection of Col. D. P. Heap, of the United States Lighthouse Depot at Tompkinsville, Staten Island. A pole 70 feet high has been erected at Tompkinsville, and signals have been sent to a lighthouse tender off Coney Island. The current was sufficient to ring an electric bell, but no messages have as yet been transmitted.

The Manufacture of Caviar.

Formerly caviar was all imported, but now it is made in considerable quantities in the United States. The weight of the roe is about 10 to 14 per cent of the sturgeon. The roe is taken from the fish, and thrown into tanks; it is then washed and rubbed through screens until the eggs are all separated. They are then packed in kegs with salt and kept cool until it is canned.

Automobile News.

A large plant for the Daimler Manufacturing Company at Steinway, N. Y., is now under way.

There has been great difficulty in London in finding drivers for electric vehicles, and one company has dismissed its employes and closed up its plant on this account.

Arrangements are now being made for another motor carriage race in France. It will be run about the 15th of August, the course being from Malo to St. Omer and back via Calais. The distance is seventy-five miles.

In New York city there are 5,000 cabs that ply for hire. In Paris the cost of the current for the electric cabs is about 90 cents per day. If the 5,000 horse cabs in New York should all change to horseless cabs, the amount which they would pay for power would be of great assistance to the income of the central stations.

A New York bicyclist crashed into an automobile coming in the opposite direction. The bicyclist was thrown and broke his collar bone. Accidents of this nature, at the present time, are unfortunate, for no matter whether the wheelman or pedestrian is at fault, the automobile is sure to receive the blame for the accident.

A traction engine drawing three loads of furniture in Wales recently became unmanageable and dashed down a hill at a terrific speed. The furniture van was stopped by a large tree and collapsed, but the engine continued on its course, and after felling a large tree which stood in its path it turned over. One man was killed in the accident and two were injured. Traction engines have always been considered very safe and this is certainly an extraordinary accident.

Among the curiosities in the way of automobile fittings in Paris is the wheel of M. Izart. It really consists of two wheels; one the wheel proper of the vehicle and the other a loose wheel tire which is kept in place by lateral bars. It is claimed that this invention diminishes the friction by one-third and that the vibration is very much lessened by its use. It is also claimed that it will aid in driving carriages over ruts and over obstacles.

Attempts are being made in Berlin to introduce omnibuses which are propelled by electricity. One of the most interesting has been constructed by Siemens & Halske. It can run on the street railway tracks or on the ordinary pavement. It is provided with a collector which enables the accumulators to be charged from the overhead trolley wires during the journey over the tracks. It is calculated that this vehicle will have no difficulty in making eleven miles an hour and run several miles on one charge.

A correspondent recently visited the automobile show at Paris, and expressed himself as being very much astonished at the multiplicity of types exhibited by the manufacturers. He states that they are far behind their orders. Gasoline carriages seem to be the favorite for private owners in Paris. Small motor tricycles are very numerous and are quite noisy. The great speed of the gasoline carriage is particularly noticeable. They all use the horn as a signal of approach, and it is now as well known as the incessant snapping of the whip, at which the Paris "cocher" is an adept.

The German Minister of War recently stated that the military authorities were following the development of the automobile industry with the greatest attention and would do everything to further and make use of it. The appropriation for this purpose in the Military Budget was voted for unanimously. The general introduction of automobiles would increase the mobility of an army fourfold, especially in cases where the roads are such as to permit of rapid movement. Automobiles can be made use of as regimental baggage wagons and as ambulances for army postal service. In modern warfare the more the army can get rid of living creatures, man or beast, which are not combatants, and replace them by mechanical substitutes, the more confidently will a general take the field.

The "motor scout" was exhibited at the Automobile Club's recent show at Richmond, England. It consisted of a quadricycle fitted with a 1½ horse power petroleum motor. It is convertible, carrying either two persons or one person, and a light Maxim gun. The gun is mounted in front over the leading wheels, and it is arranged so that it can be fired with the vehicle going at full speed. Below there is a tray sufficient to store 1,000 rounds of ammunition. Another type is termed a "war motor car." According to The Mechanical Engineer, it is plated with armor and has a ram both in front and behind. The armament consists of two quick-firing Maxim guns carried in two revolving turrets. The steering is done by the aid of information obtained by mirrors so that the crew need not expose themselves. The car is driven by a four-cylinder Daimler motor developing 16 horse power. An electric search light is provided, the dynamo being worked by the main engine.

Engineering Notes.

Two separate railroads into the Grand Cañon of the Colorado are now assured. The preliminary surveys have been completed for one of the roads, and the line is being slowly located ahead of the graders.

The British government is now manufacturing a new bullet which is even more deadly than the dum-dum. The new projectile has a soft metal point which expands with the friction caused by flight. It is said that 200,000,000 rounds of the bullet are already in stock.

The last large gun of the battleship "Kearsarge" has reached the shipyard at Newport News, and now the main battery is complete. The smaller guns will not be put in position until after the trial trip, which is expected to take place soon. The guns of the secondary battery will probably be put on at the New York or Norfolk navy yard.

The first elevator was built in 1850, using worm gears. Owing to the low height of buildings, there was little demand for elevators until the localization of commerce filled the great centers of distribution with merchants and merchandise, so that story after story was added to buildings, necessitating the rapid development of the elevator. In the current SUPPLEMENT, the first installment of Charles R. Pratt's paper on "Elevators" is printed.

It was on the 22d of June, 1799, that the meter, the basis of the metric system, was decided upon by the Corps Legislatif, upon the report of French scientists. Consequently, the meter is one hundred years old, and we must admit it has made a remarkable progress in that period. At the same time there is great room for improvement in this respect, and it is to be hoped that by the time another century passes away it will be in universal use by every civilized country on the globe.

The total displacement of ships now under construction for the British navy amounts to no less than 488,000 tons. In the current number of the SUPPLEMENT there is a most impressive illustration showing in a group the vessels as they will appear when they are completed. There are six battleships of 12,950 tons; six battleships of 15,000 tons; six battleships of 14,000 tons; four armored cruisers of 14,100 tons, with a speed of 23 knots; six armored cruisers of 12,000 tons with a speed of 21 knots; and four armored cruisers of 9,800 tons with a speed of 23 knots, besides fourteen protected cruisers.

An important railway project, both from a commercial and political point of view, says The Nation, is the continuation of the Anatolian Railway from Angora to Bagdad. The necessary capital is to be furnished by the Germans. The country which will be opened up is rich in natural resources, and most of it was formerly densely populated. Russia naturally objects to this route, because it comes so near to the Russian sphere of influence, although two hundred miles from the frontier. There is little doubt, however, that much trade would be diverted from Russia to Germany, and German interest would become paramount in a region where Russia has been hitherto without a rival.

A navigable waterway from Birmingham to Mobile is under contemplation. The scheme was originated by Mayor Van Hoose, of Birmingham, Ala. Such a waterway would be a great thing for the iron and steel industries of the South. The plan is to put Birmingham in communication with Mobile by way of the Valley and Warrior Rivers at tide-water, in order that loaded barges may be taken direct from the wharves in Birmingham to the West Indies and other Southern ports. The last Congress appropriated $800,000 for the improvement of the Warrior River, putting in a system of locks and dams which makes it navigable to a point within fifty miles of Birmingham. It would require $6,000,000 to $8,000,000 to complete the job of extending the waterway to Birmingham.

Various devices have been used in Europe for the ventilation of tunnels. In some cases, oil-burning or electric locomotives have been substituted for the trip through the tunnel, and in other cases artificial ventilation has been used. In the St. Gothard tunnel, in Switzerland, an increasing number of trains has resulted in materially altering the conditions which existed when the tunnel was first built. Finally, the plan of M. Saccardo was adopted. This consists in forcing a volume of air at high speed into an annular chamber which encircles the whole circumference of the tunnel at one end. From this chamber the air escapes on the inside face of the tunnel, and it is either drawn out or forced in so as to produce an artificial current. The plant is installed at Goeschenen, at the northern end of the tunnel, and will act for the most part to push the air out from north to south in the ordinary direction of the natural draft. The ventilating machinery consists of two blowers revolving at a rate of seventy revolutions per minute. With their aid a current with a velocity of 2·8 meters per second is produced. Travelers over this beautiful and well managed road will appreciate the change.

Electrical Notes.

The Viege-Zermatt electric mountain road is to be extended from Stalden to Saas-Fée, a distance of ten miles. The rack system will be employed at all points where the grade exceeds twenty-five per cent.

The magnetic observations at the Vienna Observatory have had to be entirely discontinued on account of the bad effects of the electric tramways and electric light wires. The director of the observatory has submitted a plan to the government for a new observatory, to be situated some distance from Vienna.

Prof. F. B. Crocker, of Columbia University, conseders that the Japanese are very unsuccessful as electrical engineers. While labor is eight times as cheap, the product is proportionately poor. He states that the electrical studies are thoroughly up to date, the lectures being given in English or with a liberal use of English words.

Electricity is coming into very general use in Poland. It is being largely adopted in many factories, superseding rope and belt driving. Electric lighting of factories is also becoming general. Most of the important railway stations are lighted with electricity. The Germans have succeeded in getting the lion's share of contracts for electrical equipment.

Chicago is now planning to use the current of the drainage canal for lighting and other purposes. Where the stream discharges into the Desplaines River a dam is building. At this point a head of sixteen feet will be secured. Two routes have been under consideration. One called the central route has been adopted, and it is estimated that the enterprise will cost only $265,000 and 15,000 or 16,000 horse power will be realized with the present maximum flow which is available.

The Chairman of the Metropolitan Underground Railway of London has announced that at the beginning of October electric traction will be installed on the lines of the Company. All who have ever visited London know that this wonderful system of underground roads is not particularly pleasing to ride on, owing to the smoke and gas from the engines. The introduction of electricity will be a vast improvement and will undoubtedly tend to increase the business of the Company.

Further details of the destruction of the Como Silk and Electrical Exhibition have come to hand. Within thirty-five minutes from the time the first alarm was given, all the buildings were entirely destroyed. An attempt was made to use fire hose, but at first the pumps refused to work, and when they did get into working order the fire had become unmanageable. The immense boilers used for driving the dynamos exploded, and two air or gas tanks also blew up. The whole exhibition was valued at $2,500,000 and was utterly destroyed. No lives appear to have been lost but salvage operations were precluded by the rapid spreading of the flames. The only objects saved were a painting and Volta's sword of honor. Keen regret is expressed for the loss of the invaluable Volta records as well as the instruments.

The life of the champagne manufacturer is made miserable by the breakage in the cellars and the leakage of the gas from the bottles. A French scientist has devised a plan for obviating the latter difficulty which is simple, and if not too expensive it might be put into practical use with advantage. He covers the cork and the neck of the bottle with a layer of copper, deposited electrically. The bottle is coated with black lead or zinc powder and then placed in a bath and plated. After it has been coppered there will be no difficulty in plating on a copper base with either gold or silver. Probably champagne bottles would be the only bottles which could be treated in this way, owing to the expense; but if it could be cheapened, it would undoubtedly have many other uses.

Mechanism has been installed in one of the steeples of St. Patrick's Cathedral, of New York city, for ringing the chime of bells. There are nineteen bells, which vary in weight from 300 pounds to 7,000 pounds. The mechanism for striking the bells consists of a horizontal air cylinder connected to the tongue of each bell. The bells are hung around the belfry in two tiers, the larger ones being in the lower course. A system of steel I-beams is arranged to provide support for the operating cylinders. The cylinders for the large bells are 4⅝ inches in diameter, and they grade down to 2 inches in diameter. The bells have double clappers balancing each other. The piston rod of the air cylinder is attached to a central stud projecting below the center of the clapper. The piston is only used for a stroke one way, the weight of the clapper returning it. The air compressor is an 8×8 inch horizontal, double-acting, single-stage machine, making 150 rotations per minute, and is driven by an electric motor. The air is forced into an air reservoir, from which it is conveyed to the belfry through a 2-inch pipe, where there is another reservoir. The bells are operated by a keyboard which is in electrical connection with magnets controlling the valves of the air cylinders.