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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.

RETROSPECT OF THE YEAR 1902.

WIRELESS TELEGRAPHY.

If one were asked to name the most important scientific achievement of the year just closed, he would, without doubt, give that distinction to a feat which was performed, in the closing days of the year, on a barren headland on the eastern shores of Cape Breton, where Marconi, a few days before Christmas, exchanged messages of congratulation by wireless telegraphy with some of the crowned heads of Europe. At the close of the year 1901, Marconi had given to the world the first pledge that he would before long make transatlantic wireless commercial telegraphy possible, for he had received on a single wire, suspended from a kite, an agreed-upon signal in the form of the repetition of the letter "S." It was merely a hint of coming possibilities, for the signal was only perceptible by the use of a sensitive telephone. Between that and the transmission of commercial messages was a wide gap, and that the brilliant young Anglo-Italian should have closed that gap within a period of twelve months, and that he should stand to-day prepared to transmit commercial messages across the Atlantic, must be regarded as certainly the most remarkable scientific achievement of the year. Marconi's final experiments were carried out with the same absence of self-advertisement, the same professional dignity, which has characterized his work from the very first. He spent about a month at his Cape Breton station, sending and receiving messages, before he made a final announcement of his success. It was inevitable that in the five years of his brilliant work he should be subjected to those ungenerous attacks that seem to dog the steps of every inventor of an epoch-making device. To read these criticisms, one would think that Marconi had invented nothing at all, and that to the army of imitators or emulators that have gathered in his train, all the credit belongs; and yet the fact remains that he was the first man to show the commercial possibilities of wireless telegraphy, and that he has passed from his first crude experiments to his present marvelous triumph, with a swiftness and a completeness without a parallel in the history of invention. What Stephenson was to the locomotive, Edison to the electric light, and Bell to the telephone, Marconi will be, as long as history is written, to wireless telegraphy. Other systems with more or less claims to utility have been industriously developed by their various sponsors. In this country the DeForest type seems easily to lead its competitors in the practical results accomplished. It has done good work in the naval maneuvers, and it is having a fair amount of general commercial success. Fessenden, moreover, has secured his patents during the year, and has achieved encouraging results, particularly in respect of speed of transmission; while Prof. Pupin's system of selective resonance or tuning, application for patents on which was made as far back as 1894, has now been protected by the Patent Office, and he has concluded arrangements with the Marconi Company by which they are granted exclusive license in this country. Fessenden uses a form of receiver which he calls a "wave detector," that gives promise of much greater rapidity than the old coherer. Indeed, of late, the efforts of experimentalists in wireless telegraphy have been directed especially to the invention of some form of receiver that will be more reliable and rapid than the form with which Branly's name is associated. Branly himself has brought out an improved radio-detector, which is based on the important discovery that any two pieces of metal, provided one of them be polished or oxidized, will serve all purposes of the old Branly tube. In Germany, where the Slaby-Arco system has been adopted by the government, fair results were obtained this year in the army and navy maneuvers; although the Slaby-Arco does not begin to approach the Marconi system in range of transmission. The problem of the future in wireless telegraphy is that of "tuning," or the confining of messages to one particular receiver, to the exclusion of all others. In connection with wireless telegraphy progress mention should be made of the completion, after more than fifty years of growth of the British cable system, of a complete telegraphic connection around the globe. This was achieved by the laying of the British Pacific cable from Vancouver to Australia, which includes one length from Vancouver to Fanning Island of 4,000 statute miles—the longest stretch of cable in the world. Our own transpacific cable is also in process of being laid, and before long we shall be in direct communication over our own wire with our new eastern possessions.

CIVIL ENGINEERING.

The year just closed has seen the completion of one of the largest and most beneficent civil engineering works of this or any age—the great dam at Assouan on the Nile. This structure, together with the barrage across the Nile about 250 miles above Cairo, was undertaken by the British government as one among many schemes for the improvement of modern Egypt. The two works together cost $25,000,000. The dam at Assiout is 2,750 feet in length, and will bring about 300,000 acres under cultivation in middle Egypt. The dam at Assouan, 600 miles above Cairo, is an enormous structure a mile and a quarter in length, with a maximum height, from foundation to crest, of 130 feet. Its construction gave employment to 11,000 natives; and by its completion it has become possible to store one billion tons of water for irrigation purposes in the dry season. The opening ceremonies took place on December 10, in the presence of the Khedive; and it was stated on this occasion by Lord Cromer, that this great work will increase the agricultural earning power of Egypt by $13,000,000 every year; that it will permit the additional irrigation of 1,600,000 acres, and that it will provide an additional revenue to the Egyptian government of $1,900,000 a year.

Most important steps have been taken during the year in clearing away preliminary obstacles to the construction of the Isthmian canal. As matters stood at the commencement of the year, the Isthmian Canal Commission, because of the exorbitant price (over $109,000,000) asked by the owners of the Panama property, had advocated the construction of the Nicaragua Canal, at a cost of about $190,000,000; but subsequently the Panama Company signified their willingness to take $40,000,000 for their properties, and an investigation made during the year in Paris has shown that the titles to these properties are perfectly valid. The only obstacle remaining to be cleared away is that presented by the Colombian government, which seems disposed to make capital out of the present situation, and demands an excessive price for the strip of land through which the Panama Canal is to be constructed. It is probable, however, that before long a satisfactory treaty will be concluded for the purchase of the right-of-way, and preliminary steps toward construction taken.

The Rapid Transit Commission, its engineers, and its contractors, are again to be congratulated upon the splendid record that they have made during 1902 in pushing the Subway toward completion. The work is now in such an advanced stage that it is a practical certainty that trains will be running over the greater part of the route by January 1, 1904. The contract for the $10,000,000 extension from City Hall Park to Brooklyn has been let, and work is under way, three years being the probable time limit necessary for the completion of the tunnel under the East River. Interest in this great work has been redoubled during the past few weeks by the unparalleled congestion which has occurred on the various lines of transportation in this city. The elevated railroads, despite the fact that they have been almost completely equipped with electrical traction, have at times been completely paralyzed, the flood of traffic having swamped even the six-car trains and more frequent service afforded by the new equipment. Similar congestion occurred on the Metropolitan Street Railway system, and there is no question that, unless immediate steps are taken to enlarge the Subway system by the construction of several north and south lines, the great growth of travel in New York city will produce a positive deadlock before many years have passed.

Undoubtedly the most far-reaching civil engineering work dealing with transportation in New York, is the great system of tunnels beneath New York, connecting New Jersey and Long Island, for which the Pennsylvania Railroad Company received a franchise from this city during the closing days of the year. These tunnels will connect, by direct rail communication, New York city and the vast system of roads which at present have their terminals on the west shore of the Hudson River; and will also give new and effective means of suburban transit by rail to the large residential districts lying to the east and west of New York. Another important franchise is that granted simultaneously with the Pennsylvania charter to the New York and New Jersey Railroad Company, whose tunnel will enter New York at the foot of Christopher Street. These two enterprises will doubtless do much to relieve the great traffic congestion referred to above.

During the year, the East River Bridge construction has proceeded with the same exasperating leisureliness which has marked the construction of this greatly-needed work, from the time the contractors for the cables first took it in hand; and the occurrence of a fire at the top of the Manhattan tower seemed at one time to threaten the very existence of the great cables themselves. Fortunately, the damage was relatively slight, and can be repaired at the cost of three or four months further delay. The work of sinking the Brooklyn caisson of the East River Bridge No. 3 has moved along steadily during the year, and the contract for sinking the caisson on the Manhattan side has been let. It is a matter of great regret that more expedition has not been shown in the construction of this bridge, which cannot possibly be ready for public use under five or six years. The question of the construction of the Erie Canal is once more before the public, and it seems likely that the larger scheme involving a 12-foot depth and 1,000-ton barges will ultimately be adopted.

MERCHANT MARINE.

Unquestionably, for the United States, the great event of the year in the merchant marine was the consummation of the steamship combine, by which five of the largest transatlantic companies, the White Star, Dominion, Leyland, Atlantic Transport and American-Red Star, were merged into a single company with not far short of one million tons of shipping under its control. The combination is formed on strictly international lines, with a joint American and British control, the General Manager of the line being an American with residence in this country. The organization is such that the various companies included in the consolidation preserve their autonomy, and every respect is shown their national and local surroundings. The avowed object of the combination is to afford better transatlantic service at decreased cost, with more uniform rates, and a better distribution of traffic over the American and Canadian seaports. This merger, which is the most important event that has happened in the history of the American merchant marine, has greatly increased our prestige, bringing it up to the point which it held prior to the great civil war. The year 1902 is of special interest, moreover, in this connection, because it marks the growth of American shipping to the standing which it held in 1861, the total tonnage in that year of our shipping being 5,539,813 tons, and in 1902, 5,797,902 tons. The shipbuilding industry is in a healthy state, 1,491 vessels of a gross tonnage of 461,831 tons having been built in this country during the year. We have so recently, in our special Transportation number, given the full details of the present standing of our merchant marine, that the reader is referred to that issue for further information. During the year, both the largest vessel in the world and the fastest vessel have been launched, the "Cedric," of 37,870 tons, being about 1,000 tons larger than the "Celtic," and the "Kaiser Wilhelm," with a proposed speed of 23½ knots, and a probable sea speed of 24 knots, being the fastest afloat. A notable event in the competition for the speed record of the Atlantic is the arrangement entered into between the Cunard Steamship Company and the British government, by which the former are to receive a heavy subsidy in consideration of their constructing two vessels which will be the largest and fastest in the world. The contracts for these vessels have recently been let, one to the Fairfield Company, on the Clyde, and the other to Vickers, Sons & Maxim. They are to be 750 feet long by 75 feet broad, and with 50,000 horse power are to show a sea speed of 25 knots an hour. This will be a great increase in size and speed over the "Kaiser Wilhelm II.," which is 706 feet long by 72 feet beam and 23½ knots speed.

Apart from the construction of a few very fast ocean steamers by the German, and now by the English lines, the tendency is toward the construction of extremely large cargo passenger ships of moderate speed, say from 14 to 17 knots an hour. It is found that the cost of carrying freight is steadily reduced as the size of the ship is increased; and as there seems to be no limit to the application of this rule in theory, it becomes an interesting question just how large the ships of the near future will be built. At present it seems that the only limit will be that of depth of channels and length of dock accommodation.

STEAM ENGINEERING.

In the field of steam engineering, the most notable progress has been in the development of the steam turbine; indeed, it is safe to say that this form of motor is destined to work the most radical innovation that has been seen in steam engineering since the introduction of high-pressure steam and multiple-expansion engines. Every year in the history of the turbine serves to demonstrate more fully its good qualities, and to justify the faith of its inventor in its ultimate substitution for the reciprocating engine in the majority of the uses to which the latter is now put. In the present stage of its development, its advantages may be summarized as follows: On small units doing continuous service in a power station, it has shown a steam consumption of under 13¾ pounds per indicated horse power per hour; while in a larger unit it has

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shown as low as 10.17 pounds per indicated horse power per hour. It has been found that in plants already built, or now under construction, the steam turbine requires only about 80 per cent as much space as is necessary for a vertical engine of the same power, and only 40 per cent of that needed for a horizontal engine. In one case the volume of masonry foundation required for a turbine was found to be only one-ninth as great as that for a vertical, and one-fifteenth as great as that for a horizontal engine, while the cost of the building to house the same was only about one-half that of the horizontal or vertical. The turbine plants that have been in operation during the past few years have shown high economy and call for practically no repairs. In marine work the turbine has repeated, in the new river passenger steamer "Queen Alexandra," the good results shown in the "King Edward." On her trial trip this vessel made 21.63 knots an hour. Compared with passenger steamers of similar size, but having reciprocating engines, the installation of turbines has shown a gain per indicated horse power in favor of the turbine steamer of 20 per cent. Its compactness and absence of vibration have led to its introduction on steam yachts; one, the "Resolution," has been built and is running in this country, and three others have been built in Great Britain. In a paper recently read before the British Association, Mr. Parsons stated that the adoption of the steam turbine for large battleships, cruisers, and transatlantic liners will be attended with greater proportional advantages even than those shown in smaller vessels. Outside of the steam turbine there has been no radical change to record in steam engineering during the past year. Steam pressures for water-tube boilers remain at from 250 to 300 pounds per square inch, and for Scotch and locomotive boilers, at about 200 to 225 pounds.

OIL FUEL.

Intimately related to steam engineering is the question of the use of oil fuel, which, on account of the enormous development of the oil fields of Texas and Borneo, has become one of the burning questions of the day. The production of successful oil burners has resulted in the application of oil fuel to locomotives and marine transportation on a rapidly increasing scale; the locomotives of the roads that pass through the oil fields being in some cases almost exclusively operated by oil, while there are lines of steamers in which the use of oil fuel is also nearly exclusive. The most important tests in this country were those carried out on the steamship "Mariposa," in a report on which Rear-Admiral Melville expressed his conviction that by future experimental work the engineering features of the problem would undoubtedly be solved, so as to render the fuel satisfactory to commercial interests, if not for use in the navy. The experience gathered during the year, however, does not warrant the belief that there will, for some time to some, be any general substitution of oil fuel for coal.

AERONAUTICS.

The history of aeronautics during the past twelve months has been fraught with tragedy, and each disaster has served to write large the ultimate doom of the balloon-supported airship. On May 12, during a trial of his "ship," there was an explosion of the balloon due to ignition of the gas by the motors, and Severo fell from a height of some 1,500 feet. A few months later De Bradsky met with a similar fate, both himself and his engineer being instantly killed by the collapse of their balloon. Santos-Dumont, however, still survives, and in spite of the fiasco of his visit to America, where he failed to make his much-advertised ascent in his airship, he is now at work in Paris on yet another balloon in which he proposes to make a trip, in consideration of somebody offering a prize of the moderate proportions of $50,000, from Paris to London. The most successful trip of the year was accomplished in a combination aeroplane and balloon by Stanley Spencer, who, in September, traveled some thirty miles over London in an airship of his own construction. Great interest is attached to the conditions of the races for the capital prize of $100,000, offered by the management of the St. Louis Fair. Two hundred thousand dollars are appropriated altogether, and in addition to the capital prize, $50,000 have been appropriated for minor prizes, and $50,000 for the general expenses incidental to the competition. Just at present the balloon airship has the field pretty much to itself, and by its doubtful successes and undoubted failures it is clearing the way for the development of the more scientific and more practical aeroplane, some form of which is certain ultimately to be adopted as the only practical means of air navigation; but we are many years distant from that event at present.

RAILROADS.

In our Transportation number we have dealt so fully with the question of railroads that there is little to be said just here. The increase in size and weight of locomotives continues, showing no signs of diminution. The latest of the heavy locomotives is a huge freight engine built by the Baldwin Company for mountain service, with high-pressure cylinders 19 inches in diameter, low-pressure cylinders 32 inches in diameter, and a common stroke of 32 inches. This engine carries a boiler with a 6-foot 6¾-inch barrel, and a firebox 108 by 78 by 80 inches, the total heating surface being 5,390 square feet. The engine alone weighs 267,803 pounds, and the tractive effort is 31 tons. In American passenger locomotives, the heating surface has risen to 3,533 square feet, and the tractive effort to 32,000 pounds. Compounding is making much slower progress in this country than abroad, where the four-cylinder system operating on either a single or two axles is winning increasing favor and showing excellent results. The fastest long-distance train in the world is hauled between Paris and Calais by a four-cylinder compound, the distance of 184½ miles being covered in three hours, or at a speed of 61½ miles an hour. The longest fast run of any express train is that made by the Twentieth Century Limited between New York and Chicago, which covers the distance of 980 miles in twenty hours, or at the rate of 49 miles per hour. The rapid increase in the speed and weight of express trains of late years suggests that when electric traction becomes a serious competitor to trunk roads, the locomotive men will be prepared to make a very strong bid to retain their hold on the situation.

ELECTRIC TRACTION.

One's thoughts naturally turn from the steam railroad to its younger sister, the electric road; and here the rate of progress has been phenomenal. In this city we have seen the opening of the great Manhattan power station with its eight units of 8,000 rated and 12,000 maximum horse power each, the total horse power of the station being 100,000. An even larger station, in respect of its maximum output, is that of the New York Edison Company, where, when the whole plant is completely installed, there will be gathered in a single engine room no less than sixteen engines of 8.000 maximum horse power and capable of a combined output of over 125,000 horse power. Work is also under way on another 100,000 horse power station in New York city which will furnish power for the Rapid Transit Subway. This plant will consist in part of reciprocating and in part of turbine engines, three of the units consisting of 4,000-kilowatt turbines of the Parsons-Westinghouse type. In this connection it may be mentioned that the turbine will play an important part in the electrical equipment of the London Underground railroads, four 5,000-kilowatt turbines being now under construction for the Metropolitan District Road, and three of 3,500 kilowatts for the Metropolitan Road. Speaking of London, now that the development of electric traction is under way, that huge metropolis is making the change on a truly wholesale scale, some $200,000,000 being required to carry through the various extensions which the construction syndicates have in hand. The most important question in electric traction during the year has been the development of the alternating current motor. The Berlin-Zossen trials, in which a speed of just under 100 miles an hour was obtained, were brought to a close by the unsuitability of the track for such high speeds; but a new locomotive has been constructed with a view to the reduction of axle weights, in which the transformers carried on the car have been abandoned, and a 10,000-volt alternating current is boldly applied directly to the motors. Further experience has been gained with the three-phase Valtellina road, 66 miles in length, and as far as can be learned the results have been thoroughly satisfactory. On this line, a three-phase alternating current of 3,000 volts is used directly at the motors. In this country great interest attaches to a new interurban road which is to be operated with alternating current throughout. This is the Washington, Baltimore, and Annapolis Electric Railway, with a total length of 55 miles. Alternating current will be generated at 15,000 volts, and it will be transformed at suitable stations to single-phase current of 1,000 volts, which will be sent out on the trolley wire for use directly at the motors. Another American development in this direction is the Arnold system of electric traction, in which single-phase alternating current will be used at the motors; while a peculiarity of the motors themselves is that both armature and field are capable of revolution either separately or together. Two engines are attached to armature and field in such a way that they may be used either for compressing air for storage in a reservoir, or for utilizing this compressed air in driving the car. Great Britain has taken up the matter of trunk line electrical traction in earnest, one company, the North-Eastern, being now engaged in the electrical equipment of 35 miles of double-track road, 4 miles of single-track, and 2 miles of four-track road. In this country the New York Central has professed its intention of equipping electrically its suburban roads that enter New York city, and the engineers who have this work in hand have made a series of most elaborate tests of the comparative efficiency of steam and electric traction for this service, using General Electric motor cars in competition with New York Central suburban locomotives. The result showed that electric cars accelerate much more rapidly than locomotives, and that they maintain a high average speed with lower maximum speeds, thus consuming less energy for a given run.

AUTOMOBILES.

The year past has witnessed a great increase in the popularity of automobiles, and there is every indication that with the inevitable decrease in the price of the smaller machines, bringing them within the means of the general public, the automobile will enjoy a popularity probably as great as, and certainly more lasting than, that of the bicycle. A visit to any of the large automobile shows, or even a casual inspection of the machines that one meets in the public highways, proves that the many experimental and unsatisfactory types which have sprung up like mushrooms during the past few years are being weeded out, leaving a few standard types, with easily-recognized characteristics which are likely to become permanent. Internal combustion motors continue to hold the undisputed lead as a drive for all classes of machines, while in this country the steam-driven and electric machines are strong competitors. Gasoline remains the popular source of power for internal combustion engines, although great progress is being made in Europe with the alcohol-driven automobile. Except for racing purposes, there is a reaction of sentiment against the ponderous 40 to 60 and even 70-horse power machines of the previous year, and even for racing there is a tendency to place restrictions upon weight. The beneficial effect of these restrictions was seen in several of the important races of the year, when light and compact racers, of moderate horse power, had no difficulty in holding their own with the more massive machines.

NAVAL AND MILITARY.

In naval and military affairs the past year has not been marked by any startling developments, either in ships, armor or armament. The naval building programmes of the year show that the tendency toward battleships of huge displacement continues, the new "Connecticut" in our navy being of 16,000 tons maximum displacement, and the new "Prince Edward" class of the British navy of 16,500 tons displacement. Except in our own navy, the very highest value seems to be placed upon speed, both in battleships and cruisers, the battleship "Vittorio Emanuele," of the Italian navy, carrying two 12-inch and twelve 8-inch guns, having a speed of 22 knots an hour, and the British armored cruiser "Good Hope," which is now carrying the Colonial Secretary to South Africa, having shown a speed of over 24 knots an hour on a four-hour trial. As compared with these speeds, our new armored cruisers of the "Tennessee" type have only the same speed as the Italian battleship, and two knots less than the British cruisers, while the "Connecticut" is to have a speed of 18 knots. At the same time, what we have sacrificed in speed we gain in power, the batteries of the "Connecticut" and "Tennessee" being greatly superior to those of the "Vittorio Emanuele" and the "Good Hope." For the first time in the history of our new navy one of our battleships has made on trial 18 knots an hour, this being the speed shown by the new "Maine." It is significant that in a vote taken among several of the most eminent naval designers of the world, the 22-knot Italian battleship, above referred to, received the first place, outranking even our own powerfully armored "Connecticut." The question of whether more armor and guns and less speed, or more speed and less armor and guns, gives the most effective battleship for future warfare, is an entirely academic one, which will never be settled except in the stress of actual conflict. In ordnance, there has been no marked advance chronicled during the year, the types of 1900 and 1901 having been carried to a point of efficiency at which the Ordnance Bureaus seem to be content to let them rest for a while. The same is true of armor, Kruppized plate remaining to-day the best all-round plate in the world. So, too, with smokeless powders. There have been improvements, but they have been merely in matters of detail of manufacture. In our army, however, there has been produced a new rifle of much greater velocity and general efficiency than the Krag-Jorgensen. Indeed, its ballistic results are superior to those of the Mauser, whose best points it embodies. That white elephant of our military Ordnance Department, the 16-inch gun, has been taken to Sandy Hook, where the problem of sinking so many thousand dollars in providing a temporary mount for testing confronts the Proving Ground authorities. In view of the fact that we have a naval 12-inch gun of half the weight, and, in nearly every respect, superior efficiency to this 16-inch gun, it is evident that no more of the type will be built. Perhaps it is safe to say that the submarine boat has been attracting more attention during the year, in naval matters, than any other new form of development. There is no question that the trials of the "Adder" and "Moccasin," while they have by no means met all the conditions that naval men require, have decidedly improved the standard of the submarine as such in naval circles.

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