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RETROSPECT OF THE YEAR 1899.

Looking back over the year that has just drawn to a close, the American who has the interests of his country deeply at heart will find abundant cause for satisfaction. It has been a record of unqualified prosperity.

OUR EXPORTS.

The year 1898 saw the success of our arms, and the advancement of our naval and military prestige; its successor has witnessed an equal and more pleasing triumph in the arts of peaceful industry. With rapid strides we have moved up to the front rank as a great exporting nation, and not only have we easily held our own and strengthened our position in those lines of manufacture in which we had already made a good beginning, but we have gained a secure foothold for our products in new territory which was supposed to belong exclusively to our foreign competitors. It is unnecessary to multiply instances, and it is sufficient to refer to the construction of the Atbara bridge in the Soudan and the shipment of American locomotives to England, as instances of the fact that our industrial methods enable us to build so cheaply, so expeditiously and so well, that we can lay down a manufactured article in Great Britain or her possessions in less time, at less cost, and of equally serviceable quality as the British firms themselves. Our exports of electric railway equipment have grown enormously, the important new London underground roads and the Glasgow corporation tramways coming to this country for their material and equipment. American locomotives and American bridge work, indeed, are becoming familiar the world over, the latter going abroad in increasing numbers to Japan and China, while the contracts for English engines find their counterpart in an order for twenty locomotives for the Saxon State Railways of the German Empire. The Soudan episode has been repeated in Burma, where an American firm offered to build in one year for $300,000 a bridge for which the most favorable English tender asked $590,000 and three years time to complete. The instances quoted are a few among many which indicate the vast possibilities of the future, among which we may reckon the ultimate advancement of this country to the position now held by Great Britain as the greatest trading nation of the world, with New York as the world's commercial center.

OUR EMPIRE.

The problems of colonial (for the want of a better word) administration, remaining to us as a legacy of the Spanish war, have been solved, during the year, with a reasonable measure of success. In Porto Rico, as the result of the devastating hurricanes of last summer, our efforts have been chiefly in the way of relief for a starving peasantry; and the cry is still for help. In Cuba our efforts have been largely directed to the cleaning up of the accumulated filth of the cities, and such relief of the impoverished country as could be accomplished. The absence of political disturbances after the perpetual strife of Spanish rule indicates that, so far as outward appearances go, the pacification of the island is complete; but it is too early to judge of the practical results of our government or to determine how long our occupation of the island must continue. The splendid work already accomplished by General Wood at Santiago is a good augury for the future of the island under its newly appointed governor. In the Philippines, if we may judge from the reports of General Otis, the insurrection is practically at an end, the insurgent army broken up and dispersed and Aguinaldo a fugitive. The problem in these far distant islands is big with possibilities, and its solution will call for the most careful consideration. In some respects it is as difficult a question as ever confronted an American Congress. If the administration of these islands be carefully safeguarded from the worst features of political influence, we have no doubt that the Philippines will be pacified and rendered in due time extremely prosperous under American rule.

CIVIL ENGINEERING.

The record of the year in the sphere of civil engineering is remarkable as much for the works proposed as for those accomplished, although we must make a notable exception in the case of the great Chicago Drainage Canal, which is now practically completed, and the new St. Lawrence Canal locks, which, by making it possible for ocean steamers 270 feet in length to pass between the Great Lakes and the Atlantic, will place the Great Lake cities in direct communication by water with the Atlantic seaboard. The Chicago Drainage Canal, primarily intended to carry off the sewage of Chicago, is one of the greatest canals ever constructed. It has a depth of 22 feet of water, with a maximum width of 202 feet, and its total length is 35 miles. It has cost over $33,000,000, and the total excavation, including the river diversion, is over 43,000,000 cubic yards. Another canal of less dimensions but great historic interest completed and opened last year is the Dismal Swamp Canal, 10 feet deep, 80 feet wide, and 22 miles long, which will enable vessels to go south from Norfolk by the inland route, avoiding the dangers of Cape Hatteras. The Panama Canal has been prosecuted steadily throughout the year, and with the Nicaragua Canal and other proposed canal routes across the Isthmus is being made the subject of investigation by a United States commission, with a view to selecting the best location for a national canal. The most important hydraulic works in the hands of British engineers are the great dam at Assouan on the Nile and the barrage at Assouat. About 8,000 men are employed on the former work and 12,000 men at the barrage. When this work is completed, a large area of the Nile Valley will be brought under cultivation, with a corresponding increase in the wealth and prosperity of that historic country. The opening of the railway to Khartoum, the death of the Khalifa and the final dispersion of his army, events which marked the close of the year, are all important steps in the rehabilitation of the devastated regions of the Upper Nile. The most important water works in course of construction in the United States, the Croton Dam, for the supply of New York, and the Wachusett Reservoir, for the supply of Boston, have been pushed forward during the year, the Croton Dam being now within two years of completion.

Early in the year the Great Boston Terminal Station, the largest structure of the kind in the world, was opened for traffic, and the important work on the Philadelphia Subway and Tunnel, involving an expenditure of $6,000,000, has been pushed to completion. In New York city a start has at last been made in the matter of rapid transit, and the awards will shortly be made for the construction of the tunnel road. The new East River bridge has so far progressed that the tower foundations are completed and the two anchorages nearly so, while the steel work for the towers and approaches is being delivered and the contracts for the cables have been closed. Two other bridges across the East River to cost respectively $13,000,000 and $15,000,000 are to be commenced, unless the present Controller of New York succeeds in substituting his proposed tunnels as an alternative and more economical scheme. Indeed, tunnel schemes of great magnitude are very much in evidence just now, for in addition to those suggested beneath the English Channel and the Irish Sea is one to connect Europe and Africa at the Straits of Gibraltar—of which it is sufficient to say that it is as little likely to be built as the other two. The most important harbor improvement of the year is the cutting of a 40-foot channel into New York Harbor. The contracts have been let, and work is being pushed on a set of mammoth suction dredges, similar to those which have done such good service at the mouth of the Mersey, Liverpool. Work during the year has been prosecuted with feverish energy on the Trans-Siberian Railway, which with its European connections will have a total length from Atlantic to Pacific of about 6,700 miles.

MECHANICAL ENGINEERING.

There have been no very notable developments in the field of mechanical engineering. The water-tube boiler continues to advance in favor, as do superheating and mechanical stoking. Central stations are growing in size and in the bulk of the separate units. The most striking instances of this are to be found in this city, where three mammoth stations of from 70,000 to 100,000 horse power total capacity are under construction. The separate engines vary from 6,600 to as high as 10,000 indicated horse power, something altogether unprecedented outside of the engine room of an Atlantic liner. In the smaller classes of steam engine we notice a distinct revival of interest in the rotary engine, much of which no doubt is due to the stimulus of the steam-driven automobile, for which a successful rotary engine would be the ideal motor. If the rotary type is ever successfully applied to the automobile, it will probably be in the form of a steam turbine, with worm gearing to reduce the speed of revolution to the desired rate. The light weight of the turbine in proportion to its power, its perfect equilibrium, great range of expansion, and silent exhaust, would seem to render it an ideal motor for the purpose. Meanwhile both the Parsons and the De Laval machines are extending their field of operations, and Parsons turbines are being built or planned of from 1,000 to 1,500 horse power. According to Prof. Thurston, we must not look for much further development in the steam engine, as it has been so far perfected that but little more in the way of economy can be expected of the designer, recent tests of a pumping engine, carried out by the college over which Prof. Thurston presides, having revealed an efficiency, measured against the perfect engine of Carnot, of 84 per cent and a duty measured on a basis of 1,000,000 B.T.U. of 163,000,000 foot-pounds.

ELECTRICITY.

The year's progress in the electrical world has been marked by steady advance along established lines, with few or no startling inventions or discoveries to be recorded. Perhaps the most striking development has been that of wireless telegraphy, a system which was shown for the first time in successful commercial operation in this country by Marconi himself during the international yacht races. During the summer wireless messages were successfully transmitted between ships of the British navy which were separated by 80 miles of water, and decipherable messages were also dispatched from Chelmsford in England to Boulogne in France, over 110 miles of land and water. Marconi has done enough to establish the practical value of his system for certain specified work; but its value will be enormously increased if he can discover some means to restrict the receipt of messages to the particular station for which they are intended, and prevent all interference by the waves sent out from other stations that may happen to be within range. Scarcely less remarkable results in their way have been attained by the Pollak-Virag system of high-speed telegraphy; from 70,000 to 100,000 words per hour having been transmitted between Budapesth and Vienna, while recently as high as 122,000 per minute were transmitted between Chicago and Buffalo. In this system transmission is effected by a perforated strip of paper, as in the case of the Wheatstone automatic, while a telephone fitted with two small mirrors serves as the receiver, the diaphragm of the telephone being set into oscillations corresponding to the current impulses generated by the transmitter. The SCIENTIFIC AMERICAN has devoted considerable space during the year to descriptions of the electrical development of the Niagara water power. The close of the year sees the first half of the proposed 100,000 horse power plant of the Niagara Falls Power Plant nearing completion, and steps being taken to duplicate the existing power house with another of equal capacity on the opposite banks of the company's feeder canal. The Hydraulic Power Company has an output of about 14,000 horse power, and improvements are under way which will increase this to 20,000. The Canadian Niagara Power Company is to commence work shortly on the development of 10,000 horse power, and altogether it may be said that the much talked of "harnessing of the falls" as far as it has gone has proved a technical and industrial success. Electricity continues to oust every other form of power for the operation of street railways, and the indications are that for city work the underground trolley will be the exclusive system, with the overhead trolley for suburban and short interurban lines. At the same time the third rail has given such good results on the New Haven Railroad that it is not improbable that the Shore Line from New Rochelle to Harlem will be equipped with a third rail. The electric equipment of steam railroads, however, is not proceeding as quickly as many people had expected, although the great system of the Manhattan Elevated is to be electrically equipped, an order for several thousand tons of third rail having been placed during the year. Another change from steam to electricity that has been determined upon, is the equipment of the Metropolitan Underground Railway in London. In this connection mention must be made of the excellent economy shown last year by the electric lines of the Metropolitan Street Railway Company in this city, which cost for operation per car mile 11·95 cents as against 17·96 cents for the horse car roads, and 17·99 cents for the cable roads. A service of compressed air cars has been started on two crosstown lines of this company, but it is too early to make any comparison of results with the electric or cable roads.

STEAM RAILROADS.

Transportation, as represented by the gigantic railway system of the United States, has to record a healthy growth, and the age of wild-cat railroad construction has doubtless gone for good. The present total length of our roads is 184,532 miles, and our advance is now recorded year by year, not so much by added mileage as by improved rolling stock and roadbed, more commodious stations, a faster time card, and a slowly (too slowly) lessening casualty list. Locomotives and freight cars continue to increase in size, though not so noticeably as they did last year. The fast transcontinental mail trains have called for and produced some exceptionally powerful express engines with boilers of unusual capacity, and the big freight engines of over 100 tons weight of the preceding year were followed by others of even greater weight and power last year.

The steam locomotive still holds the field as *par excellence* the traction motor for heavy or long distance

trains, the Heilmann electric machine notwithstanding, and there is no evidence that it is likely to be displaced. The fastest trains in the world during the year were those run during the summer season on the Pennsylvania and the Philadelphia and Reading roads, from Camden to Atlantic City. These trains, whose schedule speed is between 60 and 70 miles an hour, frequently made the runs of 55·5 and 58·3 miles at rates of from 68 to 74 miles an hour, with trains weighing as high as 290 tons. The palm for the fastest regular express service, however, must be awarded to the great French railroad Chemin de Fer du Nord, which is unapproached in the number and average speed of its fast trains. The service includes no less than 45 trains with a running speed, including stops, of over 50 miles an hour, and of these no less than 10 are timed to run at speeds of from 54 to 60 miles an hour. The service is worked by four-cylinder compound engines.

THE AUTOMOBILE.

Unquestionably the greatest advance in transportation is that recorded in the field of the automobile, which is evidently destined to enjoy a popularity as great as, and certainly more lasting than, the bicycle. There has been a noticeable and very gratifying improvement in the general appearance of the latest styles of automobile which have made their appearance during the year, and the constantly accumulating experience is leading to marked improvement in the motors. The field is no longer all but exclusively occupied by the gas engine and the electric motor; for the improvements in steam motors has been so great as to promise that this long established, well understood and easily managed form of power may yet become the most popular for the automobile, with compressed air a possible rival. The speed and "radius of action," to borrow a naval term, of the automobile have seen a truly remarkable increase during the twelve months. A remarkable proof of this was shown in the nine-day race around France, in which the winner covered the distance (1,428 miles) in 44 hours, 44 minutes, 9 seconds, an average speed of about 32 miles per hour. Special racing machines have made speeds on the track of over a mile a minute. Another machine has covered 85 miles in 7¼ hours without recharging, and in a trial against the Paris-St. Malo express, two automobiles covered the distance, 226 miles, in 7 hours and 35 minutes, the train taking 13 minutes longer. The progress of the industry in this country has been decidedly encouraging. The latest models of American automobiles compare favorably with the best European makes, and we look for the industry to make very rapid strides during the present year.

THE BICYCLE.

As the star of the automobile rises, that of the bicycle seems steadily to set. The latter will never cease to be used for business and pleasure; but the popular rage, which is already on the wane, will be increasingly transferred to the automobile as the price of the latter comes more and more within the reach of the purse of the average citizen. The introduction of motor-pacing has enabled some remarkable speeds to be accomplished on the bicycle, a mile having been ridden in 1 minute and 19 seconds on the track, the cyclist using a chainless wheel. Speaking of paced riding, a striking evidence that the atmosphere presents the principal resistance to a bicycle moving at high speed was afforded by the ride of a mile in 57⅘ seconds made during the year by a rider paced by a locomotive. This was done on a prepared plank track laid specially for the attempt. The most noticeable improvement in the bicycle has been in the introduction of coaster brakes, and of other forms of brake applied to the rear wheel. Beyond this there has been but little change as compared with the model of the previous year.

NAVAL.

In naval affairs there has been no cessation of the efforts of the maritime nations to increase their already stupendous fleets. The SCIENTIFIC AMERICAN has devoted particular attention to this subject during the year in a series of articles entitled "The Navies of the World." A preliminary comparison showed that the United States, at the commencement of 1899, stood fourth in power and numbers, with Germany a close fifth. Unless we make more strenuous efforts, however, we shall soon have fallen to fifth place, for the present German programme calls for the expenditure of nearly $200,000,000 on naval construction, the amount to be made available in yearly installments as needed. We think that a similar scheme, calling for the construction of so many battleships, cruisers, etc., each year, would produce better results than our present haphazard methods, in which the growth of the navy is dependent from year to year upon the caprice of our legislators. It is worthy of note that Great Britain has now under construction for her own navy warships whose total tonnage is 488,000 tons, or more than the total tonnage of the whole United States navy. France and Russia, moreover, are making relatively large additions, and Japan, whose navy is now entitled to rank as of the first class, is a liberal patron of the best European yards. We cannot afford to stand still.

The United States navy has received some notable additions during the year. The battleships "Kearsarge" and "Kentucky," carrying the much discussed superposed turrets, passed satisfactorily through their trials, in each case exceeding the contract speed, and the "Alabama" made 17 knots on her builders' trial. The "Wisconsin" and "Illinois" are also nearing completion, and the three battleships of the "Maine" class are well advanced. The three battleships of the "New Jersey" class and the 13,500-ton armored cruisers of the "California" type are "held up" by the refusal of Congress to allow the purchase of necessary Krupp armor. The new monitors are being constructed at a leisurely pace, and the contracts have been let for the construction of the six semi-protected 16½-knot cruisers of the "Denver" class. These monitors and cruisers will prove to be among the most unprofitable investments of money ever made, rivaling in this respect the "Vesuvius" and the "Katahdin." Our torpedo-boat fleet is growing apace, the vessels coming fairly well up to contract requirements. In foreign navies the effect of the improved Krupp process is seen in the lightening of armor, and its distribution over a larger area of the ship's side, the latest battleships of the "Duncan" class for the British navy carrying only 7 inches of armor on the side. The weight saved in armor shows itself in the engine and boiler rooms, for these vessels are to steam 19 knots with natural draught. The water-tube boiler has been adopted for our navy and will be used, we believe, exclusively in our new battleships and cruisers. The speed of all warships, from the 15,000-ton battleship to the torpedo boat, continues to increase. Schichau, of Elbing, has achieved over 35 knots on an 18½-mile course with the torpedo boat "Hai Lung," built for the Chinese navy, and Parsons of turbine fame is reported to have realized 37 knots in preliminary trials of an enlarged "Turbinia," although this latter needs verification. The submarine boat has been very much in evidence during the year, chiefly because of the increased attention paid to it by the French government and the very succesful trials of the "Holland" in this country.

The manufacture of the new long-caliber guns at Washington has been carried on with gratifying results. The new 50-caliber 4-inch gun has given a velocity of about 3,000 feet per second, with a moderate chamber pressure. A new, multi-perforated, all-gun-cotton powder is being made, which will give equal velocities with a pressure not to exceed 16 tons in the powder chamber. Experiments with high-explosive shells, especially in the case of a new explosive, "joveite," have been highly successful. A shell loaded with the latter substance, and weighing 523 pounds, penetrated a 14·5-inch Harveyized plate without breaking up.

THE MAGAZINE RIFLE IN WARFARE.

The progress of the South African war has proved that the modern magazine rifle is *par excellence* the weapon of the future in military operations. Although the British infantry have proved their ability to storm unintrenched or partially intrenched positions, as at Glencoe, Belmont, and Gras Pan, the repulses at Magersfontein and the Tugela, where the Boers had thrown up elaborate intrenchments, proved that direct assault on such positions, when held by such excellent shots as the Boers, are doomed to failure. The magazine rifle has put a heavy discount upon old-time valor, and the war of the future will be more than ever a war of the tacticians.

MERCHANT MARINE.

The most notable event in the merchant marine was the placing in service of the "Oceanic," of the White Star Line, the first of the modern vessels to exceed the dimensions of the "Great Eastern." As compared with the earlier vessel she is 12 feet longer, and she has 1,500 tons more displacement, while her sea speed is 20 knots as against about 13 knots for the "Great Eastern." The "Kaiser Wilhelm der Grosse" continues to reduce her own record, having made the trans-Atlantic passage last year at an average speed of 22·56 knots. She also ran in one day 580 knots at the rate of 24·17 knots an hour. The Hamburg-American Line will shortly place in service an answer to the "Kaiser Wilhelm" in the "Deutschland," a 686½-foot ship, which, with 35,000 indicated horse power, is to maintain an average sea speed of 23 knots an hour. This places the 5-day passage well within reach. The tragic loss of the "Bourgogne" has stimulated the munificent offer of the Pollok prize of $20,000 for the best device for saving life at sea. That other notable disaster, the loss of the "Paris," served to demonstrate the strength of the modern system of ship construction; for after lying for 52 days on the rocks of the stormy Cornish coast, this fine vessel was floated, and will eventually return to her duties upon the New York-Southampton route. "Roller" boats have yet to achieve the speeds promised by their inventors. The "Ernest Bazin" has been sold, and has found her legitimate sphere of activity as a show-ship, while Knapp's roller boat is resting on its laurels, with a record of having rolled 41 miles in 5 days.

AERONAUTICS.

Activity in the aeronautical world has been directed rather to the development of the airship than the aeroplane. Ever since Langley's brilliant success in achieving a flight of three-quarters of a mile with an experimental, steam-driven, machine, we have heard but little, either of the motor-driven aeroplane, or the soaring machine. The balloonists, on the other hand, have been very active, and fairly successful. By far the most ambitious attempt at the construction of an airship is that of Count Zeppelin, whose mammoth machine, over 400 feet in length, was to have made its trials in October.

ARCHÆOLOGY.

Although archæology cannot this year report such sensational discoveries as have rendered some previous years famous, gratifying results have been attained in Rome, where the much-explored site of the Forum still yields up its secrets to the antiquarian pick and spade; while in Egypt, thanks to the Egyptian Exploration Fund, over two thousand historic and prehistoric graves have given up their treasures for the enrichment of modern museums. Had they been living friends instead of "senseless" stone, the fall of the great columns at Karnak could scarcely have caused more sincere regret than was felt throughout the civilized world when this disaster was made known.

GEOGRAPHICAL AND SCIENTIFIC EXPEDITIONS.

Never was there a time when so many and so well-equipped expeditions were abroad in the effort to fill in the blank spaces in the geography of the world. Interest is divided pretty equally between the Arctic and Antarctic regions — with a preference for the former. Peary is well on his way to the North Pole. Profiting by his past experience, he is engaged in establishing the necessary line of communications before making his final dash for the objective point. He has an able competitor in Sverdrup, Nansen's old colleague, who has taken the "Fram" once more into Arctic waters, with the intention of combining Peary's and Nansen's plan of advance in a supreme effort. During the year Abruzzi has set out, and Wellman has returned from Franz Josef Land. The Belgian Antarctic expedition, which sailed from Antwerp over two years ago, has brought home a fine collection of fauna and many valuable data gathered during its deep sea investigations; while the Geographical Society of Berlin has under consideration the dispatch of a well-equipped expedition. Mention should be made also of Prof. Hatcher's exploration of Patagonia, which has yielded valuable results, and also of the exploration of the fossil beds of Wyoming, which has proved so successful that another expedition is being planned for this year.

CHEMISTRY.

After being crucified by its friends, liquid air has been attacked by the vultures. Liquid air promoting is the order of the day, with capitalizations at $10,000,000 the company, and sales of stock at the rate of $2.50 a share.

Prof. Dewar again holds a prominent place in the history of the year's progress. To the long list of his achievements has been added the liquefaction of hydrogen, the first public exhibition of the new substance having been made at the Royal Institution, London, in June of this year. Subsequently, at the Dover meeting of the British Association, he described the experiments by which he had succeeded in solidifying the same gas. Early in the year, MM. Curie and Bremona announced through Dr. Becquerel to the Academy of Sciences at Paris, the discovery of a new, supposedly elementary substance, to which they gave the name of "radium," and in May Sir William Crookes informed the British Royal Society that he had found in a photograph of a spectrum a group of lines indicating the existence of a new element, which in honor of his Queen he named "victorium."

Electric lighting has recorded no developments worthy of special mention, for great as were the expectations based upon the new Nernst lamp, they have not been fulfilled. Acetylene, on the other hand, has fully justified expectations, and both as an illuminant and a source of motive power it is giving excellent results.

OBITUARY.

Limitations of space prevent a lengthy reference to the obituary of the year, which includes the names of men who can ill be spared from the fields on which they have left imperishable monuments of their labors. In the death of Prof. O. C. Marsh, American science suffered the severest loss since the death of Prof. Cope. Of that distinguished German, Prof. R. W. E. Bunsen, it is sufficient to say that in the last half century it is scarcely possible to find another whose contributions to science have been greater in their total practical effect. The death roll of American scientists also contains the names Dr. Daniel G. Brinton, the ethnologist, Hamilton Young Castner, celebrated for his work in the chemical arts, and the naturalist, Elliott Coues; while Canada has been robbed of the geologist Sir William Dawson. Of technical experts, the army and navy have lost Gen. D. W. Flagler and Lieut. R. B. Dashiell; and Great Britain, Vice-Admiral Colomb. Sir Douglas Galton in England and Mr. Frank Thompson in America were two of the best known engineers of the day. The names of William H. Webb, the shipbuilder, and Ottmar Mergenthaler, the inventor of the "linotype" machine, complete a death-roll as illustrious as it is long.