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NEW YORK, SATURDAY, FEBRUARY 9, 1901.

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.

RAIL JOINTS AND STREET NOISES

A correspondent from the town of Bridgewater, Nova Scotia, referring to an article in this journal on rail joints and street noises, in which the use of the welded joint was suggested as the best means of getting rid of the loud pounding which seems to be inseparable from the present forms of spliced joints, asks us whether it would not be a better plan to provide a double rail consisting of two lines of rails, laid side by side, so that the joints of one rail would always lie at the middle of the adjoining rail. The idea is not new, and has been tried, we believe, on some European roads, where it was found that although the pounding was reduced, and the low-joint difficulty removed, there were so many attendant disadvantages as more than to neutralize any benefits secured. The separate elements of a double rail must necessarily be bolted together, and the difficulty and labor of keeping the bolts tight is enormous. Our recent suggestion that the elevated railways in this city would do well, in the reconstruction of their road, to introduce the welded joint, has been criticised on the ground that, except where such welded rails are embedded in concrete or Belgian blocks, it is impossible to preserve their alinement, because of the stresses which are set up by expansion and contraction under changes of temperature. We are perfectly aware of the necessity for holding the rails in line during hot weather, but are of the opinion that if screw-bolt connections instead of the inadequate railway spike were used on every tie, and if each tie were bolted to the stringers of the elevated structure, it would be quite possible to hold the rails in alinement even in the hottest summer weather. Such a construction would be costly in maintenance, and might not indeed commend itself to the shareholders; but it would bring relief to the citizens of New York from an inferno of din for which there is no parallel in any city of the world.

POUND-PER-HORSEPOWER ECONOMY.

It seems likely that to the marine engineer will belong the credit of having built and introduced an installation of boilers and engines that is capable of doing day by day work on a fuel consumption of less than a pound of coal, per horse power, per hour. We all remember the world-wide interest which was aroused by the quadruple expansion, five-crank engines of the steamship "Inchmona," which were the first to bring down fuel consumption to the one pound limit. The success of this vessel encouraged the owners of the "Inch" line of steamers, and the Central Machine Engine Works, of West Hartlepool, England, to follow up their experiments, and in the "Inchkeith" and "Inchdune" the consumption has been brought down respectively to 0.99 and 0.97 pound per horse power per hour. We must content ourselves here with giving the salient features of the installation of the vessels, and refer our readers to the next issue of the SUPPLEMENT for the drawings and full particulars. Of these vessels it may be said that every refinement that would bring the performance of their motive power nearer to the theoretically perfect steam engine and boiler has been installed. All the cylinders, with the exception of the high-pressure, are lined and jacketed, the last-named being unjacketed. The cylinders are completely surrounded by steam, all external surfaces being well lagged with asbestos. The expansion is quadruple, in five cylinders, two of which are low-pressure. The boilers are of the Scotch type, and carry a pressure of 267 pounds to the square inch. Above the boiler tubes at the front end is a superheater, and above this are nests of vertical pipes for heating the air on its way to the furnace. Special attention is paid to the feed-water, which is pumped first through a contact heater, then through a surface heater and is filtered before passing to the boilers. The feed-water, which at the hot well has a temperature of 96½ degrees, leaves the contact heater at 209 degrees, and the surface heater at 370 degrees. The steam enters the superheater at 412 degrees and leaves it at 469½ degrees. In the tests the temperature of the air on the deck of the vessel was 53 degrees, and after leaving the heater it entered the furnace at 290 degrees. The temperature of the gases on leaving the boiler tubes was 587 degrees; this was lowered 44 degrees in the superheater, and 41 degrees in the air-heating tubes. The hot gases are drawn through the air-heating tubes and delivered to the smokestack by means of a fan, and such is the saving of heat that their temperature at the fan discharge was lowered to 319 degrees F., that is to say, over 90 degrees below the temperature of the steam in the boilers.

These remarkable results were obtained on a lengthy trial carried out between Hartlepool in the North of England and Dover. If, for the sake of comparison, the consumption be taken as one pound of coal, it is estimated by our contemporary, Engineering, that it is equivalent to a consumption of 15½ tons per day, in a vessel carrying 6,170 tons at 9½ knots an hour, or to 13¼ tons a day at a speed of 9 knots an hour. To put it another way, one ton is carried one knot for a third of an ounce of coal, and with coal at $4 a ton this would be equivalent to carrying one ton of cargo a distance of 275 miles at a cost for fuel of one cent.

PROGRESS OF TURBINE PROPULSION.

An important step in the development of the turbine-propelled vessel has just been taken in the signing of a contract for the construction of a large turbine-propelled passenger steamer for use on the Firth of Clyde. The vessel is to be 250 feet in length, 30 feet in beam, and 11 feet in molded depth, and she is to attain a speed of 20 knots with turbine engines of 3,500 to 4,000 horse power. Power will be developed on three shafts, by a compound turbine; one high pressure on the center shaft, and two low pressure turbines on the side shafts. The determination to construct a vessel of this size will be welcomed by the builders of deep sea steamers, for it forms the next logical step in a development which commenced with the little "Turbinia," and was carried on in the 380-ton "Viper" and "Cobra." We understand that probably a contract for a large cross-channel steamer of about 2,000 tons displacement, propelled by turbines, will shortly be let.

AIR RESISTANCE OF RAILWAY TRAINS

Additional light has recently been thrown upon the question of air resistance of railway trains by experiments which were carried out by Prof. Francis E. Nipher, of Washington University, who, upon being called in as an expert in a legal case, in which it was claimed that a boy had been drawn under a fast train by what is popularly known as "air suction," determined to test the action of a moving train upon the air, by actual train experiments. The method adopted was to use a hollow cylinder of brass to collect the air when the train was in motion, the open end being directed toward the front of the train, and the wind pressure being shown by means of a tube connecting the after end of the air collector with a water gage in the car. The air collector was so arranged that it could be placed at a distance from the side of the car varying from nothing to 30 inches. A great number of experiments were made. During one lengthy trial, which was carried out on an express train from St. Louis to Burlington and back, a distance of 316 miles, in which 957 measurements were taken, pressures were recorded of 0.95 pound to 2.62 pounds per square foot, the pressure of 0.95 pound being equivalent to that which would be experienced by a person standing 30 inches from the passing train, and the pressure of 2.62 pounds to the square foot being that which would be experienced by a person standing immediately against a car with just sufficient clearance for it to pass. It was estimated that the pressure, when the collector was thrust far out into the undisturbed air, was 3.42 pounds per square foot. These results, it must be remembered, are true simply for a speed of 40 miles an hour, and at higher speeds of 50, 60 and 70 miles an hour the pressure would increase proportionately.

RELATIVE FIGHTING EFFICIENCY OF WARSHIPS.

We have before us an article by the brilliant Chief Naval Constructor of the German Navy, Otto Kretschmer, in which he offers a method of estimating the relative fighting values of warships. This is not by any means the first time an effort has been made to strike a mean between the various elements of fighting power which go to make up the total fighting value of a ship, and so arrive at a total numerical figure of each vessel, which should enable ships of widely different design to be compared directly and placed in the order of their merit. Such comparisons are necessarily of an arbitrary nature, and the value numbers assigned to the different elements of efficiency will vary in different writers. While the present comparison is extremely ingenious and carefully worked out, the results arrived at are, in the case of the United States vessels, to say the least, very astonishing. No one can accuse the German Chief Naval Constructor of partiality, inasmuch as the battleship "Kaiser Friedrich III." of his own navy is placed eighth on the list of the eleven battleships which enter into the comparison. The highest figure of merit is awarded to the Japanese battleship "Mikasa," which carries 15.23 points. The second most efficient vessel is also a Japanese battleship, the "Shikishima," with 14.15 points; then follow the "Formidable," of Great Britain, 12.17 points; the "Suffren," of France, 11.70; "Duncan," Great Britain," 11.46; "Cesarevitch," Russian, 11.23; "Retvisan," the battleship built by the Cramps for Russia, 9.16; the "Kaiser Friedrich," 7.38; the "Charlemagne," of France, 6.15 points; the "St. Bon," Italy, 5.23; and the "Alabama," of the United States, 5.23. While we are quite willing to admit that the "Mikasa," with 2 knots higher speed, larger coal capacity, and bigger displacement, is a better ship than the "Alabama," it is, on the face of it, absurd to affirm that the ratio for fighting values is as 15 to 5. It seems that the data used by the author was taken from an Austrian naval annual, and it is likely that the gun power of the "Alabama" is based upon the supposed use of the old brown powder. Moreover, it is also possible that the normal has been confused with the maximum coal capacity. A few errors of this kind will readily account for the low position of this vessel on the list. On the whole, we think that the comparative table before us simply affords additional proof of the impossibility of determining, except by the actual test of battle, just what is the relative efficiency of warships of widely different design.

COMPARATIVE COST OF PRIME MOVERS.

The present century will not have run very far on its course before the manufacturers of industrial establishments will be confronted with the problem of making a choice between three or four different prime movers, with a view to selecting the one which has the strongest recommendation on the grounds of economy. This choice will not be an easy one, except in certain specified localities where the conditions are such as to make the adoption of a particular type of power clearly desirable. In the nineteenth century no choice of powers has presented itself, not at any rate in the second and third quarters of the century, in which the steam engine had established itself as the universal prime mover without any serious competitor in sight. In the last quarter of the century, it is true, the wonderful development of the water turbine, the electric generator, and the transmission line, has brought into the field a competitor whose superior economy is undisputed when the competition takes place in the immediate locality in which the water power is developed. This superiority, indeed, is only challenged when the increasing length of the line begins to multiply the cost of the transmission.

The most notable developments of hydraulic power which have taken place in the past decade are those at Haute-Saboie in France, at Rheinfelden in Germany, and at Niagara; and the undoubted success of these installations has led to the construction of a large number of less important plants, that differ from these merely in the magnitude of power developed, and the details of the turbines and generators. It is probable that at the present writing the total amount of hydraulic electric power which is now being generated the world over is somewhere between 400,000 and 500,000 horse power. There are signs, in the opening years of the century, that a third competitor in the generation of large quantities of power in central stations has appeared in the shape of the utilization of furnace and producer gas in gas engines of large dimensions. Gas engines of as high as 700 horse power have been built, and they are working smoothly and economically, while at several mills in Belgium the blast furnace gases have been used for driving gas engines which supply the blast.

The question of the relative economy of steam, water and gas was treated at considerable length in a paper presented by Mr. J. B. C. Kershaw at a recent meeting of the British Association, and the conclusions which were reached were based upon a large amount of data, which had been carefully gathered from various existing plants. In order to secure a common basis of comparison the author has calculated the results upon the basis of the cost per year of 8,760 hours, the results being tabulated in connection with the locality in which they were achieved, with the object that local conditions, such as cost of labor, fuel, transportation, etc., might carry their full weight.

In regard to hydraulic power there is considerable variation in the cost, due chiefly to the wide difference in the first cost of the plant. But little preliminary work was required in some cases, while in others there was a vast amount of costly work in the construction of canals, forebays, tailraces, and other concomitants of a hydraulic-electric installation. The first cost per horse power varies from $17, at Vallorbes, to $320, at Lyons, France. The charge to consumers is determined very largely by the cost of the distribution. Thus, in Norway, the price per electric horse power, per year of 8,760 hours, is $5, while at Niagara the average price is $21, the charge depending considerably upon the amount that is required by the consumer.

From the estimates of the lowest practicable cost of steam power we gather that in America the lowest practicable cost for steam per horse power per year is under the most favorable conditions $17.50, and in the United Kingdom $18. In Switzerland the lowest cost of steam power is placed at $45 per year. Under normal conditions, for steam power to compete successfully with water power, the former must be generated in bulk. If this be done, it is estimated that a 50,000-horsepower plant using coal at $1.75 per ton could produce power at a cost of $18 per horse power per year.

With reference to gas power, the author is of the opinion that the cost depends greatly upon the source and character of the gas, while to realize higher economy for gas engines over steam engines, it is not necessary to use the largest sizes, the economy being particularly marked in motors of moderate size. It is estimated by Meyer that if blast furnace gas be used the cost of an electric horse power per year will be $20, and that with the use of Mond producer gas the cost will be $25 per year.

Summing up, a comparative estimate based upon the lowest actually recorded cost for water power and steam power shows that hydraulic power in Canada is being produced at a cost of $6.25 per annum, that in England the lowest actual cost of steam per horse power is $20 per annum, while in Germany, with gas engines using furnace gas, the lowest estimated cost per horse power per year is $20, and in England, with the use of producer gas, the lowest estimated cost per annum per horse power is $25. While this comparison verifies the general opinion that if the first cost is not excessive, the water turbine is by far the cheapest of all prime movers, when the first cost of the hydraulic plant is heavy, or the transmission line exceeds a certain length, the difference between the relative cost of water, steam, and gas power gradually disappears.

EFFICIENCY IN ACTION.

Is it not to be inferred from remarks in the December 1* issue of the SCIENTIFIC AMERICAN on "The Comparative Efficiency of the Krupp, Armstrong and Schneider-Canet Guns" that the naval ordnance expert secures efficiency of fire rather more through the medium of high projectile velocities than that of projectile weights? There appears, however, to be an exception to this rule, in the case further on recited, as relates to the German navy. It is well known that projectiles disproportionately reduced in the matter of weight for the caliber are so conditioned as to have imparted to them extremely high muzzle velocities without at the time exceeding the prescribed pressure limits, and the error of this practice cannot be better appreciated than in the case of cork or wood projected from a rifle and made to penetrate resisting media, like that of wood, plank or glass, and without change of form, when the penetration follows the instant of passage of such projectile from the bore of the gun.

If we consider this matter of projectile weights and velocities from the small arm standpoint, it will be found that there is a special ratio of weight to the area of cross-section for small arm projectiles, which serves as a guide in the ballistic problem, this ratio being 3,000 grains per inch area of cross-section.

It would therefore be unwise, before a ratio has been settled upon in the construction of any projectile, to determine beforehand upon any arbitrary velocity. It would be better in the first place to properly proportion the projectile and after that ascertain by experiment the velocity which shall accord or accommodate itself to the powder pressure restrictions. Proceeding upon any other line is absolutely incorrect and is of the nature of ignorance or pretense. Keeping in mind this idea our argument may be carried to a legitimate conclusion.

The writer of the article before referred to states that the velocities employed in the naval service are much higher than those common to weapons for field guns, and that "regret is expressed by many naval officers to see the 13-inch gun displaced by the 12-inch, the hitting power of the 13-inch shell at long range being considerably greater than that of the older 12-inch shell." Are we to infer from this that the weight of the 12-inch projectile has been reduced in a ratio to its area of cross-section not in accord with ballistic requirements and the purpose of increasing its muzzle velocity to secure a muzzle energy approaching that of the 13-inch rifle, but which ratio of construction results in disproportionate loss of energy at battle ranges?

The relative weights of properly proportioned projectiles for the 13-inch and 12-inch calibers with like "sectional density" requires their ratio to hold at figures of 17 to 14, that is inversely as the square of the diameter of their cross-sections, and not as the cube of this homologous line where a similar proportioned projectile is sought for.

"When the public hears that a gun of a certain caliber is capable of a velocity of 3,000 feet per second, as against velocities of 2,600 feet per second in other guns of the same caliber," it is usually inferred that "the high velocity weapon is incontestably the most effective," whereas should consideration not have been given to the weight of projectile employed, the statement is quite misleading.

What, we ask, is the purpose of the naval ordnance expert in so constructing projectiles as to be ill-proportioned to ballistic requirements? Are his estimates based entirely upon work at close quarters or short ranges, where muzzle energy is the criterion of efficiency; or is the sacrifice due to an effort to provide the greatest total number of rounds that the restrictions of vessels' ton displacement will permit? What is the value of muzzle energy and penetration, if followed by anything assimilating the instability in flight of cork or wood projectiles or where the impact energy at ranges where real work is expected to be accomplished is disproportionately and materially reduced?

"In determining upon the armament of their navy, the Germans have evidently been governed by this consideration (the hitting power of the projectile), for it is a fact that Krupp guns, with which their ships are armed, fire projectiles which are considerably heavier for any given size of gun than those used in any other navy.

"Although the muzzle velocities given in the ballistic tables of these guns are not so high as those of other nations, the muzzle energies are greater, and the '*remaining energies*' are *enormously* so." (The *italics* are ours.)

Here the German at least appears to be working on proper lines, and whatever reason there may be to justify a variety of velocities and projectile weights for the like caliber guns, it is not at all clear that because the 13-inch rifle in our service is disparaged by a comparison of its muzzle energy with that of its rival the 12-inch, our land defense should be expected to discount stable platforms and favorable conditions as to weights and their accessories incident to and necessary for the service of monster rifles. Certain it is this land defense must not be and never will be subordinated to the restrictions imposed upon batteries afloat, nor can it afford to avail itself of all advantages of the kind noted.

The one and half per cent of hits, of all shots fired at Santiago by our fleet in the running fight with the enemy, showed more favorably for the smaller and so-called "rapid-fire guns" than for those of larger caliber; but this engagement is insignificant in comparison with conflicts yet to be anticipated upon the sea. There has been nothing either here or at Manila to suggest the dismounting of the heaviest type of guns on our seaboard, or the removal of disappearing carriages where already they have been placed.

Reverting again to the small arm or miniature phase of the problem, here at least is a sphere of action where the fighting factors on land and sea are bound by common ties and should be governed by common principles. A caliber, 0.23, was at first selected for the navy rifle, and a 135-grain bullet was at first adopted and then discarded in favor of the 112-grain miniature *capsule*.

In this instance had the same prejudice for light weights and high velocities permeated the entire system? How much better it would have been to follow the ratio (3,000 grains per inch area of cross-section) employed in the 0.45 caliber Hotchkiss navy rifle in the army 0.45 caliber Springfield small arm, and one which had been accepted for the army 0.30 caliber magazine arm.

What follows from the 2,700 feet per second muzzle velocity of this 112-grain bullet? A falling off from the extravagant start to 971 feet at one-half mile range, while, on the other hand, a well-proportioned bullet of 135 grains weight for the caliber, with its start of 2,500 feet per second, makes a showing by some 40 feet per second in excess of this "remaining velocity" at this half-mile range.

In other words, the disproportioned bullet has lost 1,729 feet or 66 per cent of its original velocity, while the well-proportioned bullet loses but 1,490 feet or 60 per cent of its original velocity, and both arrive with energies in the ratio of 234 to 305 foot-pounds respectively in favor of the bullet of proper weight. What has the high velocity advocate to say, after this?

Further than this, the lesser weight of bullet at the greater mile range by computation indicates but 90 foot-pounds "remaining energy," against 130 foot-pounds for the greater weight projectile of the same caliber, and this notwithstanding the fact that the muzzle velocity of the more weighty bullet was but 93 per cent of that of its lighter competitor.

In the foregoing comparison of ballistic properties the writer has erred on the right side of the argument by assuming values for velocities in the computations so great as 2,700 and 2,500 feet per second, whereas such velocities cannot be and never have been realized in practice. Computation somewhat nearer the mark will be found in estimates of 2,500 and 2,300 foot-seconds respectively, and such ratio will be useful and comparable with that of the 0.30 caliber rifle projectile, which is the present adopted caliber for both services. The muzzle velocity for the 0.30 caliber arm does not exceed 2,000 feet per second, but its weight of bullet (220 grains) more than compensates for this.

The efficiency of this 0.30 caliber weight of projectile with but 2,000 feet per second muzzle velocity is quite marked at the half-mile range, and even allowing a start of 2,700 feet per second for its little (112-grain) competitor the ratio of velocities for these bullets for this range is as 901 to 971 respectively, and their "remaining energies" for the range as 234 to 397 in favor of the 0.30 caliber bullet, a ratio falling off to 175 and 90 foot-pounds respectively at a range of one mile. If anything were wanting to stimulate the practical man in his effort to secure the greatest efficiency with arms of all calibers it would be to look a little closely into this matter of weights. X.

*See also SUPPLEMENT December 1.

SCIENCE NOTES.

A fire in the pathological museum of the University of Berlin on January 16 damaged Prof. Virchow's collection of skeletons and other objects.

The new mint at Philadelphia, Pa., is being sumptuously decorated with glass mosaic. The mosaics with figures are eleven in number, and have been designed by Mr. William B. Van Ingen.

The patrol wagons of Allegheny, Pa., have been equipped with medical outfits, and the sergeants of the police have been instructed how to render aid to the sufferings of victims of accidents. The equipment includes antidotes for poisoning, dressings for burns and almost everything that is used in emergency cases.

A large pottery firm in Staffordshire (England) has been carrying out a series of experiments with a view to manufacturing glazed china without white lead. The mortality among the workers, due to white lead poisoning, is heavy, and efforts have been made for some time past by legislative and other methods to reduce the misery of the employes engaged in this trade. The firm in question has produced numerous articles by an improved process, which are equal in every respect to those produced by the white lead process. Attempts are also to be made to apply the system to the manufacture of earthenware.

The Comte da Schio is busily engaged in the construction of his airship. The first vessel will be a small one, measuring only about 100 feet in length. It will have accommodation for two passengers. The power for propelling the vessel will be placed in the fore part of the car. Should the preliminary trials prove successful the Comte proposes to construct a larger machine. The Duke of the Abruzzi is displaying a keen interest in the invention, and has expressed a desire to accompany the inventor upon his maiden voyage. Should the machine prove successful it is quite possible that the Duke of the Abruzzi may take it with him upon his next Arctic expedition. The Comte does not claim to be able to sail against the wind. His intention is rather to take further advantage of the winds blowing in the direction in which he is traveling, to aid him in the steering of his machine.

The strike among the lace workers of Calais will have the effect of considerably injuring this important French industry. No less than 14,000 employés are standing idle. For some years past the competition between the Calais and Nottingham lace manufacturers has been very acute, and now that cessation of work has ensued at the French center, the lace makers of Nottingham will reap inestimable benefit. The specialty of the Calais trade industry, however, is the manufacture of the silk lace for mantle makers, but, owing to the demand for the article being very limited, it is not anticipated that the Nottingham makers will compete very energetically in this field. It is in the manufacture of the Valenciennes, fancy cotton laces, and cotton fancy nets that the French trade will suffer. The French article has never been equal in quality or finish to the English product, and consequently it has been somewhat cheaper, but once the trade returns to Nottingham it is doubtful whether Calais will ever regain it, owing to the tendency among the English manufacturers to lower their prices.