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## ENGLISH AND AMERICAN MACHINE TOOLS.

It will be remembered that one of the principal grounds of contention during the great strike in the British engineering trades was the question as to the right of the trades unions to control the output of labor-saving machinery. Happily for the interests of both employers and employed, the attempt of the men to limit the output of machinery was thwarted.

In a recent editorial on English and American machine tools, The Engineer comments on the fact that the English manufacturer is at length beginning to recognize that the restriction in the way of their use being now removed, automatic machine tools are of great importance. Our esteemed contemporary expresses regret that English makers of machine tools do not devote more effort to the design and manufacture of automatic machine tools, and goes on to say : "Is it possible that English manufacturers cannot find time to devote some attention to this class of machinery, and so offer battle to the increasing competition, or is it that they still profess to despise American methods? If the latter is the case they would do well to undeceive themselves by an inspection of American machines. We have frequently heard it stated that the imported article was weak and roughly made. A few years ago that was to a great extent true, but it is so no longer. American engineers do not stand still, and they have eagerly learned by experience. The consequence is that their tools are nowadays at least as stoutly built as our own and are as well finished, while in accessibility of their working parts, in ingenious automatic devices, in adaptation for rapid work, in convenience and handiness, they are far ahead of the productions of most British firms."

The Engineer has no intention of "puffing" American productions, but speaks plainly, with the hope of "removing some of the bias" which misguides the British manufacturers; and it points out to its readers that our success is due largely to the fact that instead of waiting for customers to state what is wanted, our manufacturers have a way of taking the initiative in improvements; "they lead, and do not follow manufacture."

These are candid words and full of remarkable significance, coming, as they do, from the most conservative technical journal in Great Britain ; and if the British manufacturer fails to take the hint, it can never be his excuse that his loss of a profitable trade was due to ignorance of the underlying cause.

## SAFETY OF THE BROOKLYN BRIDGE.

The public has lately been favored with somewhat conflicting statements regarding the strength and safety of the Brooklyn Suspension Bridge, made by two engineers whose names are prominently associated with the construction and maintenance of this great structure. The first appeared in the form of a letter to The Railroad Gazette from W. A. Roebling, who, after the death of John A. Roebling, superintended the construction of the bridge; the second statement is the report of C. C. Martin, the present chief engineer of the bridge, to Bridge Commissioner Shea.

Mr. Roebling, referring to the recent buckling of the stiffening trusses, attributes it entirely to the presence of the overfloor stays. In our issue of August 13, 1898, there will be found a discussion of the accident, in which the buckling is attributed solely to these stays, which extend from the panel points of the trusses to a rigid connection with the top of the towers. Mr. Roebling states that in any future suspension bridge he would dispense with their use, and explains they were retained by him because, on account of the increased loads which were to be placed on the bridge, "long before the cables were completed" he "had to look in every direction for an increase in supporting power." "The crying evil on the bridge," says Mr. Roebling, "is that every year since it has been opened for traffic there have been numerous additions to the dead load, the climax of the overloading" being "reached when the trolley took possession of the roadways." The builder of the bridge has no fear for the cables, as they still have ample strength and "could pull up the anchorages with ease."

Mr. Martin's report, while it gives much valuable information as to the strength of the cables and the stability of the anchorages, has little to say about the failure of that part of the bridge that aroused the present discussion, namely, the stiffening trusses. While it is, no doubt, a fact that the bridge is "absolutely safe," and "no one need entertain for a moment any fears of its stability," it is nevertheless true that the stiffening trusses are altogether unequal to the demand of a sudden emergency, and that as far as they are concerned the bridge is not "stable." Since the stiffening truss is an integral part of a suspension bridge, it follows that the failure of the trusses is a failure of the bridge, and hence a bridge in which these trusses are liable to collapse under a congestion of traffic which may occur at any time, is obviously overloaded. All that can be said of the bridge is that under its present loading it is liable to a partial failure, which will not, however, involve any risk to the traffic that passes over it.

The report states that the total moving load upon the main span is 1,962 tons, the total additional weight added in the way of new tracks, cables, electric cables, trolley arms and traces, etc., is 430 tons, and the weight of the original superstructure is 5,828 tons, thus bringing the total weight up to 8,220 tons. This multiplied by 1·7 gives a total strain in the cables of 13,974 tons. The ultimate strength of the four cables, however, is 49,200 tons, which gives a factor of safety of 3·52. It is argued that since the dead weight of the structure cannot be materially increased, any increase must come from the moving load, which must, therefore, be multiplied ten times over before it could break the cables.

The stability of the anchorages is shown by the fact that they have moved forward under the pull of the cables only one-eighth of an inch in the past eight years.

The report will allay any fears that may have been entertained by the public as to the danger of a positive collapse of the bridge. Neither the floor, the suspenders, the cables, nor the anchorages can give way under any increase of loads that can be brought upon the bridge. The stiffening trusses have failed more than once and they will fail again whenever a blockade occurs on the bridge. The best thing to be done would be to remove the superfluous diagonal stays, which were one of the conducing causes of the buckling, and replace the present flimsy and inefficient stiffening trusses by others of greater depth and weight. If this were done, we should hear no more of alarmist rumors of buckling floor system or collapsing cables, and the bridge would be good for its natural life of twenty centuries.

## ELECTRIC LOCOMOTIVES FOR EUROPE.

An American corporation, the General Electric Company, has recently obtained a contract for the supply of the equipment for the tunnel of the Paris-Orleans Railway, from its present terminus in Paris at the Austerlitz station to a new station near the Quai d'Orsay, in the heart of the city. The manager of the foreign department of the company said : "Although this contract involves a smaller amount of money than the contracts secured some months ago from the London Underground Railway, it is in quality, so to speak, a more important contract, for it marks the conquest of the stubborn French prejudice against American manufactures, and against too ready an adoption of the latest improvements, waiting as they are prone to do for something better still. Moreover, the contract was won against the strongest possible competition of British and European companies during a period of negotiation extending over two years. We have contracted to furnish eight electric locomotives operated with the third rail, and that they will more than fulfill all expectations we do not for a moment doubt." It has not been decided whether the third rail will be between or outside the tracks. The system of transmission will require the use of the three-phase generators for the rotary converters, changing an alternating to a direct current of 500 volts. There were fourteen competitors in the matter of the Paris contract. French engineers were taken over to the United States and a complete demonstration was given on their experimental track at Schenectady, and the company's ability to do more than was required was shown. There is a railway of considerable length at Schenectady following the course of the Mohawk River, and on this railway a train of more weight than that of the Paris-Orleans line was run backward and forth over a distance equal to that between the stations of the Paris tunnel. The perfect mobility and power of the electric locomotive was so well shown that the French engineers were immediately convinced that it met all of the conditions in even a higher degree than had been demanded. The fact that the American company could show the greatest experience in electrical locomotive building was of far more importance than the question of cost. The only point considered was, which of the competitors could supply the most efficient locomotive and accompanying electrical apparatus. This is certainly another triumph for American engineers.

## BREAKDOWN IN DAILY NEWSPAPER OFFICES DUE TO LACK OF GAS.

The bursting of a large gasometer, which is referred to elsewhere in this issue, was the cause of trouble and inconvenience to the newspapers which use the linotype machines, owing to the fact that the supply of gas down town was cut off. In the linotype machine the type metal is kept hot by gas, so that when the gas pressure became reduced the type metal began to cool. In most of the machines there was no gas at all, and in the few in which it did burn, the flame was very feeble. Several of the papers had to set up their type by hand, and in one case twenty machines had to be abandoned. At least one newspaper which does not use machines courteously placed the composing room at the service of another paper. It is probable that after this newspapers will provide some means for heating the type metal in case the supply of gas is temporarily cut off, and devices of this nature are made.

## HAVANA'S FLOATING DRY DOCK.

On the recommendation of the American Evacuation Commission of Havana, our government will not insist that the floating dry dock of the Spanish navy in Havana Harbor shall be turned over to the United States. Admiral Sampson endeavored to persuade his colleagues that the dock was not movable property and therefore must be surrendered by Spain. Generals Wade and Butler, however, held that the dock was a floating and movable structure. Both parties were right in a way, for $40,000 was expended for establishing it in its present berth, and the fact that it cannot be moved was cited by Admiral Sampson in support of his contention. We have already illustrated this dock in the SCIENTIFIC AMERICAN for October 16, 1897.

The dock was built in England and cost the Spanish government $600,000. It reached Havana a short time before the war began and was promptly sunk, which is not to be wondered at, considering that we know now that the Spaniards are the poorest mechanics in the world. The American commission say it has been so badly used it is not worth more than half what it cost. It is probable the dock will be put up at public auction by the Spaniards and sold, as the American commissioners and Spanish commissioners have failed to agree on a price.

## SCIENTIFIC CONVENTIONS IN NEW YORK DURING THE HOLIDAYS.

Eleven associations of scientists will hold their winter meetings in this city during the week succeeding Christmas, and all are to be the guests of Columbia University. The programmes offered by the various associations are full of interest and are certain to attract many professional men to the meetings. The American Chemical Society will hold its meeting on Tuesday and Wednesday, December 27 and 28. The morning session of the first day will be held at the Chemists' Club, 108 West Fifty-fifth Street, and will be devoted to the hearing of addresses and the reading and discussion of papers, but the afternoon will be used in visiting the works of the New Jersey Zinc Company, at Newark. The second day will be given up to the reading of papers and the examination of the chemical laboratories in Havemeyer Hall, of Columbia University. On Wednesday and Thursday come the gatherings of the American Society of Naturalists, the American Morphological Society, the Association of American Anatomists, the American Physiological Society, the American Psychological Association, the American Folk Lore Society, the Society for Plant Morphology and Physiology, the Anthropological Section of the American Association for the Advancement of Science, and the Geological Society of America, while the New York State Science Teachers' Association will meet on Thursday and Friday.

Wednesday will be devoted to the business sessions of the various societies and the reading of papers, morning and afternoon, in Schermerhorn and Fayerweather Halls and the College of Physicians and Surgeons. In the evening there will be a lecture at the American Museum of Natural History, by Prof. H. F. Osborn, on "Collections of Fossil Mammals and Their Care," followed by a reception to the members of the societies, at the home of Prof. Osborn. Thursday morning and afternoon will be given up to the solid work of reading and discussing of papers, the set topic for 3 P. M., with the naturalists, being "Advances in Methods of Teaching." The programme for Friday includes visits to the Botanical and Zoological Gardens for the naturalists, while the geologists and the science teachers will still be occupied with the reading and discussion of papers. In connection with the meeting of the Science Teachers' Association there is to be an exhibition of scientific apparatus at the Teachers' College on West One Hundred and Twentieth Street. The president of the Chemical Society is Prof. Charles E. Munroe, that of the Naturalists' is Prof. H. P. Bowditch, and that of the Geologists' is Prof.

J. J. Stevenson, while the chairman of the local executive committee of the affiliated societies is Prof. H. F. Osborn and its secretary is Prof. Bashford Dean.

### FLYING MACHINES AND ORDNANCE.*

BY HIRAM MAXIM.

#### FLYING MACHINES.

In 1889 I determined to make a series of experiments with a view of ascertaining how much power was required to perform artificial flight on a large scale. All the apparatus made before this time had been so diminutive in size, so imperfect in construction, that the experiments were of little value. There were practically no data obtainable that would apply to the apparatus when constructed on a sufficiently large scale to be considered as a practical flying machine.

At that time it appeared to me that the most practical system of making flying machines would be what is known as the aeroplane system, that is, a machine made in the form of a kite.

Every boy knows that, when a kite is held up against a strong wind by a cord, it will ascend. The wind, blowing against the underneath surface of the kite, lifts it with a considerable degree of force ; conversely, if the kite should be driven forward through stationary air at the same velocity, the lifting effect would be identical.

My first apparatus consisted of a long arm revolving on a vertical pivot, the arm being of sufficient length so that the circumference around which it traveled was exactly 200 feet. This arm was provided with a screw propeller and it was possible to attach aeroplanes of any size or shape at any required angle, and to drive them around the circle at any velocity from 20 to 90 miles an hour. The apparatus was provided with tachometers, dynamometers, and various apparatus not only for determining the lifting effect of the aeroplanes, but also the actual amount of power required to propel the plane through the air ; to measure the thrust and slip of the screw ; also the amount of power required for driving the screw, and to determine exactly the velocity at which the apparatus was traveling.

The aeroplanes employed in this apparatus were for the most part about 18 inches wide and 4 feet long. Wooden aeroplanes with lightly curved surfaces were found to be best. These experiments demonstrated that 133 pounds could be lifted and propelled at the rate of 45 miles an hour with the expenditure of 1 H. P. I then constructed a very large apparatus, which was, of course, too large to attach to the rotating arm, the apparatus, in fact, being over 100 feet wide. I determined to try this machine by running it along a railway track ; that is, instead of running the machine in a circle or holding it up against the wind after the manner of a kite, I decided to run it at a high velocity along a railway track, and to provide it with apparatus to determine the amount of power consumed and the lifting effect of the aeroplanes. First, I had a steel track 9 feet gage, and outside of this and above it a wooden track 35 feet gage, made of 3 inch by 9 inch Georgia pine. The machine was provided with ordinary wheels for running on the lower steel track, and with special wheels for running on the underneath side of the outer or upper track. The wheels were adjusted in such a manner that when the machine was lifted 1 inch clear of the lower track, the special wheels engaged the outer or upper track, thus preventing the machine from rising in the air.

In these experiments the power consumed was altogether out of proportion to what I had anticipated. Had my large machine been as economical as the small apparatus, it would only have required 100 H. P. to lift it, but 100 H. P. was found to be completely inadequate, and it was not until I had increased the power to over 360 H. P. that I succeeded in getting a machine actually to lift from the ground.

These experiments demonstrated that large machines are nothing like so economical in power as small ones, and that aeroplanes, in order to be effective at a moderate velocity, should be long and narrow, rather than in the form of a kite.

Prof. Langley has constructed an apparatus similar to mine, but very much smaller, and he found that, with his apparatus, the power required per pound lifted was very much less than with my large machine, approximating closely to the original experiments made by myself with the small apparatus.

I understand that the government is spending $25,000 with a view of evolving a practical flying machine. I do not think they will succeed on the aeroplane system. I believe that, when we come to large apparatus, it will be necessary to construct a machine on a totally different plan. Moreover, the $25,000 will be found completely inadequate for the purpose, as my own experiments cost fully $100,000.

My experiments have been fully explained in various articles which I have written, which knowledge is now common property.

#### FIREARMS AND ORDNANCE.

During the last three hundred years the cleverest mechanicians of all countries have been engaged in making improvements in firearms, always with a view of greater accuracy and rapidity of fire, but it was not until metallic cartridges came into use that it was possible to construct breechloading firearms which could be fired with any degree of rapidity.

It is, however, true that long before metallic cartridges were invented, several attempts were made to construct rapid-fire machine guns. It was, I think, in about 1840 when the great Peter Cooper made what was perhaps the first machine gun ever thought of in this country. In 1854 my own father conceived the idea of making a machine gun. He proposed to make it something after the manner of a revolver, but instead of having loaded chambers, a sprocket wheel took the place of the cylinder, and this was supposed to feed up loaded links of a chain, bring them in line with the barrel and discharge them by the working of a lever by hand. He believed it would be possible to make a gun of this kind that would fire one hundred rounds in a minute. Curiously enough, the gun which was experimented on by Peter Cooper, and the one conceived by my father, of which I made a wooden model, were almost exactly alike.

The first machine gun that ever went into practical use was the Gatling. The Gatling gun had a series of from six to ten barrels arranged in the form of a cylinder, and so constructed that when one turns a crank by hand the barrels are brought successively into action. Then we had the French mitrailleuse, which had thirty stationary barrels arranged in the form of a cylinder. All of these were loaded and fired simultaneously, and the recoil was so great that the gun had to be provided with a mounting quite as strong as would be employed with light pieces of artillery. Later on we had the Gardner, the Lowell, the Pratt & Whitney, and the Nordenfeldt, all being provided with a considerable number of barrels arranged in groups, with hopper feeds, and in all cases being worked by hand by means of a crank or lever. The Nordenfeldt gun, on account of greater simplicity and lightness, met with greater success than the other types of hand-operated guns, but none of these guns were used to any extent by the great military nations of Europe, and it was not until after the automatic gun was invented that such nations as Germany, France, and Austria would even consider the use of machine guns in the service.

Many years ago, while firing at a target with a military musket, I was much surprised at the force of the recoil. It appeared to me on that occasion that this waste of energy might be profitably employed in loading and firing the arm, but it was not until I went to Europe, and, finding myself in Paris, with insufficient work to keep me fully employed, that I actually took up the question of automatic guns. I first made a drawing which I afterward took to London, and having obtained and equipped a small factory there, I commenced experiments with a view of evolving a gun which would load and fire itself. There was not a particle of data to go by. No one before had ever spent a single cent in experimenting with automatic guns. I first thought of applying the recoil to working existing forms of mechanism, but found that impractical. I then designed and constructed a totally new mechanism and a totally new system of feeding.

In the spring of 1884 I constructed the first apparatus ever made in the world in which the recoil of one cartridge would load another cartridge into the barrel and fire it. This apparatus is now in the South Kensington Museum, in London, and labeled "This apparatus loads and fires itself by force of its own recoil, and is the first apparatus ever made in the world in which energy from the burning powder is employed for loading and firing the arm."

When it was first reported in London that an American electrician had succeeded in making a gun which had loaded and fired itself, everyone was incredulous ; they looked upon it as Yankee brag or boast. Many people came to my place and wished to see the gun with their own eyes.

I had fitted up a place in the basement where a gun could be fired with loaded cartridges, and my visitors increased daily. Everybody, from the Prince of Wales down, came to see what was then considered a nine days' wonder, and it required a very considerable portion of my time to receive visitors and show the arm ; in fact, so much of my time was consumed that it became necessary to work nights in order to carry on the work and take out the patents in the various countries of the world.

I used fully 200,000 rounds of cartridges showing my first gun to visitors. The British government was the first to give me an order. They asked me to make a gun which would not weigh more than 100 pounds, and which should fire 400 rounds in a minute. I presented a gun which weighed only 40 pounds and fired 2,000 rounds in three minutes. At these trials I showed three different forms of automatic guns, and all were purchased by the government and are now in their museum.

The next step was to take the gun on the Continent and put it in competition with guns working by hand. In every case I was successful over all competitors, and received large orders. On returning to England I had a field trial before Lord Wolseley. Every one admitted the superiority of the arm, both as regards accuracy, simplicity, and ease of manipulation, but his lordship said, on observing the enormous cloud of smoke given off by the gun, that the gun would be of little use in actual service unless it was provided with smokeless powder. At that time there was no smokeless powder in England, although the French were conducting experiments with the view of finding a smokeless powder.

Acting on his lordship's suggestions, I then commenced experiments with a view of making a suitable smokeless powder for my gun. The first powder which I made was pure tri-nitro-cellulose, made from high grade gun cotton. This not proving altogether satisfactory, I added by degrees small quantities of nitroglycerine, commencing with about 5 per cent and increasing until I actually made a successful powder with as much as 60 per cent of nitro-glycerine ; but as there was great prejudice against the use of nitro-glycerine, I reduced the quantity to about 13 per cent and produced a thoroughly good smokeless powder. Both nitro-glycerine and high grade gun cotton are violent explosives; in fact, they detonate like a fulminating cap. Nobel, before my time, had attempted to tame or slow up nitro-glycerine by the addition of a sluggish explosive, like collodion cotton, but no one had attempted to make a slow-burning powder from two violent explosives.

Sir Richard Webster, in the celebrated case of Nobel v. Government, admitted that I was the first man in the world to make smokeless powder from nitro-glycerine and gun cotton. It was, I think, about nine years ago that I sent a quantity of this powder to this country. It was in competition with many other kinds of smokeless powder. It produced excellent results, and, according to the official report printed at that time, it was superior to any other powder submitted, and to-day it may be said that little or no improvement has been made in this original powder submitted by me at that time. The powder employed by the government to-day is practically of the same composition and the pressures and velocities are also practically the same.

A few years later the French, wishing to obtain a little higher velocity with an automatic gun than it was possible to obtain with the French powder, proposed to increase the length of the cartridge case, but I suggested that they might attain the desired velocities with the use of an improved form of powder. I accordingly made in England a quantity of smokeless powder with longitudinal perforations. I took it to France and produced results better than ever produced before. I attained the required velocities without increasing the size of the cartridge case, and the gun with the new form of powder was adopted into the French service.

[At the close of the lecture a fully automatic gun loaded with blank cartridges was fired in the lecture hall, at the rate of six hundred rounds a minute.

Mr. Maxim repeated this lecture before the American Society of Civil Engineers, at their club house, No. 220 West 57th Street, on the evening of December 14, and was enthusiastically received. It should be mentioned that he accompanied the lecture with numerous lantern slide illustrations of his aeroplane and ordnance factory.—ED.]

* Address delivered before the Engineering Society of Columbia University of the City of New York, December 8, 1898.

### COST OF CLEANING BRICK PAVEMENTS.

The organ of the New York Reform Club Committee, Municipal Affairs, published quarterly, has, in its last issue, a very interesting and complete report upon the reforms effected in cleaning the streets of the city. By this it is shown that the ease with which certain types of pavement can be kept clean, as indicated by careful observations of the cost of doing the work, is as follows: Asphalt, 100; brick, 100; wood (smooth karri), 100; granite, 150; Belgian blocks, 160; cobble stones, 400.

All the pavements were in good condition and the accuracy of the table was checked by comparison with the number of sweepers actually employed in each subdivision in the city. For the entire city 1,623 sweepers were employed, each sweeper keeping clean an average of 5,746 square yards, at an average cost of $2.40 per 1,000 square yards a week; indicating, according to the estimate, that asphalt, brick, and smooth karri wood paving could be kept clean at 69 cents per 1,000 yards per week.

A brick pavement, when properly laid, is not a noisy pavement, it is a good and smooth road for traction purposes or for bicycling, while it affords a better foothold for horses than asphalt does, it is more than ten times as durable, it is lower in first cost, incomparably lower in cost of maintenance, and the New York report proves incontestably that, in the important matter of cleaning, the brick pavement is in no way inferior to asphalt; therefore, we cannot understand why the vitrified brick pavement is not universally adopted in all our cities.