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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 1905.

The year that is now drawing to a close is destined to stand out in bold relief as having witnessed some of the most momentous events in the world's history. The first of these, the peace of Portsmouth, marked the gathering in of the fruits of the stupendous naval and military struggle in the Far East, and the formal entry of the Japanese people into the front rank of the great powers of the world. By that treaty Japan won for China and for herself all, and more than all, for which she took up arms, and thereby added valuable political and strategetical advantages to the moral and military prestige that she had secured by her successful prosecution of the war. The indirect results of the struggle, however, are greater than those for which the war was fought; for if we read the signs of the times aright, it will be to the disasters in Manchuria and in the Sea of Japan that Russia will be indebted for the social and political upheaval of which we are witness at this very hour. Much as we deplore the awful excesses that accompany this struggle, it is our belief that out of it the Russians will emerge a free and contented people, destined to hold more securely than ever their commanding position among the nations of the world. It is entirely possible that the signing of the Treaty of Portsmouth marked the close of the last great war to be waged between civilized powers. The enormous cost of modern war, its liability to bring about either a financial or a political cataclysm, has given to it a new terror. Kings, Parliaments, and Congresses will hesitate before they resort to arms as the final arbitrament. An even surer preventive of war, and a most hopeful sign of permanent peace, is found in the increasing tendency of the nations to fraternize as man with man. Such incidents as the recent extraordinarily friendly receptions accorded to visiting foreign fleets, and particularly the cordial fraternization of the crews as seen in France and in this country, have a profound significance. Can it be that the era of universal peace has already stolen in upon us unannounced?

THE PANAMA CANAL.

We shall not be charged with having an undue estimate of the importance of the Panama Canal, if we state that this is one of the most serious problems, political, commercial, or military, confronting this country to-day; nor shall we be accused of undue pessimism if we suggest that the way in which we have handled this great problem during the past few months has added nothing to our reputation for constructive and executive ability in a work of this magnitude. There have been resignations without number, including that of the Chief Engineer; we have appointed Boards of Control, only summarily to disband them; we have spent ten million dollars, even before we know what kind of a canal we intend to build, or by what particular method we will build it; and finally, after calling together an advisory board composed of the most representative engineers of the world, in order that they may tell us just what kind of a canal we should construct, we are hysterically threatening to ignore their decision even before they have had time officially to render it. The SCIENTIFIC AMERICAN is of the opinion that there are just three things for the United States to do, if it is to maintain its national dignity and successfully carry through this gigantic work: the first is to accept without question the type of canal recommended by the Board; the second, is to let the whole work by contract under the absolute supervision of a Chief Engineer; and the third is to vote him ungrudgingly the appropriations which are necessary to carry on the work upon the scale, and by the methods, that he shall determine. If this be done, the United States within a single decade, will possess a sea-level canal, deep enough and broad enough for any possible development in the size of the ships of the future, and capable of giving them unhindered passage from the Atlantic to the one tidal lock on the Pacific. Moreover, if these conditions are fulfilled, we are satisfied that a sea-level canal will be placed at the service of the country in practically the same time as one built with locks and having the same capacity.

ASTRONOMY.

The astronomer must surely have found the past year sufficiently eventful. Among the more important achievements may be mentioned the discovery of two new satellites of Jupiter at Lick Observatory by Prof. Perrine. Although the sizes of the bodies have been computed and likewise the inclination of their planes to the orbit of the parent planet we must wait a year or two for more definite information as to the direction of their movement—in other words until Jupiter has moved a considerable distance so that the angles of the orbits may be computed from different positions.

No less remarkable is the discovery of a tenth satellite of Saturn by Prof. Pickering—remarkable because the discovery was the culmination of mathematical research and a painstaking study of photographs extending over several years. This new satellite of Saturn has an estimated diameter of 200 miles and is just beyond telescopic vision, for which reason its presence can be detected only by the sensitive photographic plate. The acrimonious controversy which has been waged over the existence of the problematical canals of Mars seems at last to have been settled by photography. Prof. Lowell, one of the stanchest advocates of the existence of the Martian canals, has advanced what seems most invincible photographic proof that the canals are not merely optical illusions or the result of eye-strain. Under his direction, Mr. Lampland, of the Flagstaff observatory, has secured some excellent chronophotographs of the much discussed phenomena.

Perhaps the most dramatic celestial occurrence of the year was the total solar eclipse of August 30. Unfortunately the elaborate plans which had been made for comparatively studying and photographing the corona at the beginning of the eclipse, in Labrador, and at its height in Spain and Africa were frustrated. An overcast sky rendered any attempt at observation in Labrador quite vain. In Europe and Africa, on the other hand, the weather seems to have been favorable. This was the first effort which has ever been made to study the corona systematically at the beginning and end of the eclipse path, for the purpose of discovering any possible fluctuations in the appearance of the coronal streamers. From the lunar eclipse of August 14 little was expected that would be new, for which reason the phenomenon was practically ignored.

CIVIL ENGINEERING.

In the world of civil engineering, and in the now closely-allied field of architecture, the most significant fact is the truly marvelous development that is taking place in the use of steel-and-concrete, or armored concrete, construction. Its economy, reliable strength, convenience and rapidity of construction, and the extraordinarily wide range of work in which it may be utilized, render it certain that concrete-steel will exert a more powerful influence within the field of the civil engineer, than any single invention since the introduction of Bessemer steel.

During the year work has been satisfactorily prosecuted upon the great cantilever railroad and highway bridge across the St. Lawrence at Quebec. This structure with its main span of 1,800 feet, not only has the greatest capacity of any cantilever bridge yet constructed, but also embodies the largest single span, the next in size being the two 1,710-foot spans of the Forth Bridge. A notable feature of the year has been the growing popularity of the bascule bridge and the aerial bridge for the crossing of streams on which there is a frequent traffic. The popularity of the latter type is very marked, a notable instance being the new ferry at Duluth, with a span of 394 feet. An important bridge that has been completed during the year is the Victoria Falls Bridge over the Zambezi River, a trussed arch span of 500 feet, which forms a connecting link on the so-called Cape-to-Cairo railroad. With the exception of the Blackwell's Island Bridge across the East River, New York, the great structures planned across that river have made but little progress. The Blackwell's Island Bridge is completed as to its substructure, and the superstructure is now in course of erection. The Manhattan Suspension Bridge, after two years of delay, has been switched into the courts, and progress, at least on the superstructure, is at a standstill. The past year has witnessed the completion of some highly important tunnel work. First to be mentioned is the great Simplon tunnel through the Alps, in which the rock that separated the two headings was broken through on the 24th of February. The total length from portal to portal is 12¼ miles. The year's operation of the new tunnel between Boston and East Boston has been eminently satisfactory. This tunnel is 1.4 miles in length, and at its lowest point beneath the harbor the masonry is 82.3 feet below mean low water. In New York city, the Hudson Companies have completed the second or north tunnel of the twin tunnels between Jersey City and Morton Street, and at the Manhattan end the tunnels have been carried well on their way to Fourth Avenue and Thirty-third Street. In these tunnels a record has been established for rapid construction, and it is expected that the other twin tunnels located between Jersey City and Cortlandt and Fulton Streets, will be driven through with even greater rapidity. A most important event of the year was the completion of Chicago's freight, express, and mail subways; for upon the successful operation of the system will depend its extension to other cities. We believe that the congestion of vehicles on the streets of our great cities can never be relieved until heavy freight traffic is removed from the streets, and handled in a system of subways running at the level of the basement floors. During the latter part of the year gratifying progress has been made in dredging the great Ambrose Channel, 7 miles in length and 40 feet in depth, which is to form the future entrance to New York harbor. With the assistance of the two powerful government dredges which have recently been put upon the work, matters have so far progressed that, early in the spring, a 35-foot channel will be available, and probably within a year from date the depth will have been increased to 40 feet throughout. The great sea wall of Galveston, for the protection of that city against a repetition of the disaster of September 8, 1900, was completed during the year, and the work of filling in back of it, and thereby raising the grade of the city, has been steadily carried on. This huge concrete wall, which is 4½ miles in length and weighs 40,000 pounds to the lineal foot, measures 16 feet at the base, 17 feet in height, and is 5 feet across the crest. It is built upon 45-foot piles, and is protected from the undermining action of the Gulf storms by an apron of rip-rap, 27 feet in width. The grade of the city will ultimately be raised to the level of the top of the wall. An interesting coincidence in the field of civil engineering is the completion during the year of the two largest modern reservoirs built for city water supply, namely, the Wachusett reservoir for the supply of the city of Boston and the new Croton reservoir for the supply of New York city. The Wachusett reservoir dam extends 129 feet above ground level and 158 feet above its lowest foundation, and it impounds 63,000,000,000 gallons of water. The Croton dam extends 157 feet above ground level, 297 feet above its lowest foundation and it impounds 32,000,000,000 gallons. The Jerome Park reservoir, in New York, easterly basin has now been fully concreted and is ready to receive water. The important task of providing additional water supply for the future needs of New York city has been advanced by the passing of the necessary legislation. The Board of Water Supply has presented a report of the plan of its engineers to secure a daily additional supply of from 500 to 600,000,000 gallons of water. The scheme involves the construction of a great reservoir at Ashokan in the Esopus valley, and the construction of an aqueduct, passing beneath the Hudson, capable of delivering, as its maximum capacity, 500,000,000 gallons per day. The total estimated cost of this work is about $162,000,000. Work has been actively prosecuted on the government irrigation projects for the reclamation of arid western lands, and the State of Nevada has witnessed the inauguration of the great irrigation canal known as the Main Truckee Canal—a part of the Truckee-Carson project—which on June 17 received its first water from the Truckee River.

STEAM AND ELECTRICAL RAILROADS.

During the year, work has been prosecuted with considerable activity upon the two great terminal stations now being built in New York city by the New York Central and Pennsylvania Railroad companies. So far, the work in each case has been almost entirely one of excavation, and as the two schemes together call for the excavation and removal of between 4 and 5 million cubic yards of rock and earth, it can be seen what a gigantic task each company has set itself. The New York Central station excavation is about one-half completed, the two electrical power stations at Yonkers and Port Morris are well under way, and the widening of the roadbed up to Croton Landing is being completed as fast as the material is brought from the Forty-second Street excavation. The experimental work on the company's six-mile stretch of electrified track near Schenectady has yielded results very favorable to electric traction. A series of comparative tests between a 170-ton steam locomotive and the 100-ton type electric locomotive, hauling trains of identical make-up and weight, on parallel tracks, have shown a difference in favor of the electric locomotive of 30 feet 8½ inches in length, 72 tons in weight, 5¾ tons in concentrated weight on driving axles, 51¼ tons of revenue bearing load back of the locomotive, of 0.148 mile per hour acceleration, and of 76 seconds in the time necessary to reach a speed of 50 miles per hour. The fine results shown by the New York elevated railroads, after the motive power had been changed from steam to electricity, have been repeated in the operation of the New York Subway which, almost from the

day of its inauguration, has been an unqualified success. Save for some congestion in the first two or three weeks succeeding its opening, the Subway system has been running now for over a year with absolutely clock-like precision, and the speed, especially of the express trains, has been rather over than under the original estimate. During the year, the road has carried over 300,000 passengers per day. Already, however, it is becoming congested, the travel on a single day recently having risen as high as half a million in the twenty-four hours. Sixty miles of additional Subway lines have been authorized by the Rapid Transit Commission. A most serious problem encountered has been that of ventilation, the heat given off by the motors and by the brakes being sufficient to render the temperature almost insufferable during the hot summer weather. An important proposition made during the year with the indorsement and backing of some of the leading engineers and financiers of this city had in view the construction of a moving platform across Manhattan Island beneath Thirty-fourth Street. In the hearing before the Rapid Transit Board, the remarkable statement was made by Mr. Stilwell, the chief electrical engineer of the Interborough Railroad, that, estimating the rolling friction of the platform at about 6 pounds per ton, 10 kilowatts, instead of moving, as in the case of the Subway, ten passengers, would move 260 passengers on the moving platform, the difference being due to the small dead load, the absence of stopping, and the low coefficient of rolling friction. As an important preliminary to the operation of the Pennsylvania Railroad Terminal and Suburban System in New York by electric traction, a large section of the newly electrified Long Island suburban railroads was opened to the public at the close of the year. At the present time there is in operation a total mileage, when reduced to a single track basis, of about 100 miles; and during the next few months large additional stretches of track will be included in the electrically-operated zone. In all the work done hitherto around New York, the direct-current system has been used; but a mild sensation was produced by the recent announcement that the work of equipping the New York, New Haven and Hartford suburban and terminal lines in New York is to be carried out with the single-phase alternating current. The company has been encouraged to make this decision by the results obtained in the United States by the two interurban trolley roads upon which the single-phase alternating current system has been installed, one of these being a high-speed line between Indianapolis and Rushville, and the other a relatively low-speed line known as the Pontiac-Odell line. A valuable feature of the Westinghouse single-phase alternating current motors is that they will operate successfully when required with direct current; and accordingly the alternating current will be used on the New Haven tracks as far as Woodlawn, the motors drawing upon the direct current through the third-rail conductors on the 11-mile stretch of New York Central tracks from Woodlawn to the Grand Central station. It is impossible within the limits of this review to mention the steam railroads that are already equipping or proposing to equip their suburban and terminal service electrically, but the movement is widespread and we look to see within the next decade practically every great railroad so operated in the vicinity of all great cities.

Meanwhile the development of the steam locomotive is being studied with an enthusiasm which would indicate that the locomotive engineer, at any rate, has no fear of the immediate extinction of the old by the new method of traction. Perhaps the most marked feature of this development is the growth in favor of the use of superheated steam which, in the European locomotives that have been using it during the year, has shown economical results that are at least equal to, and in some cases better than those secured in compound locomotives that make no use of superheat. Compounding is again to the front, and the four-cylinder arrangement, with the high-pressure cylinders attached to the trailing and the low pressure cylinders attached to the leading axle, a type that is due to the celebrated French engineer De Glehn, seems likely to become the prevailing model. The De Glehn locomotives built for use on both English and American lines have shown highly satisfactory results, much of which is, no doubt, attributable to the Walschaert gear. The speed of express trains as a whole is about the same as it was last year, although a few special trains have been accelerated, and the length of some celebrated non-stop runs has been increased. The summer service of trains from Philadelphia to Atlantic City still remains the fastest in the world, with its average speeds of 66 to 68 miles per hour. Some remarkable non-stop high-speed runs have been made both in England and in this country, a notable instance being the Ocean Mail Special train on the Great Western, running between Plymouth and London, which ran from Exeter to London, a distance of 193¾ miles, without a stop, at an average speed of 71 miles an hour. The famous twenty-hour trains between New York and Chicago, both on the New York Central and Pennsylvania railroads, have been accelerated and placed under a schedule of eighteen hours, the former train covering 959.4 miles, at the rate of 53.3 miles an hour, and the latter covering 905.4 miles at the rate of 50.3 miles an hour. The longest non-stop trip by a regular train running under schedule is that of a train on the Great Western Railway which runs regularly between London and Plymouth, a distance of 245¾ miles, without a stop, at the average speed of 55.64 miles per hour. An important change that will gradually take place in the construction of passenger cars is the substitution of steel for wood. The first step in this direction was taken by the Illinois Central a few years ago, and it was followed on the New York Subway where the cars have proved a great success. Steel mail and baggage cars have been constructed; the New York Central and the Pennsylvania roads have given large orders for steel cars; and we understand that the Pullman Company proposes to manufacture all-steel cars for passenger service. The SCIENTIFIC AMERICAN has for many years been an earnest advocate of the steel car, mainly because we believe it would prove to be the greatest protection to the life and limb of the passengers of any device that has been introduced of late years into railroad service. Such protection is needed; for in spite of the extension of the block signal system, the number of casualties on our railroads is increasing far faster than the increase in passengers carried. The accident statistics of the Interstate Commerce Commission show that the number of passengers killed increased from 303 during the year in 1902 to 537 in 1905, while the number of injured passengers rose from 6,089 in 1902 to 10,040 in 1905. During the same period the number of employes killed rose from 2,516 to 3,261, and the number of injured from 33,711 to 45,426.

NAVAL AND MILITARY.

It goes without saying that the most important event in the annals of naval and military affairs during the past year was the great battle of the Sea of Japan. It was the decisive event for which students of naval warfare had been waiting these many years past; for unlike the battle of August 10, this was a struggle in which neither side hesitated to close in for the final arbitrament of gun against armor. On each side were battleships which embodied the most up-to-date practice of the leading naval architects of the world. The battle was fought at ranges at which the guns could get in their most effective work; and every type of modern warship with the exception of the submarine was given an opportunity to prove itself. The result was first and last a triumph for a highly trained personnel over one greatly inferior. What Russian ships were not sunk by gun fire succumbed to the torpedo, or were captured by concentration of overwhelming forces of the enemy. At least two Russian ships were sunk by having the thinner secondary armor above the main belt blown bodily in upon the ship, or so badly perforated that, in rolling in the heavy sea that was running, the vessels shipped large quantities of water and sank comparatively early in the battle. Speaking broadly, the results of the war are a strong vindication of the theories upon which the modern types of fighting ships have been constructed. The progress of our own navy has been marked by the addition of a large number of battleships and armored cruisers of the first class. Practically the whole of the six armored cruisers of the "California" class are now available, while the powerfully armed and armored battleships of the "Rhode Island" class are rapidly having their trials and before many months all of them will be in commission. A most gratifying result is the rapidity with which the "Louisiana" at Newport News and the "Connecticut" at the Brooklyn navy yard have been pushed toward completion. At the present writing the "Connecticut," which is being built by the government, is about 93½ per cent completed, and the "Louisiana" is about 91½ per cent completed. The stimulating effect of government construction upon private yards is proved by the fact that these two ships are about as far advanced as the five battleships of the "Georgia" class, although the "Georgia" class was authorized in 1899, and the "Connecticut" class not until three years later. It is sincerely to be hoped that the policy of maintaining at least one warship under construction at our leading government yards will continue to be steadily followed. It certainly will be, if the interests of the nation at large are considered to be superior to that of the individual shipbuilding firms. Judging from the fine performance of the "Rhode Island" the "Georgia" class bid fair to make and exceed their contract speed of 19 knots an hour. The influence of the late war has made itself felt in the construction bureaus of the various navies. Already there seems to be an agreement among all the navies (except that of Japan, which surely ought to know best) to abolish intermediate caliber guns from the battleship, mounting only 12-inch guns, and a numerous battery of small rapid-firers to repel torpedo attack. The British are building a type battleship of 18,000 tons displacement which is to be driven at 21 knots speed by turbine engines, and is to mount ten 12-inch guns with a numerous battery of 12-pounders. The United States government is now debating whether to build an 18,000-ton ship with ten 12-inch, or a 16,000-ton ship with eight 12-inch, so disposed as to give a broadside superior to that of the ten-gun ship. Germany and Russia are credited with designs with similar innovations. The new Japanese battleships which will soon be completed carry four 12's, four 10's, and twelve 6's. A most important change in the relative battleship power of the world's navies has been made by the recent refloating of Russian warships sunk at Port Arthur and their addition to the Japanese navy, which now possesses nine battleships and nine armored cruisers. With the addition of the new 16,000-ton battleships now building in England, Japan will possess a great preponderance in ships-of-the-line over any other nation in the Pacific. The effect of the addition of the Port Arthur ships to the Japanese navy, moreover, has been to give Japan a distinct lead over Italy, and place her in the fifth position among the navies of the world, or next to the United States. The progress of the submarine has been marked by many vicissitudes; for although it has shown in the various maneuvers, specially those carried out with the larger types in France and Great Britain, that it is an element of naval warfare that has to be recognized and reckoned with, the year has been marked by some terrible disasters. It is but fair to state, however, that the latter were due more to inefficient handling and inexperience than to inherent defects in design. In the development of artillery, there is a steady increase in the length of guns and in the capacity of powder chambers, with a consequent rise in velocities and energies. At Sandy Hook the army has been testing two 6-inch, wire-wound guns, both of which have shown velocities in the neighborhood of 3,300 feet per second. As was to be expected these high velocities were attended with erosion trouble. Erosion is the problem which above all others is demanding solution at the present time; for until it has been solved, the artillerist will have to seek for increased energy by increasing the weight of the gun and projectile, rather than by raising the velocity. The wire-wound gun continues to more than hold its own with the hooped gun, and the probability is that as pressures increase it will become the ultimate prevailing type.

MERCHANT MARINE.

Judged by the ships that have been put in service during the present year, the tendency among the transatlantic steamship companies is to build combined freight and passenger steamships of moderate speed and large carrying capacity, rather than high-speed vessels such as the "Lucania," "Deutschland," and "Kaiser Wilhelm," in which the demands of the motive power for space prohibit the carrying of cargo. On the other hand the North German Lloyd Company has given orders for the construction of another 23½-knot steamer of the same size as the "Kaiser Wilhelm II.," and the Cunard Company has under construction two 25-knot vessels that are to be about 800 feet in length. During the year, three vessels of the largest size have been added to the already large fleets that trade with American ports. In March of this year the new steamship "Coronia" of the Cunard line made her maiden trip, and as we go to press the "Carmania," a sister vessel, is on her maiden trip to New York. The "Coronia," driven by reciprocating engines, made on her trial a speed of 19.5 knots, and the "Carmania" made about a knot more, or 20.43 knots on her trial trip. In the spring of the year the American-built 15-knot "Dakota," 630 feet in length, a sister of the "Minnesota," sailed from New York for Seattle to make her maiden trip from Seattle to Japan. Toward the close of October the Hamburg-American line dispatched to New York the new twin-screw 17-knot liner "Amerika," a vessel of the same popular passenger-and-cargo type, which is remarkable for the extraordinary richness and novelty of her appointments. The increase in size of transatlantic ships has had its counterpart in some of the huge cargo vessels that have been turned out this year for the ore-carrying trade on the Great Lakes. Among these are four vessels, known as the "Gary," "Corey," "Perkins," and "Frick," which are each 569 feet long, and are estimated to carry about 15,000 tons of ore at a single trip. There has been a steady advance in the application of devices to render travel upon the high seas more safe, chief among which may be mentioned the method of closing all bulkhead doors from the navigation bridge, the further extension of wireless telegraphy, without which no ocean steamer is to-day considered to be fully equipped, and the introduction of the system of signaling under water by means of the submarine bell. This last may be considered as one of the most important safeguards yet introduced against

(Continued on page 479.)