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MURPHY'S BICYCLE RIDE A HINT TO THE RAILROADS.

There are some commonplace truths which only take on a practical value in men's minds when they receive some startling and easily understood illustration. Of such a kind is the theory of atmospheric resistance to moving bodies. People who are, or ought to be, greatly interested in the subject (foremost among whom are the railroad men of the country) are aware that air resistance is one of the impediments that keep down the speed of moving bodies; but we question if one in a hundred of them realizes that this is not merely one, but probably at high speeds the chief resistance. Engineers and architects are all familiar with the tables of wind pressure, from those of Smeaton to the later ones of Trautwine, Kent and others; and roofs, bridges and other frame structures are proportioned to meet pressures which range anywhere between 30 and 56 pounds to the square foot, according to the particular selection which is made from among the many tabulated guesses as to wind pressure which adorn the accepted technical pocket-books of the day. But while it is believed that a 60-mile wind will exert an 18-pound (Smeaton) or a 36-pound (Trautwine) pressure per square foot, it does not seem to occur to practical men that a 60-mile train (action and reaction being equal) will be subject to the same unit of pressure—or if it does occur to them, the fact is steadily ignored.

Elsewhere in this issue will be found a full account of the ride of a mile a minute recently made by a bicyclist behind the shelter of a locomotive and car. The facts are profoundly significant. Here is a man who, even if exerting himself to the utmost, could not ride a mile unpaced at the rate of thirty miles an hour, can yet sweep along behind the shelter of a railroad train at a speed of sixty-four miles an hour, and have a reserve of strength to spare.

Let us look at the matter as a question of mechanics. A pressure of 33,000 pounds exerted through a distance of one foot in one minute equals one horse power—at least so we are all agreed to believe. A pressure of one pound exerted through the same distance in the same time would equal $\frac{1}{33000}$ part of a horse power, and hence a pressure of one pound exerted through 5,280 feet, or one mile, in one minute would equal $\frac{5280}{33000}$, or 0·16 horse power. Let us suppose that a rider, when bent down into the racing position, represents about 3 square feet of front vertical surface, and that the wind pressure at 60 miles an hour is even less than that given by Smeaton's original formula, or say only 15 pounds per square foot, then $3 \times 15 \times 0{\cdot}16 = 7{\cdot}2$ horse power; that is to say, a bicyclist must exert over seven horse power to make a mile a minute against still air. Now, as a matter of fact, it is questionable if any but a few of the crack racing men can exert a full horse power, and they are capable of sustaining this effort only for about an eighth of a mile. Prof. Denton, of the Stevens Institute of Technology, tested one or two powerful riders on the Webb floating dynamometer, and found that an "extremely powerful rider using his utmost effort" could only exert for a few seconds power at the rate of 19,780 foot-pounds of work per minute, while another in a hill-climbing test exerted 21,200 foot-pounds, or say two-thirds of a horse power, but only for a fraction of a minute. The difference (supposing our assumed unit pressure for the atmosphere to be correct) between less than one horse power and over seven horse power represents a part of the work which was being done in the recent trial by the locomotive, which was opening out the atmosphere, as it were, to allow Murphy to ride through it in the body of still air within the shield.

Now applying these facts to a train composed of an engine, tender, and say half a dozen cars, moving at the rate of a mile a minute, we see at once that the accumulated atmospheric pressure on the front of the engine, the front of each car, the front of each set of trucks, and the various projections of ventilators, window recesses, etc., must mount up in the aggregate to an enormous figure, and it is certainly a proof of the extraordinary conservatism of even such practical people as build and operate our railroads that nothing whatever has been done to smooth down and close in our trains, so that the engine should do for the train that follows it what it did for the cyclist Murphy.

For the train to get all the benefit of the "pace" (to use a cycling term) afforded by the engine, the front car should be connected to the engine and each car to the one behind it by a continuous sheathing, similar in cross-section to the shield built for the recent bicycle trials. Sheathing should also extend from the sides of the cars to the rails, as in the wind shield, and this sheathing should be continuous from the pilot of the engine to the rear steps of the last car. The train would thus be vestibuled from the roof to the rails and from the pilot to the rear platform, and the result would be that the total front vertical area opposed to the atmosphere would be reduced about three or four hundred per cent. As trains are now built, the air that is pushed aside by the engine closes in upon the first car, and upon the front of every car that follows it. Each truck also, and all of the brakegear, etc., add to the total resistance, until we think there is little reason to doubt that at high speeds the resistance of the air exceeds by many times the internal and the rolling friction of the train.

The best work, indeed the only exhaustive work upon the subject, is that written by Frederick U. Adams a few years ago, after an exhaustive and costly experimental study of the problem. At a speed of 60 miles an hour he estimates that the total front surface exposed squarely to the wind on a six-car Pullman train is 605 square feet, and the total air pressure 11,374 pounds. He urged upon the railroads the necessity for building their trains with a wedge-shaped front and flush and continuous sides extending to the rails, with vestibuled connections, and an absence of all deep recesses for windows and ventilators. It is a curious coincidence that the cross-section of the car proposed by Mr. Adams is almost identical with that of the shield built for the bicycle trial.

It is strange that with all of our earnest effort to reduce fuel expenses and increase the hauling power of our locomotives, by improving the track, compounding the cylinders, enlarging the boiler and so on, we have taken not one of the obvious and simple precautions by which the greatest of all train resistances might be overcome.

If at 60 miles an hour 7 horse power is consumed on the 3 square feet surface of a bicyclist, how much is consumed on the 400 to 600 feet front surface of an express train of the same speed? We commend the subject to the consideration of our master mechanics and railroad superintendents throughout the country.

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EXTREME RANGE OF SIXTEEN-INCH GUN.

The great 16-inch 126-ton gun building for the United States at the Watervliet arsenal will have a range power of 20·978 miles. This statement is based on a calculation made by Major James M. Ingalls, the greatest recognized authority on ballistics in the United States army and the present head of the Artillery School for Officers at Fort Monroe. Major Ingalls has prepared a firing table for the 16-inch gun, which shows that a range of 20 978 miles is attainable on a muzzle velocity of 2,600 foot-seconds. The angle of elevation necessary for the piece he estimates at 40 degrees. The trajectory, or path described by the projectile, which Major Ingalls has plotted shows that in ranging to 20·978 miles the shell will reach a maximum elevation of 30,516 feet. The weight of the projectile he assumes to be 2,370 pounds.

On a muzzle velocity of 2,000 foot-seconds Major Ingalls' calculations show a range obtainable of 13·971 miles. This latter range yields a maximum elevation in flight of 19,302 feet. As in the former case, the gun attains the lesser range on an angle of elevation of 40 degrees. The importance of Major Ingalls' calculations may be better understood when it is known that the greatest range ever attained in the world was recorded by a Krupp 9·45-inch gun on the Meppen range in Germany. The shot was fired in the presence of the Emperor on April 28, 1892. The range was measured and found to be 22,120 yards, roughly, 12½ miles. The greatest height reached by the Krupp shell in its flight was 21,456 feet. The time occupied between the firing of the gun and the striking of the projectile was 70·2 seconds. The German artillerists pointed with pride to the fact that had the German gun been placed at Pre St. Didier in the Alps, with an elevation of 44 degrees, and fired, its shell would have ranged 8,956·8 feet higher than Mont Blanc, and its fall would have been in the neighborhood of Chamounix.

Prior to the Meppen shot, the greatest range ever attained was recorded by a 9·2-inch English gun at Shoeburyness, England. The gun was fired on the occasion of the Queen's Jubilee, at 12 o'clock noon. Several months before the date of firing, the English officials sent out data to the recognized artillery experts of foreign countries, and the request was made that the range of the shell be calculated. Major (then Captain) Ingalls was handed the English data, as the officer selected to solve the problem for the United States army. Major Ingalls worked alone, and when his calculation was made, it was duly sealed and forwarded through the diplomatic channels to the British War Department.

It was understood from the first that the papers were not to be opened until after the shot had been fired. To enable the foreign officers to calculate the more closely, the English authorities furnished all possible data in advance which might be needed. The data set forth the type of gun, weight of shell, nature and weight of charge, angle of elevation, and a table of atmospheric readings, showing what conditions had prevailed at Shoeburyness for ten years back for the hour on corresponding days on which the shot was to be fired.

The range attained by the English shot was about 12 miles. When the papers of the foreign officers, as well as those of the English officers, were opened, it was found that the closest calculation of all had been made by Captain James M. Ingalls. The next best calculation was turned in, it is understood, by an Italian artillerist. Captain Ingalls plotted the fall of the shot only a few hundred feet short of the actual distance. The rival calculations placed the point of fall at distances varying from 1,500 yards short to several miles short. On overlooking the data of the firing with the actual conditions of weather which prevailed at Shoeburyness, on the day in question, Captain Ingalls was able to place the shell practically at the very spot where it struck. In his previous calculations he had worked up the problem, using the mean average atmospheric data for the ten years past. From the artillerists' standpoint, Ingalls' wonderful showing has never been equaled, and it is doubtless a fact that this officer is more appreciated for his great attainments in Europe than he is in the United States. Ingalls' works on ballistics have been translated into a number of languages, and are standard text books, it is said, in many foreign services.

The calculation which has just been made by Major Ingalls regarding the new 16-inch gun is all the more interesting in view of the estimate made not long ago by an artillery expert of the Krupps, who expressed doubt of the American 16-inch gun being able to attain a greater range than sixteen miles. The German expert admitted that a sixteen-mile range might be reached on a muzzle velocity of 2,600 foot-seconds, but he assumed that the gun must be laid at an angle of elevation of 44 degrees, and this he thought could not be accomplished except on an experimental carriage. It will be noted that Major Ingalls takes issue squarely with the figures of the German expert, and in his table he works out the twenty-mile range on an angle of elevation of only 40 degrees.

In connection with the 16-inch gun data, Major Ingalls has developed a table for the new 12-inch navy gun which shows a range attainable of 19·935 miles on a muzzle velocity of 3,000 foot-seconds. The maximum elevation plotted for the 12-inch shell is 32,515 feet. The weight of the 12-inch shell he assumes to be 850 pounds.

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SCHENECTADY LOCOMOTIVES FOR ENGLAND.

The first of the ten freight locomotives which the Schenectady Locomotive Works are building for the Midland Railway, England, has a decidedly handsome appearance, and impresses us more favorably in this respect than the engine built for the same company by the Baldwin Company, the first of which was illustrated in the SCIENTIFIC AMERICAN of May 20. The designers have paid that careful attention to contour and general outline which characterize all the Schenectady engines, and while we do not suppose there will be anything to choose in the excellence of the workmanship of the two the Schenectady locomotive is certain to find greater favor with the English people, who place such high store upon the neat appearance of their engines. The running-board is slightly below the level of the tops of the drivers and extends straight without a break from the cab to the forward end of the steam-chest, upon which it rests. There it curves down and forward to the bumper beam. The cab is of metal; its sides flush with the outer edge of the running-board. It is of the standard American type, with four windows in front and two on each side. Inside the English engineer will find the American arrangement of throttle and reversing-lever, and he will be given an opportunity to compare them with his own system. The cylinders, 18 by 24 inches, are outside the frames, with the steam-chest on top, instead of, as in English practice, on the side. The bell and sand box on the top of the boiler are missing, the former because it is never used in England and the latter because it is replaced by smaller sand boxes, two on each side, beneath the running-board. These are placed in front and to the rear of the main driver, and each is supplied with a steam sanding device which blows a fine spray of sand under the tread of the wheels. The locomotives are of the Mogul type, with a single pair of leading wheels and six wheels connected. The tender is of the standard six-wheeled English type.

The firebox and staybolts are of copper, as are also the tubes. This metal is used because of its great wearing qualities, the firebox outlasting, with good usage, the other parts of the engine.