SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN & CO., - - Editors and Proprietors

Published Weekly at

No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year for the United States, Canada, or Mexico $3.00
One copy, one year, to any foreign country, postage prepaid. £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS.

Scientific American (Established 1845)	$3.00	a year
Scientific American Supplement (Established 1876)	5.00	"
American Homes and Gardens	3.00	"
Scientific American Export Edition (Established 1878)	3.00	"

The combined subscription rates and rates to foreign countries will be furnished upon application.

Remit by postal or express money order, or by bank draft or check.

MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, JANUARY 13, 1906.

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.

FUTURE OF DIRECT-CURRENT TRACTION.

The controversy as to the relative merits of direct and alternating current traction, particularly with reference to steam railroads, shows no signs of abating. It was aroused by the fact that two great railroad systems which enter the same New York terminus, and use the same suburban and terminal tracks for a distance of several miles, are employing two different types of motor, one direct-current and the other single-phase alternating current. The controversy is wider than that of merely the two railroads concerned, for it includes the two largest electrical manufacturing concerns in the world; one the General Electric Company, which is furnishing the direct-current equipment, both for power stations, lines, and rolling stock; and the other the Westinghouse Company, which is furnishing the single-phase alternating equipment for the New Haven lines from Stamford to their junction with the New York Central system at Woodlawn. The alternating-current advocates have expressed surprise that such an important installation as that of the New York Central terminal lines should have been equipped with the direct current, arguing that it is approaching the stage at which it will not compare in economy, particularly for long-distance work, with the more convenient and flexible alternating current.

It is stoutly maintained by the direct-current advocates, that it has by no means reached its final stage of development, as proved by the fact that recently tests and results of 1,500-volt direct-current railway motors have become available, and that there are rumors of a 700-mile direct-current transmission. It is urged that 500 to 600 volts is merely a stepping stone to more efficient pressures, which are sure to be used. A correspondent of one of the contemporary journals devoted to street railways, claims that it is now practically possible to furnish reliable direct-current railway apparatus for a voltage of from 1,000 to 1,200 pressure; and that with proper designing of the magnetic circuit in the motors, and the placing and insulation of the controlling apparatus, there is no reason why the advantages of high voltage should not be realized under the direct-current system, as they now are in the alternating system.

DESIGNING THE STEAM TURBINE.

It is seldom that, in the development of a new art, the public is taken into the confidence of the designer, and treated to such a luminous exposition of the principles that govern both design and construction, as is given in a paper recently read by Mr. E. M. Speakman before the Institution of Engineers and Shipbuilders in Scotland, on the Dimensions of the Marine Steam Turbine. Although there have been many papers read on the general subject of the steam turbine, we doubt if there is any approaching this paper in the completeness of the ascertained data that it contains. In the nature of things, turbine design was, in the earlier stages, and in some respect is yet, largely empirical; and hence, results that have been established in the day-by-day working of the marine steam turbine are, just now, of extreme value. Limitations of space prevent us from giving this paper, which is published in full in the current issue of the SUPPLEMENT, more than a brief review in these columns.

Turbine efficiency and propeller efficiency must be considered separately, and also together, because it may be found that the use of revolutions somewhat below the maximum obtainable will increase the combined efficiency; while on the other hand to obtain certain advantages in weight and space, this efficiency may be slightly sacrificed at the highest speed. Roughly speaking, the weight of the turbines will vary inversely as the square of the revolutions. The minimum size of propeller required to avoid cavitation must be calculated at the beginning of any design, as it is almost impossible to assume certain revolutions, and later on to design a propeller to suit. Cavitation is partly the result of attempting to obtain too much work per square foot of blade area, and partly of excessive peripheral speed. It has been found by bitter experience that there is a narrow limit to the tensional pressure possible on the water, beyond which propeller efficiency drops very rapidly. This pressure is approximately from 10 pounds to 12 pounds per square inch at the depth of 12 inches below the surface. The speed of the tips of the blades of turbine-driven propellers varies from the enormous velocity of 12,400 feet per minute in the British torpedo-boat destroyer "Viper" of 36 knots speed, whose screws were 3 feet 4 inches in diameter, down to 8,125 feet per minute on the "Carmania," whose screws are 14 feet in diameter. The percentage of slip has varied from 28 per cent in the "Viper" down to 14 per cent in the Channel steamship "Viking." In the large ocean-going vessels, the slip is from 16 to 20 per cent.

Although the laws governing the best velocity of steam and blades are similar to those for water turbines, some modification is necessary in practice, and the best ratio of blade speed to steam speed is still a matter of opinion. This ratio has varied in Parsons turbines from 0.25 to 0.85 of *Vs* where *Vt* represents blade velocity of mean diameter, and *Vs* steam speed due to expansion across the row in question. The steam consumption must be accurately known in order to proportion these ratios correctly. With these results before us, we are not surprised to hear Mr. Speakman say that the best blading arrangement, scientifically and commercially, is the result of much theory and practice, and that this data being based on long and costly experiments is naturally withheld from publication. With regard to speed of turbine blades, we are told that blade speed is governed to some extent by blade height; and that the speed should be so modified that this may be at least three per cent of the mean diameter to reduce the proportion of clearance losses.

Leakage over the tips of the blades is, perhaps, not so detrimental on account of actual leakage loss as in its superheating effect on the steam between the row past which it leaks and the last row, which seriously affects the fluid efficiency. That the turbine is not suited to slow vessels is due to the fact that the propeller controls the speed of revolution, and to the fact that there is a necessary proportion between the blade height and the diameter. In slow cargo steamers, though the revolutions may be high enough, the power required is not sufficient to enable a sufficient blade height to be adopted for the prevention of undue leakage. The ratio of blade height to mean diameter should not be less than 3 per cent or more than 15 per cent, because in the first case leakage will be excessive, and in the latter the bending moment on the blades becomes too great. The trouble with the stripping of the blades may be set down to bad workmanship, defective blade material, whipping of turbine spindles (due to bad design or bad balancing), and to excessive cylinder distortion due to temperature. This last is the most fruitful cause, and is a serious one, being due entirely to poor design. Great care must be taken in proportioning the cylinders; for under wide ranges of temperature, when the turbine is working there may be a fall from 400 deg. to 100 deg. F. in a distance of 6 or 8 feet. The radial expansion, therefore, is greater at one end than the other. Hence, ample clearance must be allowed. This clearance will vary from 3/16 of an inch for a 1-inch blade to ½ an inch for a 10-inch blade, and ¾ of an inch for a 30-inch blade.

Finally, on the question of the performance of turbines as compared with reciprocating engines for marine work, both the Admiralty and the British railroad companies that employ Channel steamers have been able to test similar ships under the same conditions and secure most reliable data. In the earlier trials of the cruiser "Amethyst," it was shown that only below 55 to 60 per cent of its full speed does the consumption of the turbine exceed that of the piston engines. In later trials of the "Amethyst," after the steam piping had been altered so as to permit the auxiliary exhaust steam to pass through the main low-pressure turbines, the low-speed consumption of the "Amethyst" was brought down below that of her sister ships for all speeds to 10 knots an hour, which is about 45 per cent of her full speed.

THE AUTOMOBILE IN 1906.

The annual automobile exhibition in New York city, for the year 1906, marks a distinct advance on its predecessors on every point of comparison. In respect of magnitude, it is sufficient to say that two of the largest buildings in this city are required to afford sufficient space for the exhibition of the automobiles and their accessories. In order to separate the exhibits into two distinct groups, the Licensed Association of Automobile Manufacturers confined their display to Madison Square Garden, showing only cars which are licensed under the Selden patent, while the Automobile Club of America houses its display in the handsome new armory of the Sixty-ninth Regiment, the entries in this show being confined strictly to cars that are unlicensed. Not only is the display far larger than any that has preceded it, but the buildings themselves have been decorated and arranged on a plan which renders the effect extremely handsome. Elsewhere in the present issue we have illustrated and described individual cars, that represent the present progress in the art of automobile manufacture; and it is, therefore, our purpose in the present article merely to outline what might be called the type touring car, as evolved during the past ten years of the development of the industry in the United States.

The standard car, then, at the opening of the year 1906, is a four-cylinder touring car of 24 to 28 horse-power, weighing from 2,000 to 2,200 pounds, or a 30 to 35 horse-power machine, weighing from 2,200 to 2,400 pounds. The four-cylinder motor is housed in a bonnet at the front, and the power is transmitted through a three-speed, sliding-gear transmission by shaft-drive and bevel gears to a live rear axle. The wheels are distinctly larger, being 32 to 34 inches in diameter, with large tires 4 or 4½ inches in diameter. Our standard car shows marked improvement in the arrangements for lubrication of the engines, a continuous circulation being secured by some form of mechanical forced-feed oiler, the oil passing through sight-feed glasses carried at the front of the machine on the dashboard. The familiar leather-lined cone-clutch has given place to a multiple-disk clutch, and as the disks run continually in oil, there is a certain amount of slip when the disks are first compressed, so that the clutch takes hold without jar or jerk. This renders it possible to start a car on the high speed from a standstill.

Although the majority of the cars still make use of cooling water and a centrifugal circulating pump, there is evidence that the air-cooled motor may ultimately become the prevailing type, even for the high-powered car. Two makers exhibit this year six-cylinder, air-cooled motors. They were encouraged to take this step by the good results that have been obtained by air-cooled motors in the various reliability and economy runs that have been held during the past year. Another make secures its cooling effects by permitting the cylinders themselves to revolve; but practically all of the others make use of fans, one of the few exceptions being that of a light four-cylinder runabout, one of which performed the feat of crossing the continent. There is no question that the air-cooled car has falsified the predictions of failure which have been made freely in the past; and the good results secured are to be attributed to a careful study of conditions and well-thought-out design. The powerful air-cooled car is distinctly an American production, and the fact that it has won its way to successful recognition among the higher-powered machines is a subject of congratulation to those who would like to see the United States contribute more fully than it yet has done to the development of the perfect automobile.

Although the four-cylinder, four-cycle motor is the standard type to-day, the two-cycle motor is making distinct progress. One of the oldest manufacturers in the United States has worked on the problem with such success that he has brought out a two-cylinder, 25-horse-power touring car which weighs only 1,700 pounds. If certain inherent disadvantages of the two-cycle motor, such as the small range of speed, and the difficulty of keeping the crankcase tight, can be overcome, there are certain manifest advantages, in the way of lighter weight and greater simplicity, that will tend to make this type a favorite. It is quite possible that the future motor will be of the two-cycle, four-cylinder, mechanically air-cooled type; such a motor, except for the air-cooling feature, is shown in the exhibition. That this type can work successfully in the larger sizes would seem to be proved by the fact that a western railroad, which has been very active in the introduction of gasoline motor cars on its system, has recently received a four-cylinder, air-cooled, two-cycle motor of 200 horse-power for one of its new cars. The abolition of the valves, the circulating water pump and radiator, and the reduction of weight per horse-power in the motor, would mark a decided step in advance in respect of the weight, cost, simplicity, and convenience of operation of the automobile.

But to return to our typical car; we note that it is fitted with spring-separated ball bearings in the transmission and the wheels, with the choice of roller bearings for the rear axle, wheels, and countershaft. Ball bearings have been in use now for two seasons, and may be considered as standard practice. We note that one car shows roller bearings on the ends of the engine crankshaft. The greater ease and smoothness of running are attributed to shock-absorbers, rebound-checking devices, and pneumatic tires of large diameter. Although our type car does not carry them, we observed that inventors have been busy endeavoring to find some device which will permit of the use of solid tires on the road wheels, without losing the shock-absorbing and high tractive efficiency of the pneumatic tire.

The standard car depends for ignition upon the jump spark, with high-tension magneto or storage battery; although we noted in the exhibit several cases of low-tension magneto ignition. The valves are mechanically operated and are interchangeable, two sets being used, one on each side of the motor. The type car may carry either cellular radiators or those of the finned tube pattern, while some of the cars use flattened tubes provided with radiating fins. The type car carries two separate brakes, one of the expanding ring type, the other a band brake, acting within and on the outside of a drum on the rear wheel. The band brake, worked by a pedal, is for ordinary use, and the expanding ring brake, which is applied by the hand, is used for emergency. Finally, we note that the engine is controlled by separate spark and throttle levers, mounted on stationary sectors in the steering wheel.

It is a matter of congratulation that the industry has now grown to such proportions that the manufacturers are enabled to turn out a standard car which is at once superior in construction and lower in price.

PROGRESS WITH THE ELECTRIC AUTOMOBILE.

Although King Gasoline has gone on rapidly conquering the world, the beggar maid, Electricity, is soon coming to her own. She has been hard at work for the past several years doing more and more of the world's drudgery, and, according to present indications, she will yet have the honor of moving a considerable percentage of its pleasure vehicles as well.

The improvements that have been made in electric automobiles are of two kinds, namely, those in the vehicle and motor, and those in the battery. One class is quite as important as the other and the changes made during the last few years have been almost as great in the one as in the other. The result is that the modern electric vehicle for pleasure purposes can now be constructed to consume only about 50 watt-hours per ton mile at a speed of 15 miles an hour, where some years ago it used nearly three times as much; and reliable batteries delivering 15 to 18 watt-hours per pound can be had, as against the 8 or 9 watt-hours of usual practice. Thus it will be seen that vehicle and batteries have improved 100 per cent. That this is not merely theoretical improvement is seen from the fact that an electric stanhope having a guaranteed mileage of 85 on a charge, is now on the market, and larger, long-distance pleasure vehicles are being rapidly perfected. In France last fall several "raides electriques" were made to show what can now be done with ordinary stock vehicles. The most notable of these was the run from Paris to Trouville (about 130 miles) on one charge. Even more worthy of notice was a trip in this country from Cleveland to Erie (100 miles) over ordinary country roads some of which were sandy and which included several steep hills. A trip such as this on one charge makes the possibility of the practical electric touring car seem within grasp. With the high-capacity batteries and the improved motors and methods of power-transmission, the discharge rate of the battery is lowered with respect to the capacity, which results in lengthened life, so that a year of service can be assured before the replacement of the positive plates becomes necessary. A set of negative plates will usually outlast two sets of positives, and the upkeep of the battery can usually be placed at a fixed sum per annum.

Regarding types of storage battery other than the lead-lead type, there has been no great advancement of late. The lead-zinc battery, if ever perfected, will doubtless be the ideal battery, as the light weight of such a battery (25 watt hours per pound) coupled with its high voltage (2.5 volts) and heavy rate of discharge possible make it just what is needed for automobile work. The Edison battery is practically perfect in the last-named respect, as a heavy discharge does not affect the capacity. Bulk-for-bulk, too, the Edison battery is lighter than those of the lead type. Its low voltage (1.25 volts), however, makes more cells necessary, and it suffers such a serious loss of capacity under the effect of cold as to make it impractical. The results of an interesting series of tests of this battery by a well-known foreign electrochemist were published recently in the Supplement. Despite the defect mentioned, this expert believes that batteries of the Edison, or nickel-iron, type will in a few years drive the lead battery from the field.

The method of power transmission found to be the most efficient is a single motor with individual chain drive from a countershaft to the rear wheels. On heavy vehicles two motors are generally used, but the chain drive replaces the old-time spur gear. With two motors the battery cells can always be connected in series, and none can be discharged more than others. But if a connection breaks the vehicle is stalled until a repair is effected. The low-voltage battery (12 to 24 cells) is largely used for light vehicles and even some of the largest machines are now so equipped. Its advantage is a smaller number of cells; its disadvantage, inefficiency in charging from 110-volt circuits, as energy is lost through a rheostat.

In the business and commercial vehicle line, for city work, the electric still reigns supreme. Hansom cabs, coupés, delivery wagons, and trucks are daily increasing in numbers. Besides their readiness in all weathers they do not emit smoke or the odor of half-burned gasoline—a nuisance that has become so great as to be the subject of legislation and police interference in London. The speed of the passenger-carrying electrics is as great as that of the corresponding gasoline car for city work, and they have all the advantages, without the liability to breakdown of the latter.

Among novelties in the electric vehicle line may be mentioned an electric tractor, or fore-carriage, which can be used with various bodies, and a trolley arrangement by which an electric automobile can be run by current from the street railway trolley wire, and at the same time recharge the batteries, when following the track.

INCREASING DEMAND FOR THE MISSISSIPPI PEARL.

BY K. L. SMITH.

If the truth were known about many of the pearls that we see nowadays, we would discover that a fair share of them, even among the expensive ones, came from the Mississippi River or its tributaries. Pearl hunting in these localities has become an established business, and regular pearl prospectors are examining rivers and creeks, with a view to locating beds of mollusks that may contain valuables. Attention to the rare pearls to be found in these streams was first called about twenty years ago, when large numbers of pearl-producing mollusks were found in a small creek in Dane County, Wisconsin. The farmers began searching the beds of streams with such success that thousands of pink, purple, and blue-tinted treasures were sold, bringing in a profit of many thousands of dollars. The excitement that prevailed at that time gradually died down, but enthusiasm has broken out again in localities bordering on the Mississippi.

There is a fascination about the business that smacks strongly of speculation, for a man may find any time a gem that may mean a fortune. The men who live this outdoor life are rugged and healthy, and each carries a tin box, which in one season may become the receptacle for holding thousands of dollars' worth of large and small pearls. The pearl hunters have learned to be experts in valuing their finds, and few gems sell at small prices. Generally they are sent East to lapidaries to be valued, and they are sold at once, for the pearl hunter knows that he does well to avoid the "middleman," who is sent out by eastern firms to gather the "finds." Some pearls are sold for a thousand dollars, and a necklace twenty-eight inches in length, made of small Mississippi pearls for the great singer Nordica, who desired a souvenir of Minneapolis, cost two thousand dollars.

Pearl hunting is an exact science, and the successful hunters are skilled in the business. Usually the prospector has a boat, which he allows to drift with the tide. Behind this is fastened a long pole, to which is attached hundreds of lines with bait on the ends. The mollusks close their mouths over these with tenacity, and as they are hauled in as soon as the lines are filled, many bushels are obtained daily. This is the easiest part of the process. The next operation is to open them, which if done with an oyster knife is so laborious it lives long in the memory of the novice. On this account most prospectors either steam the mollusks over a mild fire, or spread them out in the sun to slowly dry, when the two parts of the shell separate readily. The exciting moment comes when the contents of the shell is divulged, for much or nothing hangs on the revelation.

In fact, this insignificant-looking, dirty clam that may contain a treasure of value is an object of interest in itself. Content to lie in almost any kind of water, living on animalcules, very prolific, and a pearl producer, he travels slowly back and forth from mid-stream to shore unless he is gobbled up by the muskrat, who loves him dearly and eats him, pearl and all. The pearls are always near the shells, and can be squeezed out of the meat, with the fingers. Sometimes they are found loose in the shell, and at other times they are attached to it. If loose, the chances are that they may fall out, and good pearl hunters on this account search the bed of the stream, and even dig up the dirt to see what will "pan out."

In the early days of the industry, the slugs or small pearls were thrown away, but now they are kept and sold by the ounce or separately. These are always in the meat, and sell from two to five dollars. New processes in setting jewelry have made them in demand. Contrary to general belief, the expensive pearls are not always round or oblong in shape. Many fine specimens are "baroques," that is, they assume grotesque forms, a fact that can be accounted for by their origin, for scientists tell us that a pearl is really a malformation caused by some foreign substance finding entrance to the shell, and irritating the mollusk to such an extent that he exudes a liquid, which hardens and eventually becomes a precious pearl.

The prospector moves from one part of the stream to the other as soon as one mollusk bed is devastated. Some beds seem to contain more pearls than others, but it is the size and thickness of the pearl that make it invaluable for some articles of jewelry, and lapidaries in our large cities are using them freely. If any criticism is to be made, it is that they lack the yellow tint of the Oriental product. Many sell for high prices, however, and the black pearls which are occasionally found are exquisite.

To the casual observer, pearl hunting seems the easiest way in the world to earn a living, but it must be remembered that not one in fifty of the right species contains a pearl, and many mollusks are so light colored that they are known to be valueless, and are thrown away without being opened. It is a hit-and-miss sort of business, into which many start. Those that remain to the end get a good living, and every summer finds so many engaged in the work, that pearl hunting has become one of the established means of livelihood in the Mississippi Valley.

SCIENCE NOTES.

In a paper presented to the German Physical Society, F. Meyer treats of the permeability of argon for the ultra-violet rays. He uses an apparatus which is the same as he employs for ozone researches and is on the same plan as the photo-electric photometer devised by H. Kreussler. A glass tube 8 inches long and 2 inches in diameter, closed at the ends by quartz plates, is used as an absorption tube. After filling the tube with a mixture of argon and nitrogen, the author measures the extinction of the radiation by alternately inserting or removing the gas tube. The results he obtains show that argon is quite free from appreciable absorption for ultra-violet rays between $\lambda = 186$ and 300. In any case the absorption does not exceed 3.2 per cent under the conditions of the experiment. As the ordinary air contains about 1 per cent of argon, the latter cannot play any important part in the absorption of the sun's rays having short wave-lengths. Accordingly, we must abandon Hartley's hypothesis, which holds that the substance contained in the air and to which is due the sudden ending of the solar specter for $\lambda = 293$ is identical with argon.

A new process brought out in France relates to the preparation of a derivative of castor oil which can be mixed with the mineral oils. A product of this kind has been already obtained by distilling castor oil up to the point where it loses a determined weight, and stopping the distillation before a product of gelatinous appearance is separated out. The present process, which avoids the losses coming from the distillation and also suppresses the disadvantages which are well known in connection with the dry distillation of oils, consists in heating under pressure the oil to be treated. To carry this out the oil is heated under a certain pressure in a tight boiler until it becomes capable of mixing in all proportions with the mineral oil. It is recognized that the best results are obtained with a temperature of 260 to 300 degrees and a pressure of 4 atmospheres by keeping up the heating for some ten hours. Then the boiler is left to cool completely before it is opened. The product which is thus obtained can be mixed directly with the mineral oils. Observations which have been made up to the present also show that by operating in a closed vessel we avoid all danger of forming a gummy product from the castor oil.

L. Sindet, of Paris, finds that certain metals such as copper when placed under constantly aerated water in the presence of iron act to increase the oxidation of the latter, and that others like tin, lead, zinc, aluminium, and magnesium keep back the rusting of the iron just as alkaline carbonates do. Among the bodies which prevent the rusting of iron, arsenic holds the first place with its compounds. In presence of aerated water they furnish arsenious acid and perhaps suboxide of arsenic As_2O_3. Using arsenic in large quantities sometimes the oxidation of the iron is entirely stopped, or again it is only slowed up. Arsenic acid, arsenites, and the alkaline arsenites at 1 per cent strength completely stop the rusting. Orpiment (sulphide of arsenic) gives also a strong effect. Wishing to apply his researches to the study of the causes of rusting of tinned or galvanized iron cans which are used to carry denatured alcohol, he finds that the carbureted alcohols containing 50 per cent of light benzine have a great activity in the production of rust. Benzine having an equal volume of alcohol added to it appears to triple the speed of rusting. Aldehyde, ethyl or methyl acetate do not provoke the oxidation, but they attack the zinc, the tin, then the iron of the vessels, and it is the acetates of zinc, tin, or iron from the decomposition which begin the rusting of the iron, especially in the presence of benzine. Although arsenic, etc., totally stop the oxidation, and this during several months of contact, it is evident that we could not use them here, seeing that even though the alcohol dissolves but traces of arsenic, the latter is oxidized in the liquid and the products of the oxidation are more solid than the arsenic itself. He was able, however, to give a steel sheet a surface cementation by arsenic and it did not rust, while a non-treated sheet exposed at the same time to moist air became entirely covered with rust.