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Brick Wells for the Pier Foundations Were Sunk Under an Artificial Load of Iron Rails, Pig Iron, and Sand Until Stanched in a Substratum of Clay.

THE NARROWING OF THE GANGES AND CONSTRUCTION OF THE CURZON BRIDGE.—[See page 204.]

SCIENTIFIC AMERICAN

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

LESSONS OF THE WRIGHT AEROPLANE DISASTER.

Seldom has there occurred a more pitifully tragic disaster than the sudden fall of the Wright aeroplane, involving the death of that promising young officer Lieut. Thomas E. Selfridge, and inflicting shocking injuries on the talented inventor, Orville Wright. That the disaster should have occurred at the culmination of a series of brilliant flights, and on the eve of winning that prize of government recognition for which the Wright brothers had striven, unaided, through long years of patient toil, renders the disaster extremely pathetic, and accentuates that worldwide sympathy in which the SCIENTIFIC AMERICAN so sincerely shares.

But although the accident is deplorable, it should not be allowed to discredit the art of aeroplane navigation. If it emphasizes the risks, there is nothing in the mishap to shake our faith in the principles upon which the Wright brothers built their machine, and achieved such brilliant success. The defect was purely one of structural detail. The breaking off of the blades of the propeller of an airship is comparable to the bursting of a tire on an automobile. In each case there is the danger of an upset; but in neither should the accident be taken to indicate that the principles and design of the whole machine are at fault.

Nevertheless, it must be admitted that if the demand for absolutely first-class design and materials is strong in the automobile, it is doubly so in the aeroplane. Judged by the nature of the work it has to do, and in view of the tragic penalties which may attach to the breakage of any one of its delicate and nicely calculated parts, it would seem that a broader margin of safety should be allowed in cutting down the size and weight to secure the necessary lightness. The supporting planes, with their fragile wooden struts and hair-like wires, constitute a trussed bridge, whose strength, like that of a chain, is no greater than the strength of its weakest link. Should a single strut or wire snap, the whole fabric must collapse. Similarly, the equilibrium of the whole structure is so sensitive to disturbance, that any sudden change in the opposed forces, such as was occasioned by the snapping of one of the two propellers, must instantly upset the delicate poise, and change the aeroplane, suddenly, from a self-sustaining machine to an inert mass, subject only to the destructive force of gravity.

The lessons of this particular case are, first, that wood is too uncertain a material to safely endure the complicated stresses due to thrust, high centrifugal force, excessive vibration, or the possibility of contact with the machine to which a propeller is subjected; and, secondly, that the distribution of the thrust between two propellers, placed on either side of the center of gravity, constitutes, as this terrible accident has too clearly shown, a constant invitation to disaster. Should one propeller break, become loose, or be disconnected from its chain drive, the whole power of the engine becomes concentrated at a point several feet to one side of the center of resistance of the machine, with the result that it becomes immediately unmanageable, and is driven violently from its path; whereas the breaking of a single, centrally-placed propeller would have no greater effect upon the control than would the simple stopping of the motor.

Undoubtedly, it was the inevitable confusion created by the breaking of the propeller on the vertical rudder wire that caused the disaster; for although Wright made a gallant effort to bring the machine back to control, stopping his motor, etc., the horizontal rudders appear either to have failed or to have been pulled in the wrong direction; the aeroplane, after partially righting, taking a sudden and steep plunge to the ground.

Perhaps the most important lesson of all, however, is, that, to render the aeroplane thoroughly reliable, some method of automatic control of both lateral and horizontal stability must be devised. This control should automatically hold the rudders and plane tips in the requisite position for equilibrium, any deviation therefrom being made by separate manual control.

SOME SUBMARINE SUCCESSES.

The increase in size, power, and endurance of the submarine, and the accumulated knowledge and confidence which are being acquired by officers and men in the handling of this sensitive and capricious type of boat, are rapidly winning for the submarine a position as a well-tried and efficient type of fighting craft. On the return of the submarine flotilla to Newport after its last series of maneuvers carried out in Buzzards Bay, it was made known that the five submarines, "Octopus," "Viper," "Cuttlefish," "Tarantula," and "Plunger," representing the latest additions to our fleet, had made a most successful attack upon the United States cruiser "Yankee." The significance of the result, all five of the boats making a hit, is emphasized by the fact that the attack was made in broad daylight, and that it was expected by the "Yankee," whose officers and crew were keenly on the watch for the submerged enemy. In carrying out the maneuver, the submarines first steamed away from the "Yankee" on the surface of the water, closely observed by the glasses of the officers on board, until they disappeared from view. At twenty miles distance they submerged and proceeded to the attack under water, making observations at intervals by means of the periscope, until they came within hitting distance, when each boat discharged its torpedo and found the mark. Although the "Yankee" searched closely for surface indications of the boats, there was no notification of their presence until the five torpedoes got home against the hull. A second attack, made from a less distant point, met with equal success. This exploit is certainly a strong demonstration of the efficiency of the submarine under the conditions existing; and it may fairly well be claimed that the fact that the "Yankee" was stationary was offset by the other fact that the time and direction of the attack was known to those on board the ship.

Another notable success was that achieved by a flotilla of Italian submarines, or to speak more strictly, submersibles, consisting of four boats, which recently made the trip of 1300 miles from Venice to Spezia under their own power and without any assistance from auxiliary boats. These craft can steam 7 knots submerged, and 14 knots in the light condition. They carry two torpedo tubes below the bow, and embody the principle which is adopted in the Lake boats in this country of carrying a heavy false keel, which may be detached should the submarine, through accident, sink to the bottom. Comparable with this 1300-mile trip, in a semi-submerged condition, of the submersibles is the recent cruise, under war conditions, of the British submarine flotilla for a distance of 300 miles, during which they stayed for forty consecutive hours under water.

The three performances above recorded are very encouraging, since they foreshadow the ultimate mastery of two difficult problems in the submarine: radius of action and certainty of attack. The submarine of the future will grow in size, and as it does so its speed and radius of action will steadily increase—possibly even to the point at which the largest type will be capable of accompanying a fleet in its operation on the high seas.

OUR PONDEROUS PASSENGER CARS.

Does it ever occur to the passenger, when he is sweeping through the country in the luxurious comfort of his heavily upholstered seat in a Pullman car, that, in order to give him that accommodation, the railroad company must haul over the tracks, not merely his individual 150 pounds of weight, but an additional two tons of weight of the car? The largest modern Pullmans will weigh over 60 tons; and, since they provide only sixteen sections, it follows that for every passenger carried, even when the car is full, two tons of dead weight must also be moved. In respect of the weight hauled per passenger, therefore, a Pullman train is the most extravagant and costly method of transportation in the world, as the following comparative facts will show. A touring car capable, when running on a good road, and if, like the railroad train, unhindered by speed restrictions, will carry seven people at the same speed as a Pullman train. The machine will weigh about 3500 pounds, or 500 pounds to the passenger. A 7-horse-power motorcycle, weighing 150 pounds and running on a good road without speed restrictions, will transport two people on the level at a speed of 40 miles per hour; while a bicycle, weighing only 25 pounds, can be driven by an ordinary rider on a good road at from 12 to 15 miles per hour, and by a racing man at from 20 to 25 miles an hour. Even that good old standby, the two-seated buggy, weighing, let us say, 320 pounds, will convey its two passengers in comfort and safety at a speed of from 15 to 20 miles an hour. Summing up our comparative results, then, we find that the dead weight necessary to carry a passenger in a touring car is 500 pounds, on a motorcycle 75 pounds, on a bicycle 25 pounds, and in a horse-drawn buggy 160 pounds, as against the enormous load of two tons of dead weight necessary for the transportation of a Pullman passenger. It may be objected that the Pullman car represents an extreme case, and that much of the weight is due to the provision of sleeping accommodations; but we find that, even in the first-class day coach, the dead weight per passenger is very high, being, in the case of coaches accommodating, according to size, from seventy to eighty-four people, about 1 1/3 tons of dead weight per passenger.

It does not require any elaborate mathematics to show that the hauling of this enormous dead weight over the track is very costly, involving heavy maintenance expenses on the part of the railroads and proportionately higher rates for the traveling public. Apart from the large expenditure of fuel, the excess weight causes a rapid deterioration not only of the tracks and roadbed, but also of the rolling stock itself. Rails are broken, or battered down at the rail joints; rails and tie-plates are crushed down into the ties; the heads of the rails and the flanges of the wheels are rapidly ground away on the curves; and, because of the heavy impacts due to the great deadweight, there is not only a more rapid deterioration of the rolling stock, but of every part of the system that comes into physical contact with it.

The great weight of passenger cars is due in no small measure to the great length to which these cars have grown in recent years. The body of a modern Pullman, over 70 feet in length, supported on a truck at each end, may be regarded structurally as a bridge carried upon two end piers; and, in the case of the car, as of the bridge, the bending stresses tending to break it in two, and, therefore, the weight of material necessary to resist those stresses, increases in a much more rapid ratio than the length. Moreover, the concentration of weight on the two trucks calls for heavy construction in the trucks themselves; and it is a question worthy of the consideration of the car builder whether a great saving in weight would not be effected by reducing the length of the cars and substituting lighter four-wheeled trucks for the ponderous six-wheeled trucks now in use. Furthermore, the roof construction could be considerably lightened by abolishing the present ventilator and substituting a plain curved roof. Considerable weight might also be saved by abolishing the end platforms, vestibuling the car bodies directly against one another, and substituting entrances at the center of the cars.

The greatest reduction of weight, however, would come from the introduction of steel in place of wood and the application to the design of the cars of those principles of bridge construction which have rendered the modern steel bridge such a marvel of lightness in proportion to its strength and the load it can carry. We believe that the weight of our present railroad cars is due not a little to the fact that too much of the coach builder's and too little of the bridge engineer's art has been employed in their design and construction. It is one of the curious anomalies of railroading, that at this late day, when so many steels and alloys offering great strength in proportion to their weight are available, we should still be building our cars of wood and building them on such massive lines. We note that in a recent discussion of this question, as applied to street railway and interurban cars, Mr. M. V. Ayers, of the Boston and Worcester Street Railway, estimates that the weight of a 60-passenger, 31-ton car could be so greatly reduced by careful design and the use of steel, that there would be a saving of $1100 per year in power cost alone, in favor of the lighter car—an economy which would more than offset the increased cost due to special design and the use of a high-grade steel. The SCIENTIFIC AMERICAN has more than once drawn attention to this important question during the past few years, and we heartily indorse Mr. Ayers's statement that more actual saving of money can be effected by reducing the weight of cars than by any other change that can take place in the art of railroading.

REPAIRING THE CONCRETE PIER OF A BRIDGE BY INJECTION OF LIQUID CEMENT MORTAR.

During the night of the 26th and 27th of August, 1906, a Dutch steamer of 8,000 tons, the "Graenyesberg," loaded with ore, steaming through the Kiel canal from west to east, collided with the north pier sustaining the fixed truss of the swinging bridge over this canal at Osterrönfeld. The impact was so violent that the entire upper part of the pier, measuring 29½ feet in length by 19¾ feet in width, was moved in an easterly direction, and those horizontal joints about 10 feet below the water gave way, and opened to the extent of 5 to 6 inches. The most important crack was that of the lower joint, and extended first horizontally for a depth of 42 2/3 feet into the pier, then turned sharply downward for about 5 feet. This crack was about 5 inches wide. The upper two cracks were of similar dimensions, reaching only for about 18 feet into the pier, and were 4 inches to 6 inches in width. In the interior of the cracks the materials were as if crushed. The bridge rested upon this pier on a fixed anchor sill with a pan, and the violence of the collision threw the bridge 15¾ inches to the east, displacing the pan. To repair this damage, it was resolved to leave the upper part of the pier entombed, and to simply consolidate the whole of the structure by forcing in the open joints liquid mortar under air pressure. This operation had to be done entirely under water. In order to do this, the bridge was first put again in its place upon the pier, and underpinned to its proper level, so as not to disturb the railway traffic. Then the supports of the bridge upon the pier were taken away, and the work of filling in the cracked joints started. First divers were sent down to examine and properly locate the fissures, and to clear away as much as possible, without danger to themselves and to the bridges, the stones covering these fissures. Then they drove in tightly hardwood wedges in the open cracks in their entire length, and calked them with oakum. Eighteen of these wedges had lengthwise semi-cylindrical notches, and were driven in in pairs, so as to form a hole for the reception of nine pieces of iron pipe with threads on the projecting end, on which an elbow could be screwed on. Through these pipes the liquid cement mortar was to be forced into the cracks. On these elbows were screwed on vertically pieces of gas pipe 19¾ feet long and 1 3/5 inches in diameter, fastened to the pier by means of clamps. The upper ends of these pipes were connected to rubber tubes, conveying the liquid mortar under pressure from the injection tanks.

In order to tighten the work still more, a canvas 5 feet wide was fastened upon the damaged part of the pier, securely rolled on top and at the bottom over two steel cables wrapped up in oakum and twisted straw and solidly anchored to two piles driven alongside of the pier on both sides, and these piles again were fastened to one another by chains drawn tight. Upon this canvas were vertically fastened, from 8 inches to 10 inches strips of wood 1 3/5 inches to 2¾ inches thick, the whole tightly secured by two iron bands, anchored to the piles and tightly wedged against the pier. This preliminary work was completed in fifteen days. The gas pipes were now put in place, and the operation of filling in the cracks begun. Two scows were anchored against the pier. One carried the engine driving the air compressor, and the air tank for the compressor; the other three tanks to contain the liquid mortar and the necessary material for filling the tanks. These three tanks were connected with the compressed-air tank and with one of the gas pipes. The air tank had a gage and a valve, and was connected by means of a cock with three openings with the mortar tanks. This cock was so constructed that only one tank at a time was connected with the air tank. Each of the three tanks had a funnel for the purpose of filling them; an agitator with a handle, for the mixing of the mortar in the tank to avoid settlement; a discharge cock opening and closing the flow of the mortar into the tube connected with the gas pipe.

The mortar used was composed of one part Portland cement and one part fine sand, with the addition of a volume of water equal to the volume of the mixture. The mortar was poured into the tanks, each of 74 quarts capacity, and forced into the cracks by means of the gas pipes. The maximum pressure was 141 cubic feet, and the work, started at 7 A. M., was finished by 9 P. M., by which time the mortar ascended to the mouth of the gas pipes, so indicating that the cracks were tightly filled. This was also confirmed by the divers, who reported that the mortar had bulged the canvas and made excrescences all around the joints.

The total quantity of forced-in mortar was 494 cubic feet, representing two hundred fillings of the tanks.

For the purpose of ascertaining how the mortar would behave under water, a wooden box lined with canvas was sunk alongside the pier at a depth of 10 feet and filled in in the same manner as the cracks. The contents of the box were examined after two weeks', and again after four weeks' immersion. At the same time the mortar in the cracks was examined by boring holes 3/5 inch in diameter in the same. At the end of five weeks the setting was considered sufficient, and on the 25th of October, 1906, the resistance tests of the pier were made. These tests were a complete success, and the circulation of the trains was immediately restored. Since then the filled-in joints have not shown any tendency to slide or to settle. The cost of the repairing was about $2,171, and the entire putting in order of the bridge for travel about $3,136. This expenditure is considered very low, and certainly much lower than if the pier had to be demolished and reconstructed.—Translated from Génie Civil.

A FEW SUGGESTIONS FOR INVENTORS OF SAFETY DEVICES.

BY EDWIN PHILLIPS.

When our forefathers first went down to the sea in ships, little was known or even thought of safeguards or "prevention." They put off to sea almost wholly at the mercy of the waves and when storms arose were in grave jeopardy. To begin with, there were no rudders to steer by, keels to prevent rolling, anchors to "let go," mariner's compasses to direct a course, life-saving apparatus for emergencies, storm warnings to put them on their guard, nor lighthouses to spread welcome beams across the broad expanse of waters. But to-day, thanks to invention, the hardy mariner possesses all these. Also many more. But more still are wanted, for hardly a month elapses but losses of life occur upon our coasts, many of which losses could be averted. Science has made efforts innumerable to anticipate storms and thereby prevent their dangers. For the sake of man's humanity to man such efforts need direct encouragement.

"How true," wrote Carlyle, "is that old fable of the Sphinx who sat by the wayside proposing her riddles to the passers, which, if they could not answer, she destroyed them." The riddle of the hour is, How can we encourage "prevention"? Why should not dray and other road vehicle wheels have a guard depending in front of them—a combination footstep, handrail and body pusher, for example? Have not fly and other wheels in factories a guard? It cannot be denied that about moving wheels there is an element of danger. "Dad, I won't carry stones any more," were the dying words of a sixteen-year-old youth in Melbourne not long since. At the inquest on his remains at the morgue it appeared that he was leading a horse drawing two tons of spawls, when, said an evening paper describing the event, he slipped, and the wheel passed over his body. Foot passengers crossing streets are liable to the same accident, and it is by no means an infrequent occurrence. The dangers attending such a fall are considerably reduced if there is a guard to push the prostrate one aside. Very true, very true indeed are Zimmerman's words, and they call for serious thought: "Laws act after crimes (accidents) have been permitted; prevention goes before them both."

"There's no education like adversity," said Disraeli, which being modified might read: "There's no education like accidents." In the past, accidents, because they have been accidents, have generally been regarded as unavoidable. But investigation teaches that in the future they may be perceived through different spectacles. Experience shows that accidents may be divided into two classes—(1) preventable, (2) unpreventable. It further shows that a hard-and-fast line can be drawn between those that can be avoided and those that cannot. Likewise that the list of accidents in variety and number is increasing every year with the increased invasion of new types of machinery. By thought and reform, accidents which were formerly consigned to the second or unavoidable class are now elevated to the first or preventable class.

The heroes of science, chemistry, and physics have in the past held doctrines that they dared not promulgate publicly. If they did it was with the fear of death to themselves and delay to the cause. That the sun and planets revolved round the earth was once a common belief. Giordano Bruno knew otherwise and for saying so was (about 1600) burned at the stake and his ashes cast to the winds. To-day his theory is an accepted fact. When Boyer in France, more than a century ago, preached inoculation as a preventive of smallpox, when Edward Jenner about 1790 announced his doctrine of vaccination, both the pulpit and the press strove to talk and write them down. A desperate battle against overwhelming opposition had to be fought before people could accept the new theory. But the great truth conquered; and another great truth is that nearly all the ailments to which flesh is heir may sooner or later succumb to preventive measures. If, with the limited knowledge of those days, Dr. Jenner could discover a preventive for smallpox, with the scientific progress made since there should be no difficulty in discovering means for preventing pneumonia, diphtheria, bubonic plague, influenza, etc. The day may, and should, soon come when instead of the human arm having one mark on it as an indicator that smallpox has been warded off, it will have many marks for each of the diseases enumerated, in fact a mark for each disease as man one by one conquers them. It is a vulgar error to assume that prevention will win no more victories, but is dead.

SCIENCE NOTES.

According to a recent census the total population of the Canal Zone is 50,000. Of this number 24,963 persons are employed either by the Isthmian Canal Commission or the Panama Railroad Company. Of the total population 14,635 are white, 34,785 are negroes, and 583 are Chinese. Of the whites 6,863 are from the United States, and of these 5,213 are males and 1,650 females; 2,030 married men and 1,048 married women; 2,713 single men and 172 single women; 451 children, 232 boys and 219 girls between the ages of 6 and 16 years. There are also from the United States 73 colored persons, 57 males and 16 females. The total cost of taking the census is given at $3,936.36.

In sinking an artesian well at Newlyn an interesting discovery has been made in tapping springs of highly mineralized water. The sinking of the well was undertaken for Mr. R. R. Bath, and the Newlyn Ice Company, in connection with the factory which has been erected for the manufacture of ice, to procure water to use in ice-making. A depth of about 180 feet has been reached, two tin lodes having meanwhile been passed through, and water from the springs reached was submitted for analysis to Mr. J. H. Bosanko, of the Penzance Mining and Science Schools. He was surprised to find that the water was highly mineralized. The simple test revealed an abnormal quantity of iron in the water, showing that it must be running through rich mineral veins. No water of this description has ever been found in West Cornwall, and it is thought that perhaps it may possess medicinal properties of some value.

From experiments conducted at Ottawa, in Canada, it appears that there are some slight grounds for the widely-accepted opinion among agriculturists that snow is a direct fertilizer, says the Pharmaceutical Journal. It is found to contain total nitrogen equivalent in round numbers to about a pound per acre of land covered by an average winter snowfall in that district. The amount of nitrogen as free ammonia was high, but fluctuated greatly, from 0.082 to 0.589 parts per million; the nitrogen as albuminoid ammonia ranged from 0.033 to 0.078 parts per million, and the nitrogen as nitrites and nitrates ranged from 0.027 to 0.390 parts per million. The average of twelve determinations from February 21, 1907, to May 4, was, nitrogen, as free ammonia 0.256, as albuminoid ammonia 0.052, and as nitrates and nitrites 0.163 part per million. The value of snow as a direct fertilizer would appear, so far as the nitrogen content is concerned, to be greatly overestimated. It is intended to continue the experiments both in summer and winter to determine definitely the manurial value of both snow and rain.

THE CURRENT SUPPLEMENT.

The extent to which electricity is used in the manufacture of street gas is hardly realized even by technical men. How much can be done by electrical means to simplify the handling of material in gas-works is set forth by Dr. Alfred Gradenwitz in the opening article of the current Supplement, No. 1708. In an Austrian oil-field there was recently installed the first machine for the extraction of oil from bore-holes by the Leinweber system. The installation is described by the English correspondent of the Scientific American. E. S. Lincoln contributes an article on "Testing Direct-current Dynamos." The Hon. Robert J. Strutt, well known as an authority on radioactivity, explains in a characteristic, clear style the radioactive changes in the earth. Charles L. Hubbard gives a brief review of liquid fuel for the benefit of those who desire a general knowledge for purposes of comparison without going too much into details. "Training the Man Behind the Gun" is the title of a stirring article that reveals the secret of the marvelous success achieved by the skilled naval gunner in firing at targets. The daily press has commented at length on the highly dramatic paper read by Francis Darwin before the British Association for the Advancement of Science, in which he explained his theories of the memories of plants, and his view that the development of any living creature from an egg seems to presuppose something akin to biological memory. The first installment of the paper appears in the current Supplement. The improved Parseval airship, which has aroused almost as much interest as Von Zeppelin's gigantic, ill-fated craft, is described and illustrated. Eugène Lemaire explains how parchments injured by fire may be restored. Does the planet Venus revolve on its axis, or does it always present the same side to the sun? The question is one that has long puzzled astronomers. Otto Hoffmann considers the question from both sides, and produces all the available evidence for and against rotation.

THE NARROWING OF THE GANGES AND CONSTRUCTION OF THE CURZON BRIDGE.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

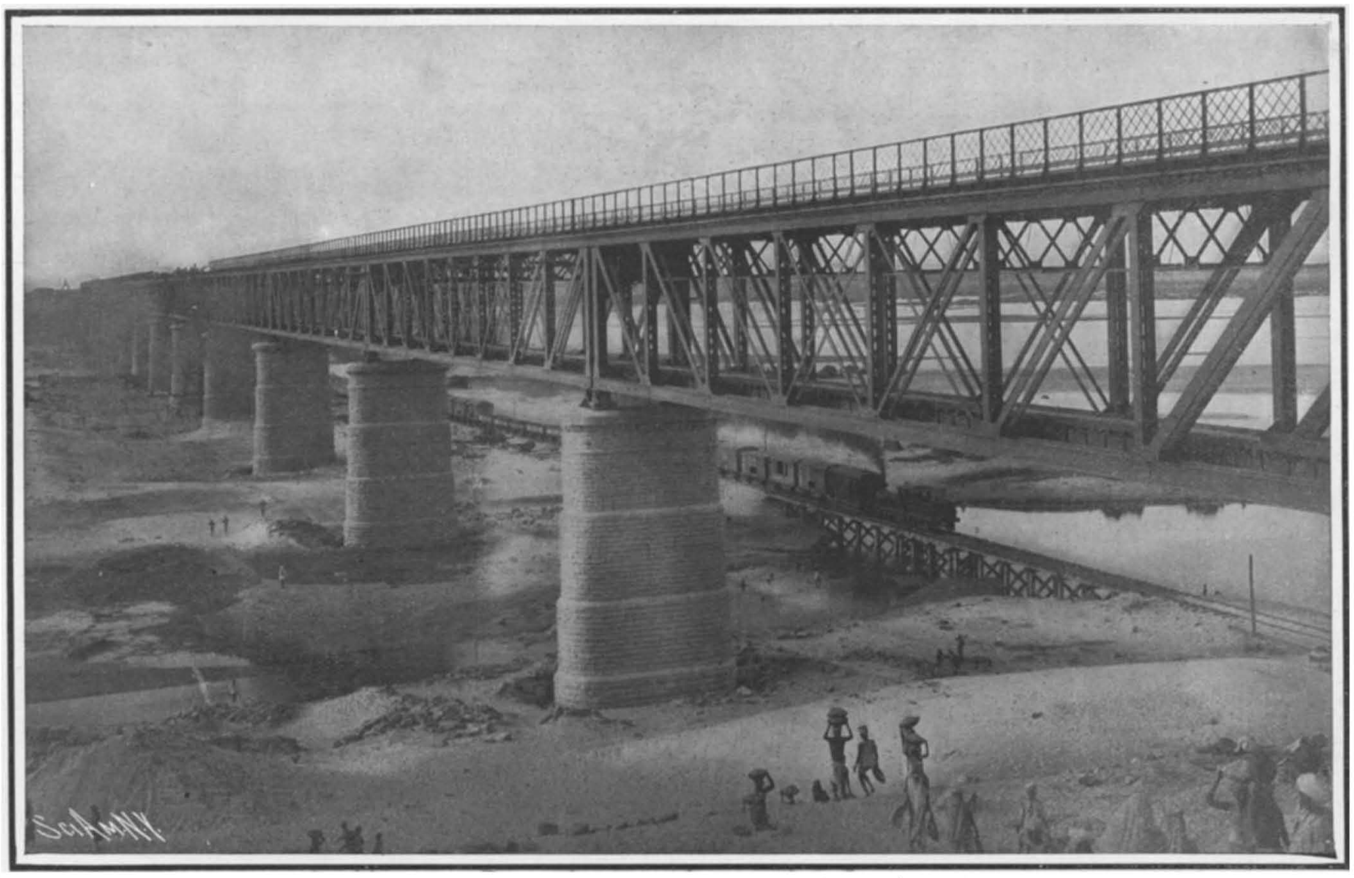
In the bridging of such alluvial rivers as the Ganges, Chenab, Sutlej, etc., in India, it is not unusual to constrict the river's channel for the purpose of expediting and economizing the cost of bridge construction. Many of the more important waterways are extremely wide, the water during periods of flood having eroded its way unchecked through the soft banks on either side of its normal channel, until further expansion has been checked by the presence of inerodible soil. Under these circumstances the rivers assume great widths, and in the flood season form a body of water possibly three miles or more in width from bank to bank. In the dry season, however, when the river is at its lowest level, large tracts of sand are exposed where the water has receded. Under such circumstances the throwing of bridges across such unrestricted waterways is an expensive, protracted, and difficult undertaking, while the possibility of reclaiming the area inundated is impracticable. The most efficient and economical solution of the difficulty, however, which has yet been found is the construction of an embankment, or training-bund, parallel with the navigable channel at a selected point, so that the course of the waterway is a constricted passage, the flow of water on the inner side of the training bund being blocked by the approach bank leading to the training-bund and the bridge. This system was first employed by Mr. J. R. Bell in carrying the Northwestern State Railroad across the Chenab River at Sher Shah in 1888, and it proved so successful that such works are now extensively employed. The latest and largest example of such work is the left-bank training-bund of the Curzon Bridge at Allahabad. The Curzon Bridge is on the line of the new Allahabad-Fyzabad Railroad, 97 miles in length, which offers a direct route between the city of Allahabad, the Oudh province, and Bombay and Lucknow. It is of the double-deck type, the lower deck carrying the 5-foot 6-inch gage of the railroad, and the upper deck a thoroughfare for vehicular and pedestrian traffic. At the point where the bridge crosses the Ganges, the waterway is approximately 1.25 miles in width; but by the provision of the training-bund, the bridge section is reduced to about 3,000 feet, comprising fifteen spans each of 200 feet length, so that the bridge itself occupies less than one-half of the width of the river. In the neighborhood of the city of Allahabad the river flows between two high banks of hard clay, which even the flood waters have failed to erode, the distance from bank to bank being about three miles. This width is entirely covered with water during the flood season, the water thus filling practically the whole of the valley. Just below the city, however, the waterway, owing to the natural configuration of the country, is decreased in width to about 1.25 miles, and this site was selected as the most favorable for the construction of the proposed bridge. The normal width of the river channel in the cold weather, however, is only 600 feet, the depth of water being about 25 feet. During the flood season the river rises at this point as much as 31 feet, the volume of water being swelled by the discharge from the Jumna, the confluence of which with the Ganges is about seven miles above the bridge. As a result of the preliminary surveys, it was decided that the waterway could be advantageously guided through a channel 3,000 feet in length, by the construction of a training-bund on the left bank. The whole of the work was designed by Mr. Robert R. Gales, M. Inst. C. E., engineer in chief of the Coonoor Railroad, to whose courtesy we are indebted for the illustrations.

The training-bund itself, which is over 4,000 feet in length, rises to 5 feet above flood level of the river. The upstream section is about 3,300 feet in length, measured from the center line of the approach bank communicating with the left-hand shore. The extremity of the upstream section has a sharp curve of about 570 feet radius. This was adopted in order to protect the training-wall from the scouring of the river, and the eddying currents which are produced when the extremity is straight. In the Curzon bund, however, the engineer anticipates that from the form of extremity adopted this destructive action, if not entirely overcome, will at any rate be considerably reduced; a result which appears to be borne out by the behavior of the bund during the short time it has been completed.

The bund, itself constructed of the sand which forms the river bed, is armored on the river side with stone pitching some 4 feet in thickness on the 2 to 1 slope, from the river bed up to flood level, while on the land side the sand bank is covered by layers of earth and broken debris, and planted with sarpat grass, the fibrous roots of which serve to hold the fabric together. The crown of the bank has a width of about 20 feet, and carries a 5-foot 6-inch gage railroad, so that in the event of any portion of the embankment being damaged, further supplies of stone may be readily brought up and dumped at the point of attack.

The construction of the training-bund presented several difficulties, the greatest of which was the shortness of the season in which the work could be carried out. Consequently, the greatest advantage had to be taken of the period available, especially as the whole of this work was being undertaken in the river bed. Owing to the magnitude of the undertaking, it was found impossible to place this section of the work in one contract, and it was accordingly divided into sections and distributed among several contractors. When the time approached convenient for commencing operations, at the middle of November, the labor was crowded upon the spot, until as many as 7,000 coolies were engaged in building the approach bank and training-bund at one time, the whole of this work being carried out by native labor. When it is remembered that some 7,000 feet of embankment, comprising 3,000 feet for the approach bank and 4,000 feet for the

(*Continued on page 206.*)



The Curzon Bridge Practically Completed, Showing Temporary Line in River Bed.

THE NARROWING OF THE GANGES AND CONSTRUCTION OF THE CURZON BRIDGE.

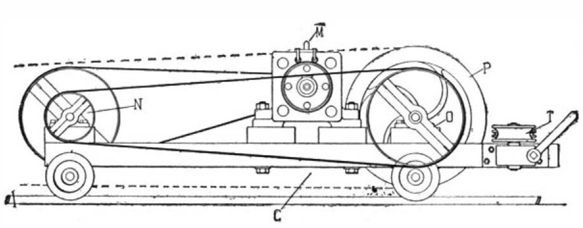


Fig. 1.—Diagram of Electric Motor and Tension Carriage.

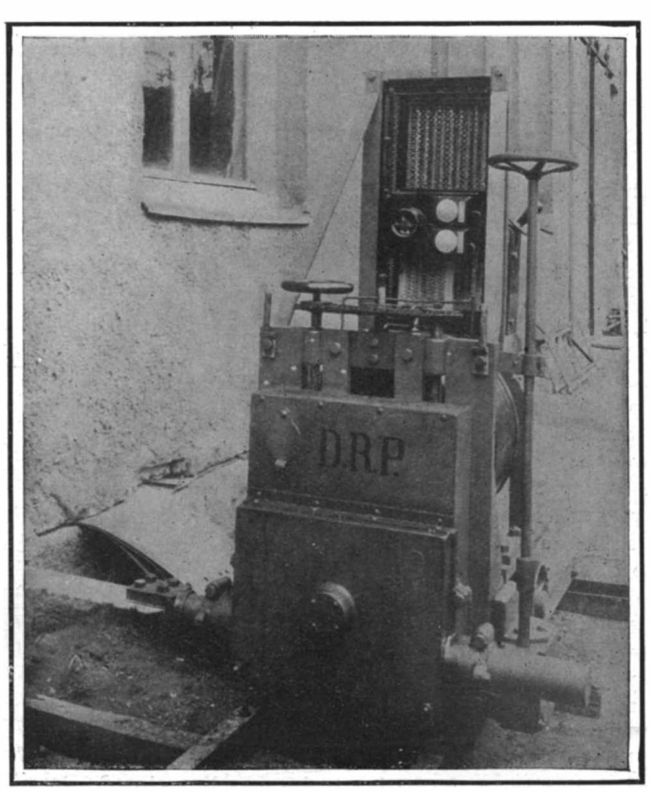


Fig. 2. Machine Which Saws Through Stone Walls and Inserts Sheets of Lead to Protect Buildings from Dampness.

Fig. 3. Interior of Church Showing Machine in Position.

SAWING BUILDINGS IN TWO.

SAWING A BUILDING IN TWO.

Dampness not only makes buildings unwholesome places to live in, but often injures them and hastens their decay. It is due, in many cases, to moisture absorbed from the soil through the foundations and distributed throughout the walls by capillary action. The oldest church in Munich has recently been protected against further invasion of dampness by the radical method of sawing the stone foundations in two, horizontally, and inserting sheets of lead, which dam the capillary channels and form an impassable barrier to the ascent of water. The operation was performed by a specially devised machine, driven by an electric motor, which automatically inserted the sheets of lead as the saw cuts were made in the foundation walls.

No less remarkable was a somewhat similar operation performed on a structure in Paris.

A four-story building was sawn in two, from top to bottom, by means of a twisted wire cable. The building is an electrical substation belonging to the Compressed Air Company, and its four stories are fitted with storage batteries, which serve to regulate the 500-volt direct current furnished by another station. In consequence of the increase in business and the impossibility of placing additional accumulators in the building, the floors of which already bore a load of more than 200 pounds per square foot, it was decided to install in the ground floor, basement, and cellar, motor generators driven by a high-voltage alternating current, for the purpose of furnishing additional current at 500 volts. It was also decided to sever all connections between the station and the adjoining buildings, in order to avoid claims for damage arising from the vibration caused by the powerful motor generators.

There were no party walls to be cut. The station is a steel-frame building, and it was connected with the adjoining buildings only by the front wall and the stone piers of the foundation, but it was a sufficiently difficult task to divide these without endangering the buildings or interrupting the service. The problem was solved very ingeniously by the employment of a twisted wire cable.

The idea of sawing stone with an endless wire cable conveying a mixture of water and an abrading powder is more than fifty years old. In 1854 François Eugene Chevalier obtained a patent which covered all possible applications of metal wires and cables to the sawing of stone. In this patent Chevalier claimed the employment, for the purpose of sawing, of one or more metallic wires, ropes, or chains, operating by a continuous or alternating rotary motion and possessing the properties of flexibility and of change of direction, so that a block of stone can be attacked simultaneously along all imaginable lines.

This interesting method, however, soon fell into oblivion, and there remained until 1880, when it was revived by Gay and Thoner. Four years later Thoner introduced two important improvements, ball-bearing pulleys and a device for cutting large holes for the separation of blocks from the original rock in quarries.

The method still presented a serious practical inconvenience, the liability of the wire to rupture and the difficulty of repairing it. The most carefully executed solderings and brazings proved ineffectual, but at last a workman conceived the happy idea of cutting the strands of broken cable to different lengths and making a splice 12 or 13 feet long. Thenceforth the employment of twisted wire cables became general in marble and granite quarries. This method of sawing stone combines rapidity with economy, avoids the employment of explosives, and, above all, makes unnecessary the excavation of trenches in the rock, an operation which is both tedious and costly. But the method was never, to the writer's knowledge, employed for cutting a building in two until it was applied to the electrical station in Rue St. Roch.

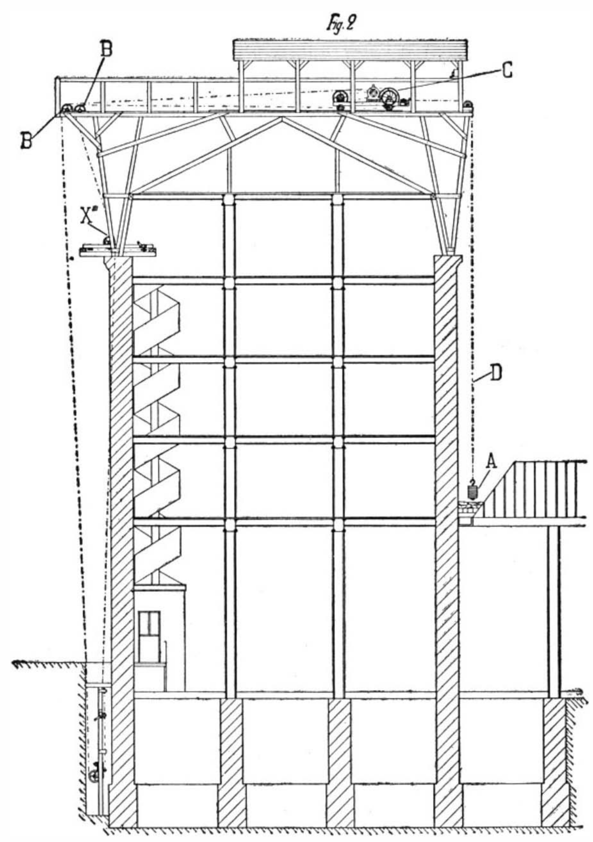


Fig. 4.—Diagram of Building, Showing the Cable Arranged for Sawing the Façade.

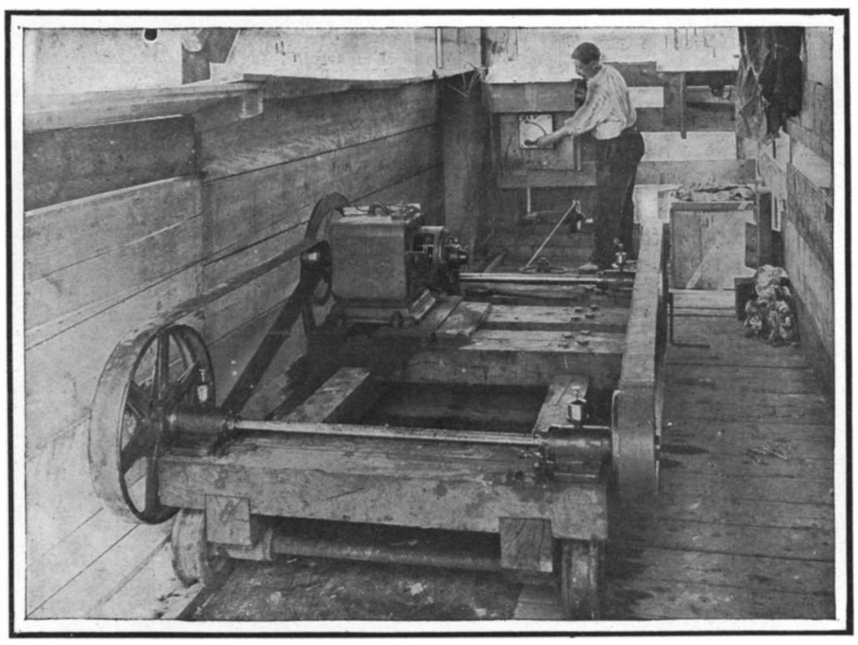


Fig. 5.—Electric Motor and Tension Carriage.

The work comprised the sawing of the façade and the foundation piers at each side of the building. It was begun by erecting two wooden towers and joining their tops to the roof by bridges for the support of the tension carriages and motors operating the wire cable. Then two shafts 21 feet deep (the depth of the foundations) were sunk in the street, and a hole about an inch in diameter was drilled horizontally through each foundation pier, immediately beneath the iron plates on which the iron columns of the superstructure rested. The doubled cable was passed through these holes.

The tension carriage *C* (Fig. 1) consists of an oaken frame mounted on four wheels. It runs on rails on the bridge, and carries an electric motor *M* of 4 horse-power. This motor drives the cable by means of the reducing train of wheels *N O*, which gives the cable wheel *P* a speed of 180 revolutions per minute, and the cable a linear velocity of about 22 feet per second. The carriage is drawn back and the sawing cable kept taut by means of the winch *T* and a fast and loose pulley and clutch operating on the cable *D* (Fig. 4) which hangs vertically over the yard of the building and bears at its lower end a weight of 440 pounds. Bags of sand are placed at a little distance below this weight, to receive it without shock in case of rupture of the sawing cable.

The sawing frames, which are shown in operation on the foundations in one of the photographs, are very similar to those used in stone yards. A carriage slides between two parallel iron guides connected by cross pins at their ends and by a stirrup in the middle. This carriage bears a wheel which presses against the sawing cable and guides its movements. The carriage and wheel are raised and lowered by an auxiliary wire cable and a winch. In the shaft in the street is a second guiding frame, consisting of a carriage and fast and loose pulleys.

In sawing the foundation piers the sawing cable runs from the wheel *P* of the motor, over the wheel *B*, descends thence into the shaft to the street, and, guided by the frame described above, passes through the small holes drilled in the piers. After traversing the entire row of piers the cable passes round a

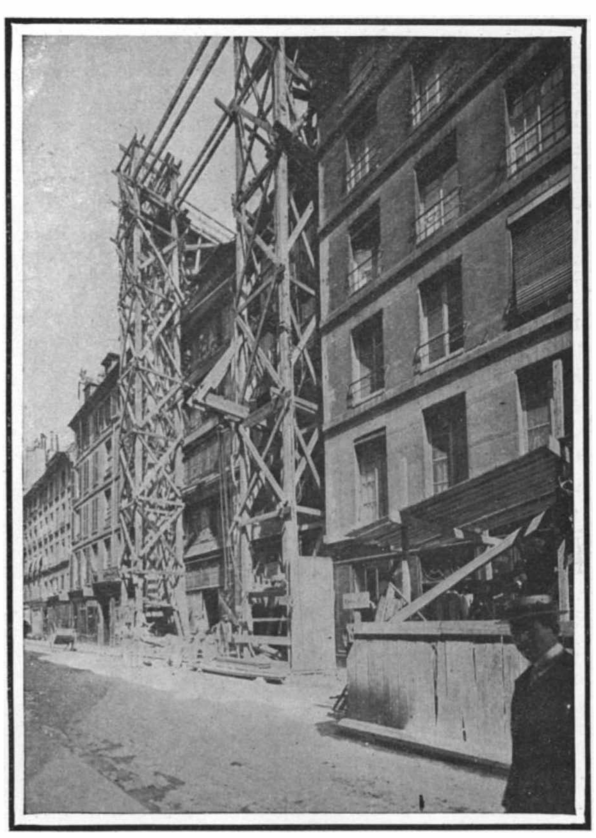


Fig. 6.—Front of Building, Showing Scaffolding.

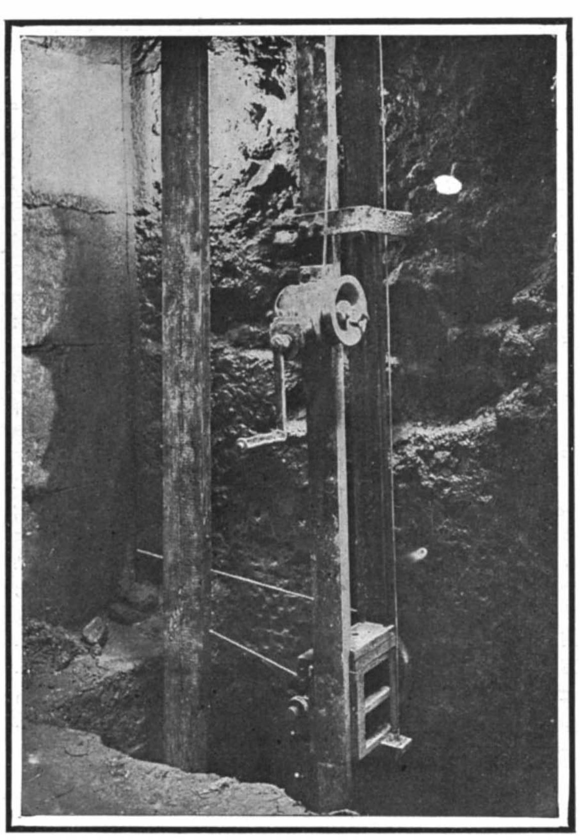


Fig. 7.—Arrangement of Cable at Foundation.

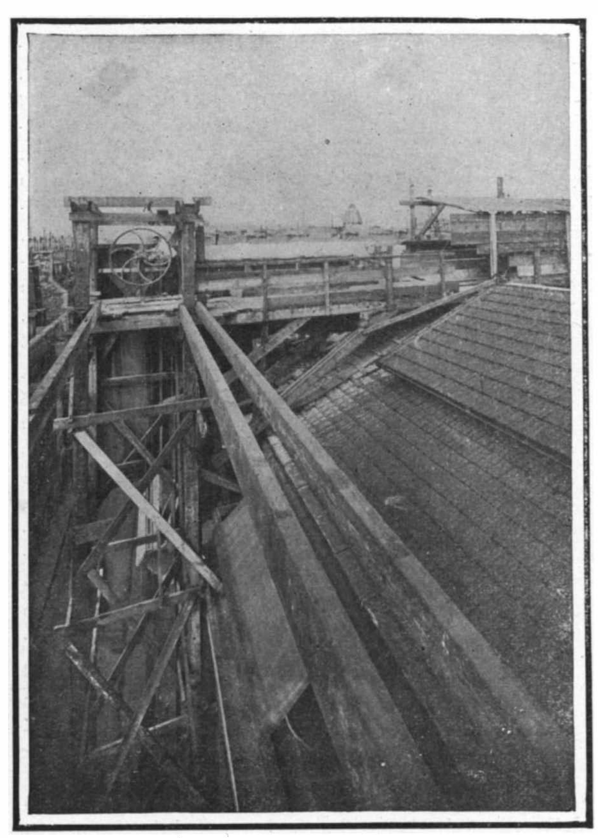


Fig. 8.—Bridge and Top of Tower.

SAWING BUILDINGS IN TWO.

pulley, and returns through the same holes to the shaft in front of the building, and thence ascends to the bridge at the top, and passing round a second wheel *B* returns to the motor wheel *P*. In front of each pier, at the level of the lower or cutting part of the cable, is placed a fine jet of water carrying fine sand in suspension. The sand gradually wears away the stone, the cable serving only to convey it. As the work advances, the pulley frames are lowered by turning the winch, the tension of the cable being maintained constant by means of the carriage *C*.

As a rule, the vertical cut through the line of piers was deepened at the rate of about 5 inches per hour. As the cable returned through the cut, it was abraded very rapidly, so that although it was more than 300 feet long, it was found necessary to replace it at the end of twenty hours of work, which corresponds to an aggregate surface of cut equal to 121 square feet. In the concrete bases of the piers the process was reduced to 3.2 inches in a day of eleven hours by the heterogeneous character of the concrete and the sand and flint which it contained.

When the piers had thus been sawn from top to bottom, the sawing cable was raised to its initial position, immediately beneath the iron bedplates, and a horizontal cut, 2 inches deep, was made by shifting the pulleys laterally to this distance, and forcing the cable against the masonry by a series of iron bars. A second vertical cut, extending to the bottom of the piles, was then made. In this way a vertical slice, 2 inches in thickness, was removed from each pier, on each side of the building.

A slice of the same thickness was removed from each side of the façade by a similar series of operations, in which the cable was pressed obliquely against the façade by means of the pulley *X‴* (Fig. 2). When this oblique cut had advanced so far that the top of the wall was cut through and the cable had begun to attack the middle of the height, the upper pulley was drawn back, the pulley at the base was pushed forward, and the lower half of the wall was sawn obliquely in a similar manner. Then the remainder of the cut, involving the whole thickness of the wall at mid-height and a thickness gradually decreasing above and below this point, was made with the cable vertical. A second cut, 2 inches distant from the first, was made by a similar series of operations, and the intervening slice of wall was removed.

The work of sawing this building in two with a wire cable was accomplished both rapidly and cheaply.

THE NARROWING OF THE GANGES AND CONSTRUCTION OF THE CURZON BRIDGE.

(*Concluded from page 204.*)

training-bund, representing a total quantity of some 50,000,000 cubic feet of earthwork, had to be handled, the magnitude of the task may be realized.

The construction of the bridge proceeded simultaneously with the building of the earthwork revetments, operations being commenced from the right-hand bank. To facilitate these operations and the transportation of the necessary materials to the sites of the foundations for the piers, a temporary railroad was laid on piles on the river bed as soon as the water had receded sufficiently. As already mentioned, the bed of the river is composed of fine sand, which extends on the average to a depth of 100 feet, where impermeable clay is encountered. The pier foundations had consequently to be carried down to a great depth, and this work was carried out upon the well-sinking principle. In executing this part of the work, the engineer made a series of calculations, by means of which he was able to deduce the weight of well required to sink by open dredging to any required depth through sand and the relationship of skin friction to the increase in depth. This is probably the first attempt to indicate such data in advance of operations. In the course of an exhaustive paper, recently communicated to the British Institution of Civil Engineers concerning the construction of the Curzon Bridge, Mr. Gales refers to this question of "sinking effort" at great length.

Owing to the bridge being designed to carry only a single track, the form of well adopted was of the double octagonal type, the curbs being 33 feet 6 inches long by 19 feet wide. The sinking plant comprised steam hoists so disposed as to be capable of serving two wells, so that merely by slewing round the sinking of one well could be carried out while the other was being built on. Taken on the whole, sinking was completed rapidly; but in one or two cases, owing to substrata of hard clay and conglomerate being encountered where only sand was believed to exist, these operations were somewhat delayed, since it was found that the dredges could not make any effect upon certain material which had to be removed by blasting. The wells were sunk until they became stanched in the clay, which was found to be extremely hard, efforts to drive the wells more than a few feet into the strata proving unavailing, even when artificially loaded with iron rails, pig iron, sand, etc., to the extent of 1,000 tons or so, as shown in the engraving. The wells were for the most part built of brick, and were carried up to within two feet of the lowest water level recorded, when the construction of the piers was commenced. The piers are of masonry, two kinds of native stone being used, one for the external walls and the other for the hearting. The wells themselves were filled with sand, ballast, and concrete as follows: The bottom of the well to the top of the cantplate of the curb with sand, followed by 9 feet of cement concrete. Upon this was pure sand for a depth of 41.25 feet, followed by a layer of sand and brick ballast rammed down for another 40 feet (the sand filling the spaces between the ballast), and crowned by 10 feet of rammed concrete. The piers themselves are stepped, so that a slight batter is secured. The bottom layer of masonry is 35 feet in length by 20.5 feet wide, while that carrying the cornice is 29 feet long by 14.5 feet. The height of the masonry piers in each case, with the exception of the shore and training-bund abutments respectively, is 60 feet. The piers are carried up a sufficient height to give a clearance of 31 feet between the normal level of flood and the under side of the girders. Even should the waterway again attain its highest recorded rise of 41 feet, which was registered in 1875, this will still give a headway of 21 feet.

The girders are of the single triangulation N type, having nine bays each of 25.75 feet length center to center, representing 200 feet in clear span, while they are 25.75 feet in height. The total amount of steel work in each span, including the flooring of the public roadway on the top deck, is 320 tons, aggregating 4,800 tons for the whole bridge.

The top deck carrying the public roadway has a clear inside width of 23 feet 2 inches, and is carried at a height of approximately 60 feet above ordinary high flood level of the river. There is a metaled roadway 15 feet in width, flanked on either side by a timber sidewalk 49 inches wide. Access to the top deck is obtained from the approach banks at either end of the bridge over steel viaducts.

The time occupied in carrying out the whole undertaking, from the commencement of the preliminary operations to the running of the first train over the bridge, was exactly three working seasons, and its rapid completion testifies to the energy with which the whole task was carried out. By narrowing the course of the river through the construction of the heavy training-bund, and thereby shortening the length of the bridgework, a saving of over $500,000 was effected. Despite the departure from general practice in the design of the training-bund, the initiative of the designer is evidently completely justified, since no signs of the defects which have characterized previous works of this type have yet developed, though it has been subjected to exacting tests by high floods.

Sven Hedin's Return.

Sven Andera Hedin, the explorer, who started in 1906 from Chinese Turkestan on a journey through Tibet, and concerning whose whereabouts there was great anxiety for many months, has arrived at Simla.

He traveled 4,000 miles or more, mainly in western Tibet, and did not see a white face until he reached the province of Pobo. Dr. Hedin states that he made valuable discoveries, but that there still was ample room in Tibet for future explorers.

Summarizing the remarkable achievement of Sven Hedin, the New York Sun thus comments editorially:

When Sven Hedin reached Gartok in the southwestern part of Tibet, late last year, he gave out that he was going to Ladakh in Cashmere, and in the spring he would travel either to India or to Peking. The event shows that he had in view another long journey in the unexplored part of Tibet. He went north to Leh, the chief town in Ladakh, ostensibly to spend the winter but actually to outfit and push again into northwestern Tibet in order to make another route through the vast unmapped region to the west of his route in 1906.

This secrecy was necessary because the Tibetans were determined to prevent him from renewing his travels in Tibet. He did not even impart his plans to his family, and they were anxious for his safety when they failed to hear from him last spring. But he has reached civilization again and is now going home after experiencing last winter the acutest phase of his privations and losses during his migratory tent life in the bitter cold of the Tibetan winter two miles and a half or more above the sea.

The work of Sven Hedin in these three years, 1906-1908, will rank among the great achievements of exploration. The results obtained are enormous in spite of the active opposition of the Indian and Tibetan officials, who did their best to prevent the explorer from getting into the country at all.

The work, spread over three years, is embraced in three journeys, each distinct from the others. In 1906 Hedin entered the northwestern part of Tibet at Aksai Chin (White Desert), crossed the vast unexplored region of western Tibet from northwest to southeast, traveled 840 miles without touching the routes of any earlier explorers excepting where he crossed the tracks of Bower and Littledale, and discovered mountain ranges, new lakes and rivers and gold fields.

The second journey, which filled most of 1907, was west from Shigatse through the southern part of the unknown area, about 1,000 miles to the southwestern corner of Tibet. On this eventful expedition Hedin discovered the sources of the Brahmaputra, Indus, and Sutlej rivers, and found that the Nin Chen Tangla Mountains, well known south of Lake Tengri, are simply part of a chain extending, he believes, clear across Tibet east and west and at least 2,000 miles long.

The third journey, just completed, carried Sven Hedin again from north to south across unknown expanses he had not seen on his route of 1906. He found everywhere repeated the mountains and valleys interspersed with fresh and salt water lakes that he had discovered two years before. He has proved that the great white expanse on the maps is practically filled with these features, for no part of it has been found to be an extensive and comparatively level plain.

In this last journey Hedin crossed the Nin Chen Tangla three times—he had crossed it five times on his first and second journeys—and he now reports complete proof that the mighty range is continuous to the western border of Tibet. Although the absolute height of all these Tibetan mountains is very great, they are not remarkably impressive as seen rising from plateau surfaces that are 16,000 to 18,000 feet above the sea.

Sven Hedin reports that he has saved his scientific material. No other pioneer explorer has ever produced better surveys for map purposes, and it is certain that his map sheets will fill with accurate details a large part of the regions both in northern and southern Tibet that were marked "unexplored" on the Royal Geographical Society map of Tibet prepared three years ago.

Coming Aeronautic Contests.

The recently-formed Aeronautic Society, mention of which has already been made in these pages, has leased the Morris Park race track in Westchester, and moved its headquarters to the club house adjoining. This fine oval course is 120 feet wide with a 1½-mile circuit, while a ⅞-mile straight track runs diagonally across it. The fences have been removed, thus making the place an ideal one for aeronautic experiments. Altogether, there is a field of 325 acres over which flights may be made. There are ample sheds for the storage of flying machines, and a machine shop will soon be ready. All members may take advantage of the exceptional facilities thus provided for aeronautical experimentation. In addition to these, Mr. W. R. Kimball will loan members the 50-horse-power 150-pound motor (which at present he has mounted upon his helicopter) for the purpose of trying out flying machines which they may have constructed but for which they have no motor. A tower with dropping weight (like that used by the Wrights) has been built for the purpose of launching gliders, and on October 17 it is proposed to hold contests for man-carrying and model gliders, self-propelled model and full-sized aeroplanes, a kite-flying competition, etc. While the Aeronautic Society intends to experiment in all branches of aeronautics, its members are chiefly interested in heavier-than-air machines. Several of these, including the Kimball helicopter, are now being experimented with at the race track. The society welcomes all inventors who are striving to advance the art and science of aeronautics and every facility will be given them to try out thoroughly their machines. For full particulars regarding the contests, address the Aeronautic Society, Morris Park Race Track, Westchester, N. Y.

Energy Consumed for Light.

In a lecture delivered by Sir James Dewar on "Flame" before the Royal Institution in London he showed the large amount of energy expended in the production of a small amount of light. The following figures show how inefficient the various lighting devices now employed are from a scientific point of view: Candle: Percentage of light, 2; non-luminous energy, 98. Oil: Percentage of light, 2; non-luminous energy, 98. Coal gas: Percentage of light, 2; non-luminous energy, 98. Incandescent lamp: Percentage of light, 3; non-luminous energy, 97. Arc lamp: Percentage of light, 10; non-luminous energy, 90. Magnesium lamp: Percentage of light, 15; non-luminous energy, 85. Incandescent lamp: Percentage of light, 99; non-luminous energy, 1.

Fire and Water-proof Cement.—Mix 10 parts of finely sifted unoxidized iron filings and 5 parts of perfectly dry, pulverized clay, with vinegar spirit, by thorough kneading, until the whole is a uniform plastic mass. If the cement thus made is used at once, it will harden rapidly and withstands fire and water.—Werkstatt.

Are Growth and Evolution Forms of Memory and Habit?*

BY FRANCIS DARWIN, M.A., LL.D., F.R.S.

Sleeping plants are those in which the leaves assume at night a position markedly different from that shown by day. Thus the leaflets of the scarlet-runner (*Phaseolus*) are more or less horizontal by day and sink down at night. This change of position is known to be produced by the alternation of day and night. But this statement by no means exhausts the interest of the phenomenon. A sensitive photographic plate behaves differently in light and darkness; and so does a radiometer, which spins by day and rests at night.

If a sleeping-plant is placed in a dark room after it has gone to sleep at night, it will be found next morning in the light-position, and will again assume the nocturnal position as evening comes on. We have, in fact, what seems to be a habit built by the alternation of day and night. The plant normally drops its leaves at the stimulus of darkness and raises them at the stimulus of light. But here we see the leaves rising and falling in the absence of the accustomed stimulation. Since this change of position is not due to external conditions it must be the result of the internal conditions which habitually accompany the movement. This is the characteristic *par excellence* of habit—namely, a capacity, acquired by repetition, of reacting to a fraction of the original environment. We may express it in simpler language. When a series of actions are compelled to follow each other by applying a series of stimuli they become organically tied together, or *associated*, and follow each other automatically, even when the whole series of stimuli are not acting. Thus in the formation of habit *post hoc* comes to be equivalent to *propter hoc*. Action B automatically follows action A, because it has repeatedly been compelled to follow it.

Let us take a human habit, for instance that of a man who goes a walk every day and turns back at a given mile-post. This becomes habitual, so that he reverses his walk automatically when the limit is reached. It is no explanation of the fact that the stimulus which makes him start from home includes his return—that he has a mental return-ticket. Such explanation does not account for the point at which he turns, which as a matter of fact is the result of association. In the same way a man who goes to sleep will ultimately wake; but the fact that he wakes at four in the morning depends on a habit built up by his being compelled to rise daily at that time. Even those who will deny that anything like association can occur in plants cannot deny that in the continuance of the nyctitropic rhythm in constant conditions we have, in plants, something which has general character of habit, i. e., a rhythmic action depending on a rhythmic stimulus that has ceased to exist.

On the other hand, many will object that even the simplest form of association implies a nervous system. With regard to this objection it must be remembered that plants have two at least of the qualities characteristic of animals—namely, extreme sensitiveness to certain agencies and the power of transmitting stimuli from one part to another of the plant body. It is true that there is no central nervous system, nothing but a complex system of nuclei; but these have some of the qualities of nerve cells, while intercommunicating protoplasmic threads may play the part of nerves. Spencer bases the power of association on the fact that every discharge conveyed by a nerve "leaves it in a state for conveying a subsequent like discharge with less resistance." Is it not possible that the same thing may be as true of plants as it apparently is of infusoria? We have seen reasons to suppose that the "internal conditions" or "physiological states" in plants are of the nature of engrams, or residual effects of external stimuli, and such engrams may become associated in the same way.

There is likely to be another objection to my assumption that a simple form of associated action occurs in plants—namely, that association implies consciousness. It is impossible to know whether or not plants are conscious; but it is consistent with the doctrine of continuity that in all living things there is something psychic, and if we accept this point of view we must believe that in plants there exists a faint copy of what we know as consciousness in ourselves.

The development of the individual from the germ-cell takes place by a series of stages of cell-division and growth, each stage apparently serving as a stimulus to the next, each unit following its predecessor like the movements linked together in an habitual action performed by an animal.

My view is that the rhythm of ontogeny is actually and literally a habit. It undoubtedly has the feature which I have described as pre-eminently characteristic of habit, viz., an automatic quality which is seen in the performance of a series of actions in the absence of the complete series of stimuli to which they (the stages of ontogeny) were originally due. This is the chief point on which I wish to insist—I mean that the resemblance between ontogeny and habit is not merely superficial, but deeply seated. It cannot be denied that the ontogenetic rhythm has the two qualities observable in habit—namely, a certain degree of fixity or automaticity, and also a certain variability. A habit is not irrevocably fixed, but may be altered in various ways. Parts of it may be forgotten or new links may be added to it. In ontogeny the fixity is especially observable in the earlier, the variability in the later, stages. Take the case of a man who, from his youth up, has daily repeated a certain form of words. If in middle life an addition is made to the formula, he will find the recently acquired part more liable to vary than the rest.

Again, there is the wonderful fact that, as the egg develops into the perfect organism, it passes through a series of changes which are believed to represent the successive forms through which its ancestors passed in the process of evolution. This is precisely paralleled by our own experience of memory, for it often happens that we cannot reproduce the last learned verse of a poem without repeating the earlier part; each verse is suggested by the previous one and acts as a stimulus for the next. The blurred and imperfect character of the ontogenetic version of the phylogenetic series may at least remind us of the tendency to abbreviate by omission what we have learned by heart.

Enough has been said to show that there is a resemblance between the two rhythms of development and of memory; and that there is at least a *prima facie* case for believing them to be essentially similar. Hering says that "between the *me* of to-day and the *me* of yesterday lie night and sleep, abysses of unconsciousness; nor is there any bridge but memory with which to span them." And in the same way he claims that the abyss between two generations is bridged by the unconscious memory that resides in the germ cells. I prefer to limit myself to asserting the identity of ontogeny and habit, or, more generally, to the assertion in Semon's phraseology, that ontogeny is a mnemic phenomenon.

Evolution, in its modern sense, depends on a change in the ontogenetic rhythm. This is obvious, since if this rhythm is absolutely fixed, a species can never give rise to varieties. This being so, we have to ask *in what ways* the ontogenetic rhythm can be altered. An habitual action, for instance, a trick learned by a dog, may be altered by adding new accomplishments; at first the animal will persist in finishing his performance at the old place, but at last the extended trick will be bonded into a rhythm of actions as fixed as was the original simpler performance. May we not believe that this is what has occurred in evolution?

We know from experiment that a plant may be altered in form by causes acting on it during the progress of development. Thus a beech tree may be made to develop different forms of leaves by exposing it to sunshine or to shade. The ontogeny is different in the two cases, and what is of special interest is, that there exist shade-loving plants in which a structure similar to that of the shaded beech-leaf is apparently typical of the species, but on this point it is necessary to speak with caution. In the same way Goebel points out that in some orchids the assimilating roots take on a flattened form when exposed to sunlight, but in others this morphological change has become automatic, and occurs even in darkness.

Such cases suggest at least the possibility of varieties arising as changes in or additions to the later stages of ontogeny. This is, briefly given, the epigenetic point of view.

But how can a new species originate according to an epigenetic theory? How can a change in the latter stages of ontogeny produce a permanent alteration in the germ-cells? Our answer to this question will depend on our views of the structure of the germ-cells. According to the mnemic theory they have the quality which is found in the highest perfection in nerve-cells, but is at the same time a character of all living matter—namely, the power of retaining the residual effects of former stimuli and of giving forth or reproducing under certain conditions an echo of the original stimulus. In Semon's phraseology germ-cells must, like nerve-cells, contain engrams, and these engrams must be (like nerve-engrams) bonded together by association, so that they come into action one after another in a certain order automatically, i. e., in the absence of the original stimuli.

This seems to me the strength of the mnemic theory—namely, that it accounts for the preformed character of germ-cells by the building up in them of an organized series of engrams. But if this view has its strength, it has also its weakness. Routine can only be built up by repetition, but each stage in ontogeny occurs only once in a lifetime. Therefore if ontogeny is a routine each generation must be mnemically connected with the next. This can be possible only if the germ-cells are, as it were, in telegraphic communication with the whole body of the organism; so that as ontogeny is changed by the addition of new characters, new engrams are added to the germ-cell.

Thus, in fact, the mnemic theory of development depends on the possibility of what is known as somatic inheritance or the inheritance of acquired characters. This is obvious to all those familiar with the subject, but to others it may not be so clear. Somatic inheritance is popularly interesting in relation to the possible inherited effects of education, or of mutilations, or of the effects of use and disuse. It is forgotten that it may be, as I have tried to show, an integral part of all evolutionary development.

It may be objected that the inheritance of anything so complex as an instinct is difficult to conceive on the mnemic theory. Yet it is impossible to avoid suspecting that at least some instincts originate in individual acquirements, since they are continuous with habits gained in the lifetime of the organism. Thus the tendency to peck at any small object is undoubtedly inherited; the power of distinguishing suitable from unsuitable objects is gained by experience. It may be said that the engrams concerned in the pecking instinct cannot conceivably be transferred from the central nervous system to the nucleus of the germ-cells. To this I might answer that this is not more inconceivable than Weismann's assumption that the germ-cell chances to be so altered that the young chicken pecks instinctively. Let us consider another case of what appears to be an hereditary movement. Take, for instance, the case of a young dog, who in fighting bites his own lips. The pain thus produced will induce him to tuck up his lips out of harm's way. This protective movement will become firmly associated with not only the act of fighting but with the remembrance of it, and will show itself in the familiar snarl of the angry dog. This movement is now, I presume, hereditary in dogs, and is so strongly inherited by ourselves (from simian ancestors) that a lifting of the corner of the upper lip is a recognized signal of adverse feeling. Is it really conceivable that the original snarl is due to that unspecialized stimulus we call pain, whereas the inherited snarl is due to fortuitous upsets of the determinants in the germ cell?

I am well aware that many other objections may be advanced against the views I advocate. To take a single instance, there are many cases where we should expect somatic inheritance, but where we look in vain for it. This difficulty, and others equally important, must for the present be passed over. Nor shall I say anything more as to the possible means of communication between the soma and the germ-cells. To me it seems conceivable that some such telegraphy is possible. But I shall hardly wonder if a majority of my readers decide that the available evidence in its favor is both weak and fantastic. Nor can I wonder that, apart from the problem of mechanism, the existence of somatic inheritance is denied for want of evidence. But I must once more insist that according to the mnemic hypothesis, somatic inheritance lies at the root of all evolution. Life is a gigantic experiment which the opposing schools interpret in opposite ways. I hope that in this dispute both sides will seek out and welcome decisive results. My own conviction in favor of somatic inheritance rests primarily on the automatic element in ontogeny. It seems to me certain that in development we have an actual instance of habit. If this is so, somatic inheritance must be a *vera causa*. Nor does it seem impossible that memory should rule the plasmic link which connects successive generations—the true miracle of the camel passing through the eye of a needle—since, as I have tried to show, the reactions of living things to their surroundings exhibit in the plainest way the universal presence of a mnemic factor.

* Abstracted from the Presidential address delivered to the British Association for the Advancement of Science. The full text of the paper appears in the current number of the Scientific American Supplement.

Death of Gardiner D. Hiscox.

The readers of this journal will learn with regret that Gardiner D. Hiscox, whose name is well known to them as a former contributor of articles on mechanical subjects to these columns and as the author of several well-known books on mechanics, died in the eighty-sixth year of his age at East Orange, N. J. Mr. Hiscox, although not a college-trained man, had a broad knowledge of mechanical, ventilating, and hydraulic engineering, gained in the hard school of experience and which eminently qualified him to practise his chosen profession of consulting engineer. In his youth he was a school teacher, but from teaching he gradually drifted into engineering and science. In his death the engineering profession has lost an able and sturdy member.

Manganese steel is now generally recognized as being the only suitable material for street railway track work where any large amount of traffic is to be dealt with, and, as is well known by street railway engineers, this material cannot be dealt with by the ordinary cutting tools, i. e., chisels, saws, files, etc., owing to the extreme hardness of the material.

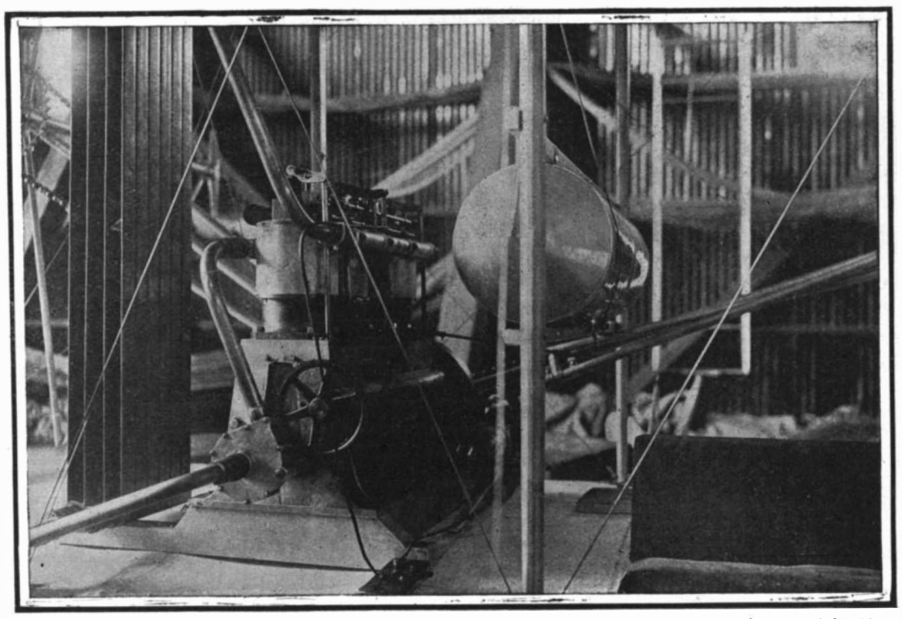


Fig. 1.—Detail Front View of Center of Aeroplane, Showing the Motor, Radiator, Gasoline Tank, and Seat.

The driving chain and sprocket of one propeller are visible at upper left-hand corner, and the crossed tubes carrying the other propeller chain can be seen on the right. The twin vertical rudder is also seen on the right at the rear.

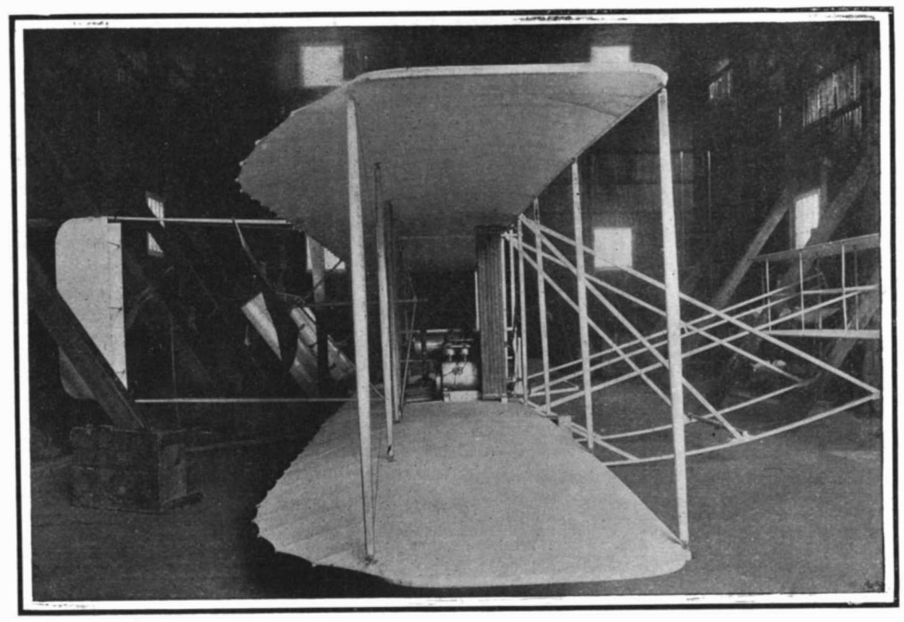


Fig. 2.—End View of the Aeroplane, Showing the Vertical and Horizontal Rudders, Propellers, Gasoline Tank, Motor, and Radiator.

This photograph gives a good idea of the slight curve of the planes as well as of their construction.

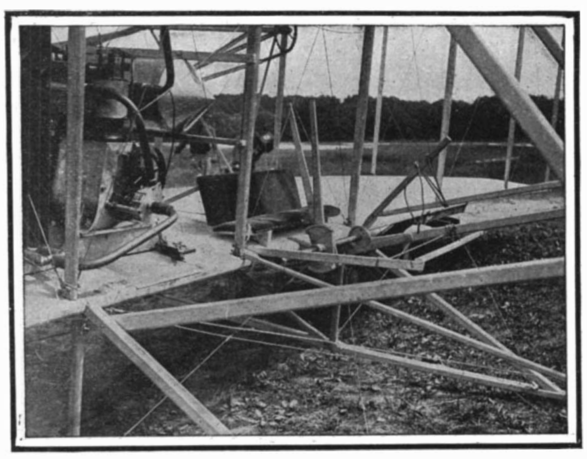


Fig. 5.—Front View of Lower Plane.

The radiator, motor, fuel tank, seat, and levers are visible. The aviator sits farthest from the motor and holds the horizontal-rudder lever in his left hand and the vertical-rudder and wing-warping levers in his right. Note foot-rest in front of levers.

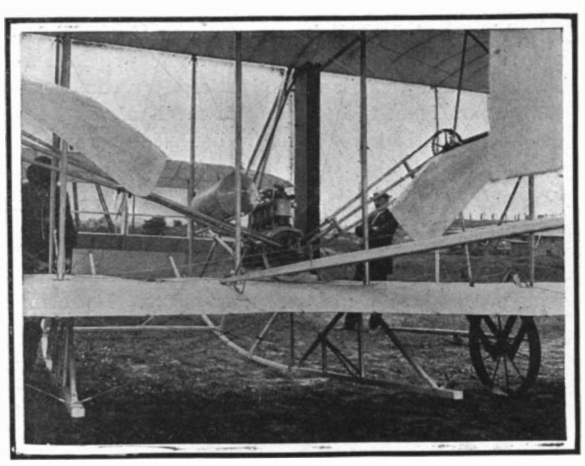


Fig. 7.—Rear View, Showing Motor, Propellers, and Driving Chains.

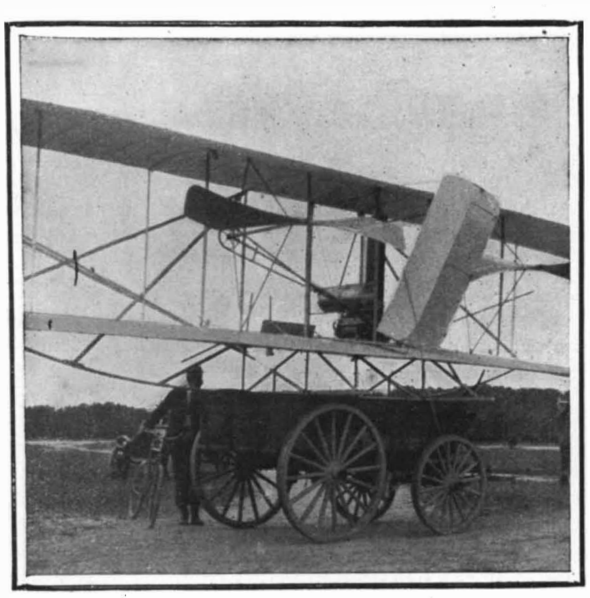


Fig. 8.—The Aeroplane on an Army Wagon.

The runners are folded back against the front edges of the planes and the rudder is placed against their rear edges.

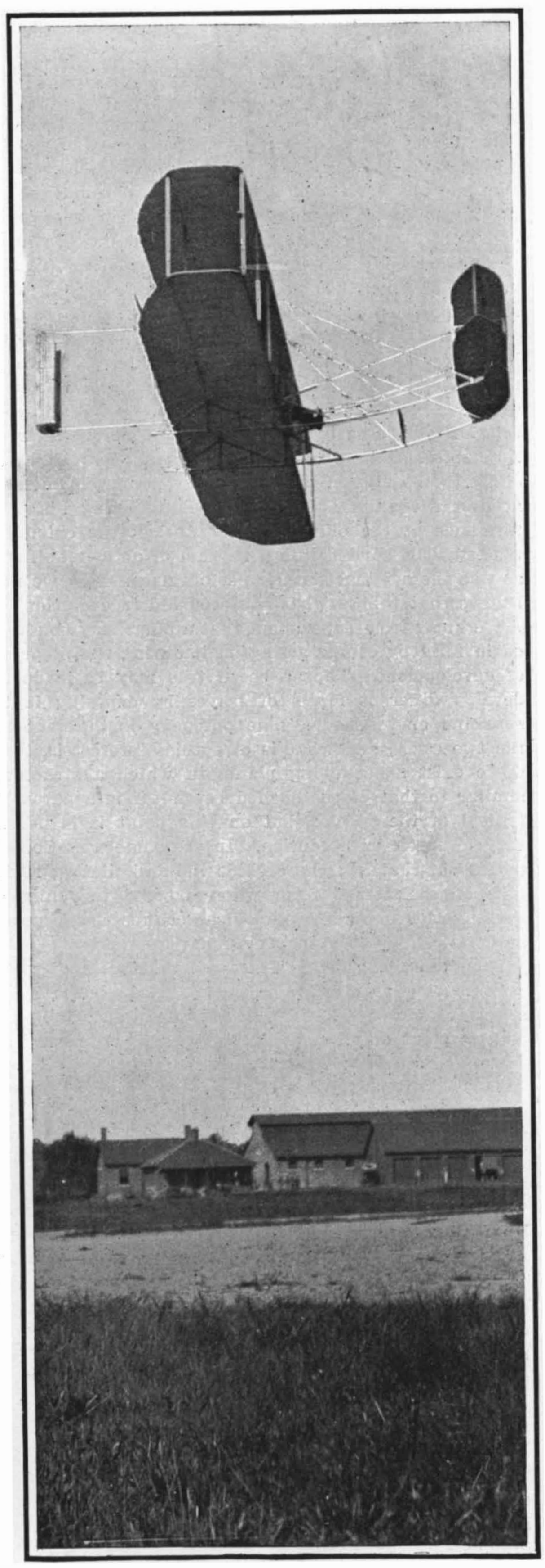


Fig. 9.—The Aeroplane Flying at a Great Height.

In some of its flights the machine is estimated to have reached an elevation of 200 feet.

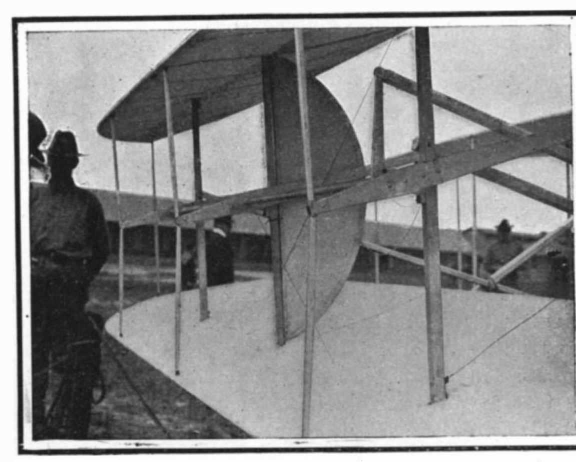


Fig. 6.—Detail View of Front Horizontal Rudder.

In this photograph the rudder is shown tipped downward. The operating lever and wood rod connecting to lever on aeroplane are visible. Also note semi-circular vertical surface which is loosely mounted at the center.

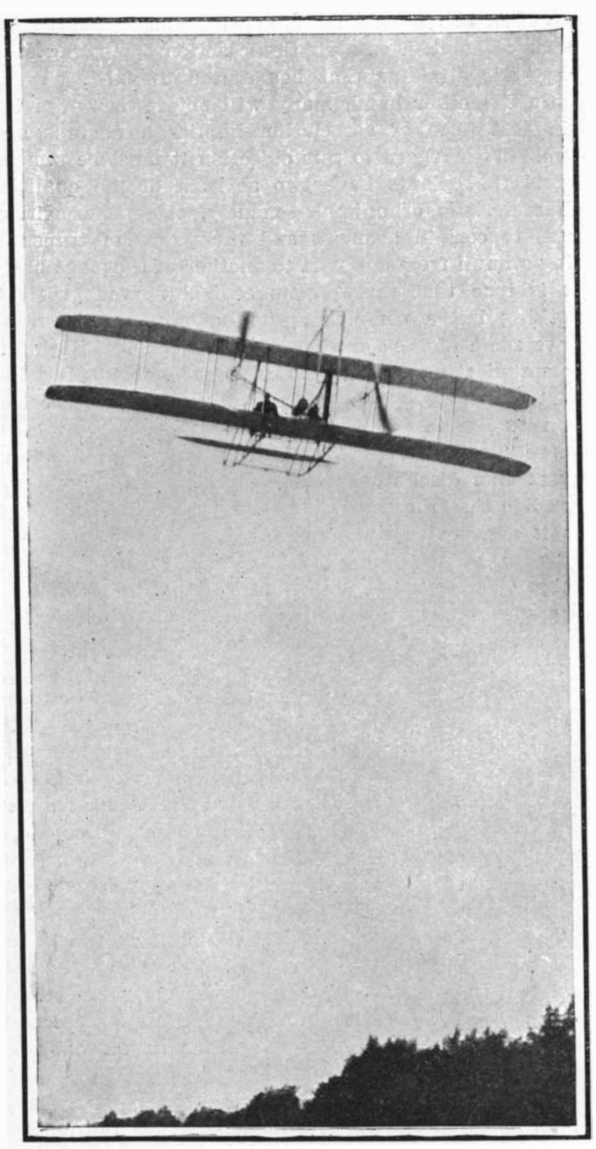


Fig. 10.—Rear View of the Aeroplane Making a Turn.

The machine can make a much sharper turn than this, and in so doing dips downward much more.

THE CONSTRUCTION OF THE WRIGHT AEROPLANE.

THE CONSTRUCTION OF THE WRIGHT AEROPLANE.

In view of the record-breaking flights made by the Wright brothers here and in France during the past few weeks prior to the accident to Orville Wright's machine, we believe that our readers will be interested in some of the constructional details of this, the simplest and, so far, the most successful aeroplane flying machine that has been built. In our issue of August 29 we gave a brief description of the Wright aeroplane, and in this issue we show some detailed photographs of its various parts.

The machine consists of two rectangular planes, rounded slightly at the rear corners and superposed, one above the other, at a distance of 6 feet apart. These planes are 40 feet long by 6½ feet wide, and have a supporting surface of about 500 square feet. They are made of unbleached muslin tightly stretched on rectangular frames provided with curved ribs extending across the frames and beyond their rear edges for about 18 inches. A wire is stretched tightly through the forked rear ends of the ribs, and to this wire the cloth is attached, while it also passes around the front edge of the rectangular frame and back under the ribs, completely covering them. The two frames are fastened together by sixteen tapered up-

the other. This has a steadying effect upon the steering of the machine. The vertical rudder is also a twin affair. It is mounted upon two horizontal sticks that project back of the machine at its center point, and is operated by one of the two levers (the vertical one) seen projecting upward close together in Fig. 5. The manner in which this is connected to the operating lever is shown in Diagram 3, Fig. 4, where *F* is the rudder and *B* the main planes. The third lever (the other one of the two just mentioned) has connected to it two wires in a similar manner to those which operate the vertical rudder. These wires run through pulleys at the rear of the lower main plane, and extend to the top of the outermost rear connecting post, as shown in 1, Fig. 4. The lower ends of the lower plane are connected together by a wire passing upward through pulleys and downward again, as is also shown in this diagram. When the lever is pulled, as shown, it draws down the upper rear edge of the uppermost plane. The lower plane, being connected to it by the upright, is also forced downward, exerting a pull upon the wire attached to it, thus raising its opposite end, which also forces upward the corresponding end of the upper plane. The ends of the planes are warped in this manner, and thus

In stopping the motor, he was obliged to take his hand off the twin levers that warped the surfaces and worked the vertical tail, and it is possible that during this moment the machine may have tipped too much to one side, and that the aviator was unable to correct this tipping during its downward plunge.

Experts believe that after the motor was stopped the machine, which had already lost speed on the end having the broken propeller, quickly lost its momentum, and that although Mr. Wright was able to regain his equilibrium momentarily, its final downward plunge was due to the loss of speed and the forward location of the center of gravity. The height of the machine above the ground was not sufficient for it to descend properly in gliding flight, as a machine of this size and type, if dropped from a height, must plunge downward 50 or 60 feet before it can obtain sufficient speed to glide successfully in a more or less horizontal position. The instability of this type of aeroplane was demonstrated by the accident, and it seems certain that some type of machine which has more inherent stability, both in a longitudinal and a transverse direction, will have to be devised.

Regarding the mechanical features of the aeroplane, its 4-cylinder, vertical, water-cooled motor and

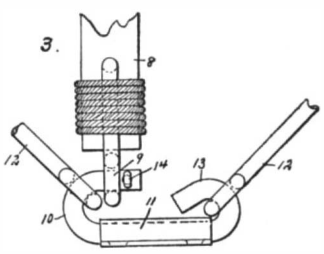


Fig. 3.—Joint Used in Connecting Uprights to Planes.

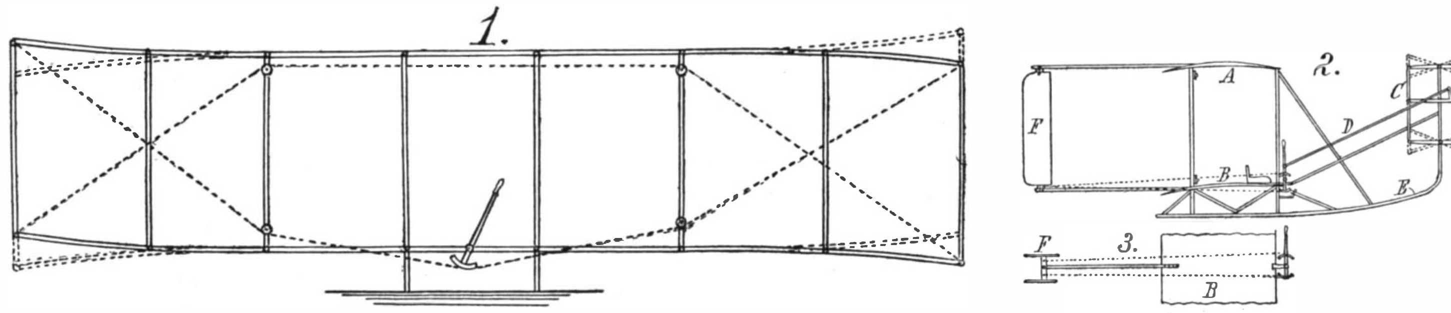


Fig. 4.—Diagrams Showing How the Surfaces Are Warped and How the Rudders Are Operated.

1. Diagram showing connections for warping the planes. 2. Side view showing connection, *D*, for operating horizontal rudder, *C*, which is carried on an upward projection of runners, *E*. 3. Plan view showing connections for operating vertical rudder *F*.

Figs. 11 and 12.—Through the Breaking of a Propeller While the Aeroplane Was Traveling at a Height of 75 Feet, with Orville Wright and Lieutenant Selfridge on Board, the Machine Became Unmanageable and Plunged to the Ground, With the Result That Lieutenant Selfridge Was Killed and Mr. Wright Seriously Injured.

THE CONSTRUCTION OF THE WRIGHT AEROPLANE.

rights, properly spaced apart along their front and rear edges. Four of these uprights on each end are secured to the frames of the planes by the hook-and-eye connection shown in Fig. 3, which makes a flexible joint. The aeroplane is mounted upon runners, which are secured beneath its center part and which extend forward and curve upward to support the horizontal rudder. This is formed of two superposed surfaces very similar to the main planes. These surfaces pivot upon a rod that runs through each of them lengthwise, a little forward of their center point. The uprights (Fig. 6) also carry a rod about half way between the two planes, and on this rod, at suitable intervals, are fastened horizontal crosspieces, which connect with vertical tie-strips that unite the upper and lower planes. A lever projects upward from one end of the rod, and is connected by means of a wooden rod to the operating lever on the front edge of the aeroplane, and which is shown projecting forward in Fig. 5. On the base of this lever is a drum with a friction band which holds the lever, and, consequently, the rudder in the position in which it is set by the aviator, and thus relieves his hand of much of the strain. In the middle of the horizontal rudder there is a semicircular vertical surface, which is allowed to flap a short distance from one side to

when a greater angle of incidence is obtained at one end, the angle is correspondingly lessened at the other. As the device is constructed, there are additional wires running from the tops and bottoms of the posts next to the end ones, and joining the wires just before they pass through the pulleys. This feature of the Wright aeroplane is patented, and is the one to which they lay the success of the machine; for by twisting the planes they are able to tip the machine readily and make sharp turns, and also to quickly counteract the effect of wind gusts. They expect to warp the surfaces and control the rudders automatically in the future, but for the present they depend upon manual control, which, of course, does not eliminate the personal equation. It may be due to this that their aeroplane made its fatal downward plunge, as a similar accident occurred during their practice flights in North Carolina last spring, when Wilbur Wright very likely would have been killed had it not been for the fact that the machine landed in the soft sand. He made a false move of the lever which operates the horizontal rudder and, instead of rising and passing over a sand dune, the machine dove suddenly downward into it. In the recent acc dent, however, Orville Wright stopped his motor, ana he should have been able to glide safely to the ground.

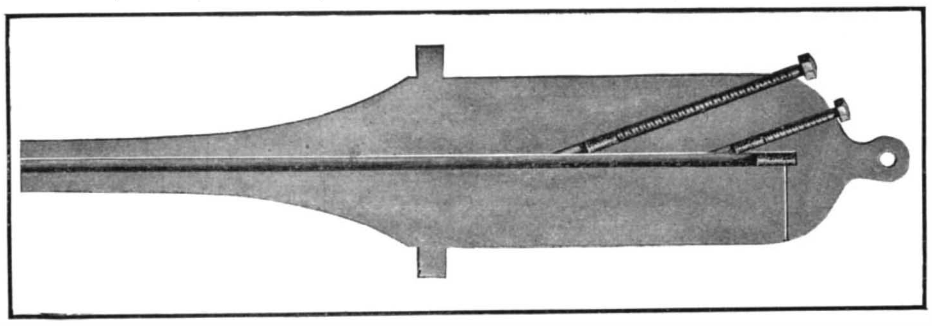
the method of driving the propellers are illustrated in Fig. 1. This engine was designed by the Wright brothers and, like the machine itself, is of great simplicity. Its total weight is 170 pounds. It is mounted in a fore-and-aft direction in the aeroplane, a little to the right of the center line of the machine as one sits in it and faces forward. The four cylinders are bolted to an aluminium crankcase; they are fitted with aluminium water jackets and the valves are located in their heads. The inlet valves are automatic, and are connected together by a suitable inlet pipe. Gasoline is pumped into this inlet pipe by a small pump in the crankcase, which is driven from the crankshaft. There is also an oil circulating pump which raises the oil from a reservoir attached to the under side of the crankcase, and distributes it to the bearings of the crankshaft. The motor is oiled chiefly by splash lubrication. The water-circulating pump is on the outside of the motor at its forward end, and is distinctly visible in the photograph, as is also the large gear of the camshaft. The flywheel is to be seen at the rear end of the motor. The cooling water is pumped through four rows of vertical radiating tubes, each consisting of six flattened brass pipes, which make a light form of radiator having considerable surface and but little air resistance. The ignition is of the make-and-break type, the igniters being operated from a horizontal camshaft running across the top of the motor, and driven by bevel gears from a vertical shaft extending into the crankcase. A magneto, driven off the flywheel, supplies current. The switch is visible in the photograph at the lower front edge of the motor. The chains which drive the propellers pass through tubular guides on their way from the sprockets on the motor crankshaft to the sprockets on the propeller shafts. One of the latter of these is visible at the left-hand upper edge of Fig. 1. The crossed tubes carrying the chain of the other propeller are also distinctly visible in this illustration. The method of reversing the direction of rotation of the propeller by crossing the chain does not seem to be an extra good one, despite the statement of Mr. Orville Wright that he has never had any trouble with this arrangement. Whether this had anything to do with the breaking of the propeller, or not, will probably never be known. The propellers which were used on the day of the accident were new ones about 9 feet in diameter and of a somewhat less pitch. The propellers which were used previously, and which were about 8½ feet in diameter and of the same pitch, are those illustrated in our photographs. They ran at a speed of about 400 revolutions a minute. Mr. Wright had hoped to increase the speed of the aeroplane by the use of new propellers, as their flatter pitch should enable the motor to obtain a higher speed and develop somewhat more power. Ordinarily, the motor developed about 25 horse-power, which was sufficient to drive the machine over 40 miles an hour. The specifications put out by the government required a speed of 40 miles an hour with two men on board, and Mr. Wright hoped to surpass that considerably. As far as endurance was concerned, he had already, on September 12, made a flight of 1 hour, 14 minutes, 24 seconds, which was practically a quarter of an hour longer than was required by the specifications. These required that he should carry a passenger, however, and it was in a second effort to see what he could do in this direction that he took Lieut. Selfridge with him on the 17th instant.

In one of our illustrations, Fig. 8, the aeroplane is seen upon an army wagon. This photograph shows it as it is being transported from the shed where it was put together to the tent where it was housed during the first few days of its stay at the Fort Myer parade ground. In this picture the vertical rudder is shown folded up against the rear of the plane, and the runners are also folded back against the front edge. When it is desired to take the machine apart, the outer quarters of the main planes can be folded back upon the central halves, and the whole machine can be quickly disassembled. Great ingenuity was displayed by the Wright brothers in constructing their aeroplane so that it would fulfill the condition of being readily dismounted and packed upon an army wagon, but the great simplicity of the entire machine is the most striking point about it, and the one which most strongly evidences a real stroke of genius. The result of the accident will be a greater striving of inventors to produce a machine having automatic stability, and which will only require sufficient attention on the part of the aviator to steer it sidewise and up and down, and to keep the motor running. It would also seem that a new impetus should be given to Langley's idea of experimenting over water where, if a machine took a sudden plunge, the aviator would at least have a chance of escaping. The accident to the Langley machine some years ago, when it plunged into the Potomac while Mr. C. M. Manly acted as aviator, illustrates this point; for, although the machine was injured, and Mr. Manly had a very narrow escape, nevertheless he is alive to-day and is one of our most enthusiastic aviators.

In the Electrical World C. E. Lord describes a method of ventilating a high-speed machine so that the noise is reduced to a minimum. The air which cools the rotor does not pass directly to the stator, but follows a restricted path through the stationary member. The ventilating passageways in the stator are arranged concentrically about the axis of the rotor, and means are provided for cutting off direct communication between the ventilating passageways and the air gap of the machine.

AN EARLY ARMOR-PIERCING GUN.

The following sketch and description of an early and decidedly novel design for an armor-piercing gun have been furnished us by Mr. W. B. Williamson, of Ames, Okla., who was on special service in Washington from 1862 to 1865, and was in a favorable position to observe the construction and test of the gun. The drawing, it should be understood, is only approximately correct, the sketch on which it is based having been made from memory after a lapse of forty years. The gun was cast at the Washington navy yard and placed in the experimental water battery (then used for drill and practice). Its length was about 11 feet, and its bore only 2⅛ inches. Its weight was about equal to that of a 32-pounder iron Dahlgren. From the trunnions to the muzzle the taper was abrupt; from the trunnions to the neck ring the piece had all the ear-marks of a 68-pounder smoothbore. The projectiles, which were forged from tool steel and turned down to caliber, were about 12 inches long. The gun was rifled, and soft metal rims were swaged on the projectile to enable it to take the rifling. The first powder charge and the projectile were loaded from the muzzle. On the right side of the breech were two holes bored at acute angles to the longitudinal axis of the gun, the first entering the bore a little ahead of the projectile, the second farther ahead, nearer the trunnions, in the position shown in the engraving. Each hole was fitted with a long, coarse-threaded breech-pin. A charge of powder, somewhat smaller than the main charge, was inserted in each chamber, and the breech-pin screwed home. Each of these auxiliary chambers was of about 2 inches bore. The gun easily pierced a 9-inch iron plate at 500 yards, and it required a 12-inch plate to stop the projectile.

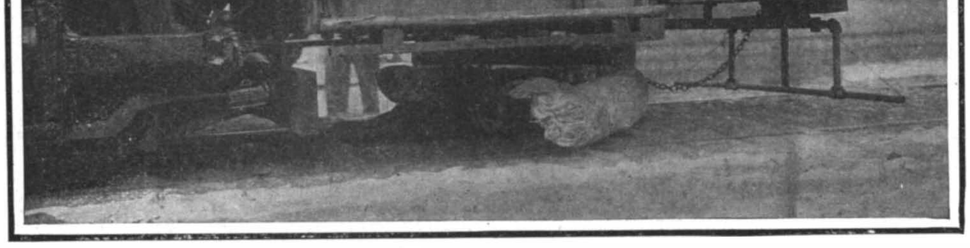


Length, 11 feet. Bore, 2⅛ inches. Penetrated a 9-inch iron plate. The gun had three powder chambers in which the charges were ignited successively as the projectile passed down the bore.

AN EARLY BREECHLOADING GUN.

It will be seen that, in a certain sense, the designer of this gun anticipated the theories of our modern smokeless powder; for the charge was burned progressively, part of it at the breech, and two other portions at succeeding intervals during the travel of the projectile down the bore.

President Lincoln, visiting the yard one day in 1862, requested to have the gun loaded, sighted the piece, and fired, making a center. Thereupon the piece was dubbed "Abe Lincoln's pocket piece."



Shows Manner in Which Defective Fender Allowed Body to Pass and Be Mangled.

CAR FENDER TESTS BY THE PUBLIC SERVICE COMMISSION.

According to a contemporary, there is manufactured in Holland a substance called liconite. It is similar to rubber in appearance and in many of its qualities. It is a compound of bitumen and various oils, has neither rubber nor gutta-percha in its composition, is elastic and tough, and is said to be non-hygroscopic, unaffected by water, dilute acids, or alkalis, and capable of withstanding all ordinary temperatures without flowing or cracking.

CAR FENDER TESTS BY THE PUBLIC SERVICE COMMISSION

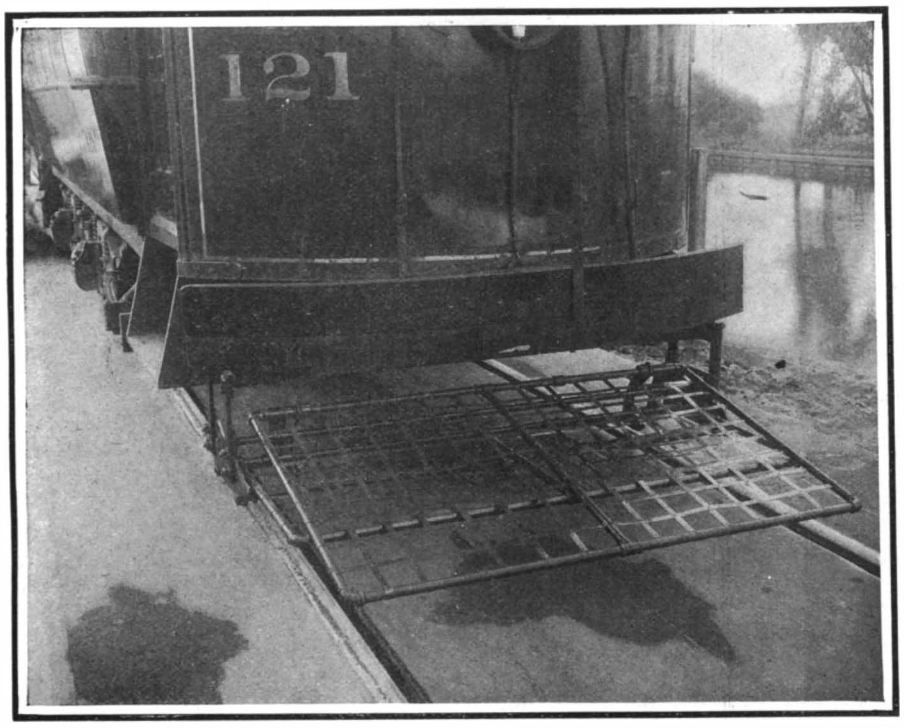
The Public Service Commission of the city of New York never inaugurated a more commendable movement than when it arranged for a series of public competitive trials of street-car fenders, with a view to selecting the most efficient type for use on the street railways in this city. It has been moved to take this step as the result of the statistics of street-railway accidents which have been gathered under its administration. These were of such an appalling character, both in number of fatalities and the shocking character of the injuries, that the Commission at once took steps to institute the present inquiry and select a really effective car fender. The tests are to be carried out partly at Schenectady and partly at Pittsburg; the first on tracks provided by the General Electric Company, and the later series on tracks near the works of the Westinghouse Company. Neither of these concerns has the least financial interest in the competition; they merely place the excellent facilities of their respective plants at the service of the Commission. The tests, of which we present several illustrations, were held upon a stretch of track running along the banks of the Erie Canal in the presence of the Commissioners and their engineering staff, eminent traction engineers from various parts of the country, and several members of the General Electric Company's own engineering force.

The first series of tests took place on Wednesday, September 16, and evidence that the competition will be of the most widespread character was shown by the fact that up to noon of the previous day, 112 men had registered for competition at the office of the Commission. The character of the tests and the conditions of the competition were given in full detail in our issue of September 19. The first fender tried was of the projecting automatic type, and was manufactured by John O'Leary, 25 Congress Street, Cohoes, N. Y. It consists of a square section of metallic latticework which, when in use, extends in front of the car close to the track, and, when not in use, can be raised and tied up to the dash board. One of these fenders was attached to a trolley car weighing 25 tons, provided by the General Electric Company. Dummies representing boys weighing 50 to 60 pounds and others representing women weighing 120 pounds were placed upon the track in various attitudes, and run into by this car with the fender in position. The tests were made with the car going 15 miles an hour and also at a speed of 6 miles an hour. There were two series of tests, one on cobblestone pavement and the other on asphalt pavement, this being done to reproduce as nearly as possible street conditions in New York city.

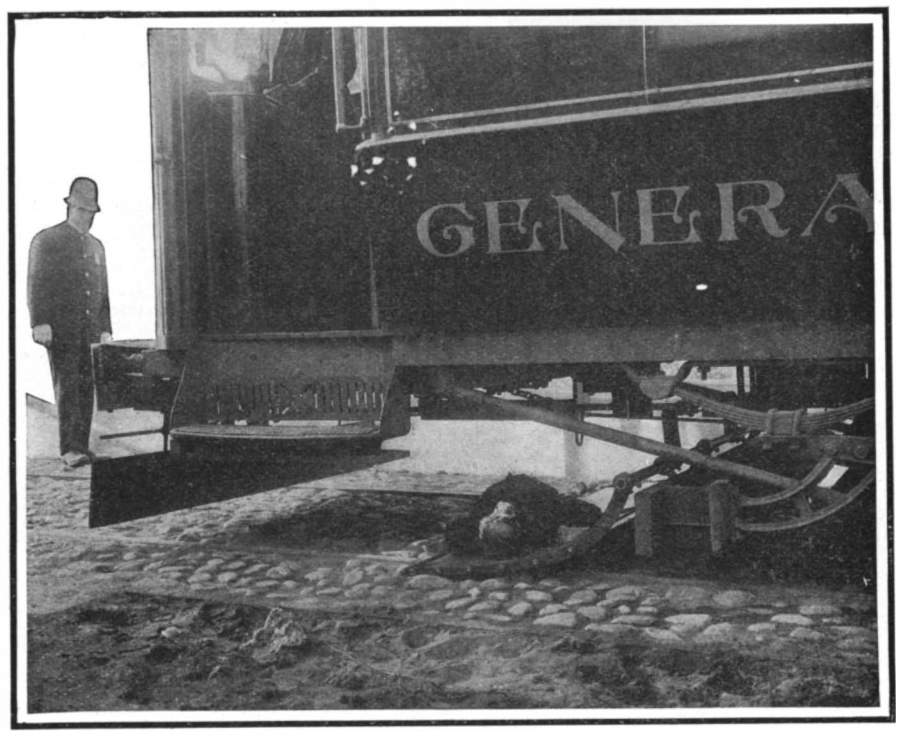
The dummies were placed on the track standing up, lying on their side, or stretched along the rail, and the effect of the contact with the fender in all such positions was noted. In most instances the fender made a clean pick-up of the dummy and carried it, as if in a basket, until the car was brought to a standstill by the brakes. In some instances the dummy was scarcely injured by the impact; in others it was deprived of one or two legs; and in cases where the fender failed to pick it up, it was rolled along over the roadbed and badly mangled. The credit marks used in each test to keep the official record were as follows: A counted 4 points for a complete pick-up or removal from the track; B counted 3 points for a partial pick-up or removal from the track, with any part of dummy remaining under fender; C counted 2 points for a partial pick-up or removal from the track, but with the dummy for the most part under the fender; D counted 1 point where no pick-up is made and when the dummy is entirely under the fender, but dragged sufficiently to prevent its going under the car. In the first series of runs made on cobblestones at 15 miles an hour, the O'Leary fender received four A's, one C, and one D. In the same series on cobblestones at 6 miles an hour it received three A's, one B, and two D's.

The dummies, as will be seen from our photographs, were constructed so as to closely approximate the forms of living persons; and the distributing of the weight, center of gravity (most important point), etc., were carefully considered. It will be noticed that the greater number of clean pick-ups was made at the quarter speed, which was to be expected.

Another fender tested on the first day is known as the drop fender, which was entered by the Charles N. Wood Company, of Boston. This fender is of that type which depends upon the motorman to drop it when approaching an object on the track. On the second day the Hoefling double fender, entered by John Caulfield, of Grand Rapids, Mich., and the Sterling wheel guard, entered by the Sterling-Meaker Company, of Newark, N. J., were tested. The former consists of two fenders, one above the other. The upper one serves as a trip to automatically drop the lower fender, when it strikes a body. The Sterling wheel guard consists of a basket-like screen, which is suspended in front of the wheels under the body of the car. It is connected with a board, which is suspended from the overhang of the car. When this board strikes a body it automatically drops the screen in front of the wheels, and the latter picks up the body.



The Regan Fender, Under Test at Schenectady.



The Clark Wright Wheel Guard, Showing Manner in Which Body Is Picked Up.

Ionic Medication.

The introduction of medicaments into the human body in the form of "ions," first applied by Leduc of Nantes in 1903, has rapidly gained ground in medical practice, and many applications of the principle are now in use. It is well known that when a current of electricity is passed through a solution of a chemical salt, the latter becomes decomposed or electrolized, the base, as a rule, going to the negative pole and the radical to the positive pole. This is accounted for by the theory that the molecules exist as ions, or electrified particles of matter, those of the base and radical carrying respectively their negative and positive charge of electricity. These ions are dissociated by the electric current, which appropriates them to the corresponding complementary poles of the circuit.

Advantage is taken of this principle to force medicinal substances in the ionic state into the tissues of the body. If a solution of, say, quinine sulphate be used to soak a pad covering the positive pole of a battery, this pole applied to the skin, and the negative pole so arranged that the current may pass through the tissues, the quinine ions will seek the opposite pole, and in so doing will pass through the tissues with the current. The ions thus forced into the body enter not only into the lymph spaces, but into the cells themselves, becoming a part of the protoplasm, and consequently their effects are much more pronounced. The principle may be shown experimentally by placing a piece of raw beef between the poles of a battery, the negative electrode being covered with blotting paper soaked in a solution of potassium iodide, and the positive electrode similarly treated with starch solution. On applying the current the iodine ions pass through the beef of the positive pole, the paper on which soon shows the blue color of starch iodide.

This process, described as cataphoresis or ionic medication, has been tried with considerable success in the case of such drugs as break up into ions. Relief of tabes dorsalis by cocaine ionization was described in the British Medical Journal in January, 1905, and since then a number of cases have been successfully treated by this method. Dr. Lewis Jones and Dr. Dawson Turner have both reported on cases of rodent ulcer cured by means of zinc ions. The process is extremely simple—a portable battery with wires has a disk or rod of zinc attached to the positive pole. The zinc is covered with a few layers of lint wetted with a 5 per cent solution of zinc sulphate and applied to the ulcer previously cleansed. The negative electrode is either held in the patient's hand or placed in a basin of salt water in which the hand is immersed. The current is gradually raised to 40 to 60 milliamperes, or as much as the patient can bear, and continued for thirty seconds. The surface of the ulcer is now white and dry, and another application may be made in a week or a fortnight, two or three applications usually being sufficient. A burning sensation like that of a mustard plaster is felt, which in sensitive patients may be counteracted by means of cocaine.

Other applications of the ionic treatment are suggested. Copper ions have been found efficacious in destroying the parasite of ringworm, and magnesium ions have cured multiple warts on the hands. The chlorine ions have proved useful in fibrous ankylosis and sclerosis, and a case of Dupuytren's contraction, which had lasted fifteen years, was recently cured in the same way. The salicylic ion has been found to relieve tic douloureux which had proved refractory to other remedies. Giovine records cases of gonorrhœal arteritis and tabetic arthropathy of the knee, in which the iodine ions from potassium iodide gave good results, also a case of sclerodactylia, which was cured by application of chlorine ions. The difficulty in the way of treating lupus has so far lain in the fact that the bacillus contains a large proportion of fat, which is a complete non-conductor of electricity.

In applying the ionic treatment it should be borne in mind that basic ions move from the positive to the negative pole, consequently the medicament must be introduced at the opposite pole. Acids move in the opposite direction. The limitations of the method are that the ions can be introduced only very slowly, and a prolonged application, possibly under chloroform, would be necessary to reach parts at great depth.—The Prescriber.

This Dummy Picked Up While Facing Car, Which Was Moving at 15 Miles an Hour.

150-Pound Dummy on Track, Sideways to Approaching Car.

This Shows Mutilation of Person Struck in Trying to Pass in Front of Car.

CAR FENDER TESTS BY THE PUBLIC SERVICE COMMISSION.

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

COLLAR AND GARMENT FASTENER.—W. M. Lowrie, New York, N. Y. The purpose here is to provide a mounting for ornaments, whereby to adapt the ornaments as fasteners for portions of a garment, and to so construct the mountings that opposing hooks are employed for attaching purposes, and to so construct the hooks that while they may be introduced into or purposely removed from a fabric, article or garment, they will not under violent exertions leave their set position.

SUSPENSORY UNDERSHIRT. — R. D. Peters, Knox, Ind. The invention relates to that class of undergarments in which an undershirt is formed on its front side with a sack or bag for supporting the scrotum after the manner of a suspensory bandage. Means are provided for securing privacy and protection from cold.

Electrical Devices.

ELECTRIC RECORDER FOR ICE PLANTS.—W. D. Cain and W. H. Williams, Durant, Okla. The invention consists in the combination of a time dial rotated by a clock mechanism, a pen or pencil arranged to bear upon the dial, and an electro-magnetic operating device arranged to swing the pen or pencil across the dial, said device being operated by a circuit and a circuit closer located in the ice chute and closed by the transit of a block of ice.

Of Interest to Farmers.

PLANT-PROTECTOR.—E. R. Drake, De Land, Fla. In this case a cheap and simple apparatus is provided which will effectually protect lettuce and other tender plants or vegetables both from cold winds and freezing temperature, and also from too hot a sun, so that their growth is promoted while they are rendered more tender, palatable, and digestible.

ROTARY WEED-CUTTING MACHINE.—J. G. Olson, Harrington, Wash. The invention relates to machines for use in killing weeds by cutting them off at or below the surface of the ground. The details of construction embody a plurality of cutter blades, carried on the ends of arms radiating from a rotatable shaft, means for supporting the shaft, means for progressively moving the same, and means for rotating the cutter shaft and blades as the shaft is progressively moved.

Of General Interest.

COLOR-STUDY DEVICE.—E. F. Wagner, New York, N. Y. The object of the inventor is to provide a device adapted to be used by persons deficient in comparing or harmonizing colors and by students of color, for comparing different colors or placing them in different arrangements, enabling contrasting colors to be exhibited or harmonizing colors to be placed in opposition.

CLOSURE FOR THE NECKS OF BOTTLES.—T. S. Rainey, New Orleans, La. The aim in this instance is to provide novel details of construction for a closure for the neck of a bottle or other receptacle, which when inserted and secured therein, after the receptacle is filled, will permit the contents to be freely decanted, but will prevent a refilling of the same.

GOPHER-TRAP.—A. F. Renken, Kramer, Neb. In this patent the purpose of the invention is to provide novel features of construction for a gopher trap, that afford a simple, practical, and inexpensive device of the character indicated, and which is adapted for killing the rodent in its burrow.

PROCESS OF MANUFACTURING NEW COMPOUNDS OF PROTEIDS WITH BISMUTH IODID.—A. Busch, 2 Blücherstrasse, Brunswick, Germany. According to this invention new compounds of albuminoids or proteids with bismuth iodid are obtained, which pass almost unattacked through the stomach by heating the precipitate of bismuth iodid and albuminous matter for some time, say eight to ten hours, at temperatures between 100 and 130 deg. C. The compound is particularly adapted to be administered in cases where a prolonged administration of small doses of iodin is required.

TRIPOD.—H. J. C. Jessen, Nevada, Iowa. This tripod is for use in supporting cameras, telescopes, transits, gun-rests, etc.; and is arranged to permit of firmly setting the tripod on uneven ground or rocks, to allow convenient adjustment of the members of the tripod to bring the article to be supported into the desired position, and to permit of folding the tripod into a small space.

Hardware.

COMPOSITE FILE.—H. Getaz, Schenectady, N. Y. In the present patent the invention is an improvement in files, relating to that class of files in which the teeth are composed of a series of cutting blades clamped together in an angular relation and adapted to be readily sharpened when dulled.

WRENCH.—H. N. Rothweiler, Seattle, Wash. The objects of the inventor are to provide a slidably mounted movable jaw for pipe wrenches in which no retaining pins or other detachable retaining devices are used; to provide an efficient pipe wrench with few loose pieces; to provide a pipe wrench having removable threads on the shank thereof.

HINGE.—R. P. Hawley, Monongahela, Pa. The improvement relates more especially to hinges for waffle-irons and other devices in which it is unnecessary to separate or revolve the hinge members on each other as much as 180 deg., usually no appreciable distance over 90 deg. The members of the hinge are rigid with their respective pivots, and may be separated or lifted apart when the hinge is open.

PERMUTATION-LOCK.—J. P. Geraghty, Jersey City, N. J. This lock is more especially designed for use on railroad car doors and the like, and arranged to render the opening of the lock difficult for unauthorized persons, and to allow ready inspection of the car seal with a view of determining whether the lock has been tampered with in transit. This is a division of the application for letters patent of the United States for a locking device, formerly filed by Mr. Geraghty.

Household Utilities.

BOTTLE-WASHER BRUSH.—C. K. Volckening, New York, N. Y. The more particular object of the improvement is to produce a type of brush suitable for mounting upon a tubular spindle and capable of cleaning the bottom and corners of the bottle and the inside of the neck, and in doing this to make the brush of such construction that hot and cold water can have but little deleterious effect upon it.

FLY-ESCAPE.—G. W. Stein, Chicago, Ill. The escape permits egress of flies from the interior of a window, and may be employed for ventilation purposes. The construction and arrangements of parts are designed with reference to simplicity and cheapening the device, and for making its application to the sash easier and also for preventing its application from interfering with the free sliding of one sash over the other in hoisting the window.

Machines and Mechanical Devices.

COAL-WASHER AND ORE-CONCENTRATOR.—A. C. Campbell, Asheville, N. C. The object here is to provide a machine for readily separating and discharging individually the same dense slimes of concentrates or of coal, the fine granular dense stuff, and the coarse and massive concentrates of ore or refuse of coal, the arrangements of parts being such that both a panning and jigging takes place conjointly and interchangeably. The invention is such as shown and described in Letters Patent of the United States, formerly granted to Mr. Campbell.

Railways and Their Accessories.

TRACK-RAIL JOINT.—J. C. Riggs, Berkeley, Cal. The purpose here is to provide the ends of track rails of standard T-form, with features which will effect a positive interlocking connection between such ends, when in pairs they are forced together in sequence, rendering a joint between two engaged ends of the rails practically continuous, and obviating jar, noise, and injurious wear, that occurs when the rolling wheels of cars impinge upon the ends of track rails that are formed and supported in the usual manner.

SAFETY DEVICE FOR AIR-BRAKES.—J. Judge, Pittston, Pa. In the present, Mr. Judge seeks to eliminate the frangible pipe of his former patent, and provide a valve and operating lever therefor, so constructed that when the lever is moved the valve opens but a return movement of the lever to its original position does not in itself close the valve. Means are provided whereby evidence will be recorded as to the number of times the safety device has been operated on each trip.

GRAIN-CAR DOOR.—J. Thompson, Garretson, S. D. This invention pertains to improvements in inner doors for box cars and especially for those cars for shipping grain and more in particular involves improvements in a door whereby grain may be shipped without danger of leakage such as would occur around the door of an ordinary freight car and whereby time and expense in opening the door may be saved.

Pertaining to Recreation.

GAME APPARATUS.—Addie M. Foster, Santa Barbara, Cal. More specifically, the invention relates to a game device in which a plurality of cups, each formed to receive an object, are connected by a flexible band which serves to project the object when the cups are separated so that the band is suddenly drawn taut, the band having a pocket to hold the object.

Designs.

DESIGN FOR A CHRISTMAS BAG OR PACK.—Mary Prugh, Los Angeles, Cal. This design is for a bag or pack which is intended for use in holding candies, toys, or various articles such as given to children at that season. On one side of the bag Santa Claus is shown in colors and holding a bag. On reverse side, the words "Merry Christmas" are printed, and Santa Claus is also shown in part.

Note.—Copies of any of these **patents will** be furnished by Munn & Co. for ten **cents each. Please state the name of the patentee, title of the invention, and date of this paper.**

Notes and Queries.

HINTS TO CORRESPONDENTS.

Full hints to correspondents were printed at the head of this column in the issue of August 8th, or will be sent by mail on request.

(10857) R. B. L. says: Will you please answer through your Notes and Queries the following questions, for they may help others than myself: 1. What is the best material with which to cover an aeroplane? A. The best material which is used for an aeroplane is probably silk, although this is generally thought to be too expensive, and ordinary unbleached muslin or any similar cloth will answer the purpose. Ultimately, thin sheet aluminium will be used. 2. What is the smallest size that you suggest to make an experimental aeroplane, that is the number of square feet? A. Aeroplane models can be made almost any size desired. We should think 5 to 10 square feet would be ample supporting surface. 3. How many square feet of surface will it take to raise a pound of weight? Will a large aeroplane lift more to the square foot than a small one? A. The amount lifted per square foot of surface of an aeroplane depends upon the speed at which the aeroplane is traveling through the air; 2½ pounds to the square foot is a good average amount at a speed of 25 to 30 miles an hour, although with the most efficient curved surface this can be raised to as high as 3½ or possibly 4 pounds. A large machine will not lift any more to the square foot than a small one, provided its surfaces are equally efficient. 4. Will you give the dimensions of Mr. Henry Farman's front main plane? A. The dimensions of the main planes of Mr. Farman's machine are: Planes 6½ feet wide by 32 feet long. There are two planes, one placed vertically above the other with a space of 5 feet between, a box-shaped tail 10 feet to the rear, in the center of which is a vertical rudder for lateral control. At the center of the planes and between them is carried a 50-horse-power Antoinette engine, weighing about 400 pounds. 5. An article in the Supplement, No. 1696, page 7, states: "The thing to praise in an aeroplane should be slowness." Do you think it would be best to work for slowness and not speed? A. Slowness is certainly a desirable quality with the first experimental machine. The only trouble is that in order to be a slow-traveling aeroplane it must be a very large one. Most experimenters try to strike a mean by making the surfaces so that they will lift the entire machine and operator at a speed of about 25 miles an hour. 6. Can you give me the names of papers published in the interest of aeroplanes, etc.? A. There is only one special aeronautical paper published in this country, Aeronautics, Thoroughfare Building, Broadway and 57th Street, New York. The Aerophile is the leading French aeronautical paper, and the Illustrirte Aeronautischer Mitteilung is the leading German aeronautical periodical.

(10858) P. J. E. says: 1. How far ought a 2-inch spark coil to transmit wireless messages with a good relay and a regular filings coherer under favorable conditions? A. A 2-inch spark under favorable conditions should transmit a wireless signal 4 to 5 miles at the outside over water and 1 to 2 miles over land. Much depends upon the coil giving this spark. If this is its longest possible spark, and is a thin blue line, the distances above are too great, and should probably be halved. If 2 inches is a fat spark from a coil giving easily a much longer spark, the distances given above will be realized. Weather conditions also make a great difference in transmission. 2. Will 3 pounds of No. 34 B. & S. copper wire make the secondary of an induction coil designed to give a 2-inch spark with two turns of No. 16 on primary? If not, will you please give me the right amount? A. Three pounds of No. 34 silk-covered copper magnet wire should be sufficient for the secondary of a coil to give a 2-inch spark, but it will not do so with two turns of No. 16 wire for the primary. No. 14 or, better, No. 12 copper cotton-covered magnet wire should be used and wound in two layers of about 8 inches in length on the core. Data for such a coil are given in full in Supplement No. 1403, which we send for ten cents. Fuller instructions for coil winding and making can be found in Supplement Nos. 160, 1124, 1527, 1605, price ten cents each. 3. Will lightning work the relay of a filings coherer with antennæ and grounded through the instruments? A. Lightning often produces signals upon wireless apparatus many miles distant. It is sometimes possible to make short words out of such signals, they simulate Morse characters so closely. 4. What kind of current passes through a telephone wire? A. In the telephone as ordinarily used the induction coil gives an alternating current. 5. What good book have you got to instruct one in the theory of the telephone, simple, for one that knows nothing about it, not over $1 or $1.50? A. We can supply you with the "A B C of the Telephone" for $1. You will find this book what you say you wish and within your limit of price. 6. I miss the Scientific American very much, but it is hard for a student to keep everything going with nobody but himself to fall back upon. I expect in time to be a permanent subscriber to the Scientific American, although I would rather have a paper devoted entirely to electricity, as it is the only subject that claims my attention. I experiment very much with it, especially in wireless telegraphy and X-rays. I have an apparatus like that described in Scientific American of December 28, 1907, for controlling distant mechanical effects by wireless. A. We are glad you like the Scientific American and we think it better for you and all others to have a paper which gives scientific news upon all subjects than to make it exclusively for those interested in one department of science. If it were limited so much in scope, we could not call it the Scientific American. It must include all subjects in which Americans are interested.

(10859) J. Z. says: When two wireless stations are working, is there any way of preventing other stations taking the same messages, or interfering with the work, between the two stations? Also can the electric spark be pitched or tuned? A. There is no way of preventing anyone who has a wireless receiver which can be tuned to any wave length, from receiving any message which comes along and whose wave length can be found while the message is passing. The tuning of the receiver to the transmitter is a necessity. See our Supplement Nos. 1605, 1622, 1623, 1624, 1625, price ten cents, for a series of articles upon setting up, tuning, and operating a wireless station.

(10860) E. C. C. says: Is it a fact that an object weighs more at sea level than it does at say 10,000 feet, or two miles, above sea level? If so, is the decrease in weight exactly proportional to the increase in height? A. An object has its greatest weight at the sea level. Above the sea level the weight diminishes in the proportion of the increase of the distance squared. At the level of the sea, an object is 3,959 miles from the center of the earth, while at an altitude of 5 miles above the sea it is 3,964 miles from the center of the earth. At the upper place its weight is $\left(\frac{3959}{3964}\right)^2$ or about 0.9975 of its weight at the level of the sea. This is in accordance with Newton's law of gravitation, the law whose discovery is considered to have been the most remarkable triumph of the human intellect in all time.

(10861) C. W. L. says: I have a steel pin about seven inches long lying on my office desk that has four distinct magnetic poles. Either end of the pin attracts the south pole of the magnet, while a point at or near the center attracts the north pole, while a little farther along on the opposite side of the center the south pole is attracted. Between these two central points and the ends the pin is neutral. Is this a common phenomenon? We are taught that magnetic bars have two opposite poles and only one neutral point. Can you explain this seeming departure from an otherwise uniform law? A. It is not so uncommon a phenomenon to find a magnet with secondary poles along its length. Such poles are called "Consequent Poles." They are alternately north and south, all the way around in a dynamo frame for the field. The coils are wound to make them so. Multipolar dynamos have many poles. A steel bar can be magnetized in this manner by using coils of wire to produce the magnetism. Near one end of the bar wind a coil of wire, perhaps 40 or 50 turns, then leaving an inch or so bare, wind another coil in the opposite direction. If the first has been wound over toward the right, the second will be wound over toward the left. This may be repeated several times if the bar is 8 to 10 inches long. Poles will result wherever the direction of the winding is changed, and they will be alternately plus and minus. As you describe your bar it seems to have two north poles with no south pole between them. This is not possible. The north pole occupies all the space along the bar over which the south pole of a magnet is attracted. It is not a uniform law that a magnet can have but two poles. That depends upon the manner in which it is magnetized.

(10862) L. S. says: I thank you for the interesting article in Scientific American, April 18, 1908, on "Weather Vane with Attachment for Indoor Reading." Would you be kind enough to inform me through your valuable paper, which kind of battery, and of how many cells, is used to work the apparatus? A. The arrangement of the indicator of the weather vane, as described in our issue of April 18, 1908, requires a closed-circuit battery, since it is always in circuit and indicates all the time. A gravity battery is the best for this use. We judge that four cells will do the work. If you do not require the indicator to be always in circuit, you can use a dry cell battery and place a push button in the circuit of the wire *G* on the front of the box *K*, and thus save battery current. When you wish to see the direction of the wind, push the button, and the needle will swing to the proper position. We should much prefer this arrangement. There is a defect in this apparatus, as described. If the needle is of iron either end will be equally attracted and if it points as shown in Fig. 4, one cannot tell whether the east or west magnet is attracting it. This can be remedied by placing all the magnets with the south pole inside, and using a small compass box with a magnetic needle in the circle of the magnets. Then the north pole of the needle will give the direction of the wind at all times.

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Inquiry No. 8848.—Wanted to buy rust proof metal for parts of wash tubs.

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Sealed proposals endorsed "Proposal for Conduit for Acute Hospital, Construction, including Steampiping" for Hudson River State Hospital, Poughkeepsie, N. Y., will be received by the State Commission in Lunacy, Capitol, Albany, N. Y., up to 3 o'clock P. M. on the 23d day of September, 1908, when they will be opened and read publicly.

Proposals shall be accompanied by a certified check in the sum of $600, and the contractor to whom the award is made will be required to furnish surety company's bond in the sum of Three Thousand Dollars. The right is reserved to reject any and all bids.

Drawings and specifications may be consulted, and blank forms of proposal obtained at the Hudson River State Hospital, Poughkeepsie, N. Y., or at the office of the State Architect. Complete sets of plans and specifications will be furnished to prospective bidders upon reasonable notice to and in the discretion of the State Architect, Franklin B. Ware, Albany, N. Y.

T. E. McGarr, Secretary, State Commission in Lunacy.
Dated Albany, N. Y., September 2, 1908.

Sealed proposals endorsed "Proposals for furnishing and installing four horizontal tubular boilers," at Hudson River State Hospital, Poughkeepsie, N. Y., will be received by the State Commission in Lunacy at the Capitol, Albany, N. Y., up to 3 o'clock P. M., on Tuesday, the 29th day of September, 1908, when they will be opened and read publicly.

Proposals shall be accompanied by a certified check in the sum of $600, and the contractor to whom the award is made will be required to furnish a surety company bond in the sum of $6,000. The right is reserved to reject any and all bids.

Drawings and specifications may be consulted and blank forms of proposal obtained at the Hudson River State Hospital, Poughkeepsie, N. Y., or at the office of the State Architect. Complete sets of plans and specifications will be furnished to prospective bidders upon reasonable notice to, and in the discretion of, the State Architect, Franklin B. Ware, Albany, N. Y.

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