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

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 horsepower, 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