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FROM CABLE TO TROLLEY.

Considerable interest is attached to the change of motive power which is now being carried out on the Broadway cable line in this city. It may be said without fear of contradiction that there is no stretch of street railway in the world which even approaches this line in the magnitude of its traffic. There are certain periods during the rush hours of the morning and evening when the cars are being run under ten seconds' headway, and even under these conditions they are packed to their utmost capacity. With such a traffic to provide for, it required no little courage on the part of the management of the Metropolitan Street Railway Company to undertake to relay the old road with heavier rails, put in place the electric cable conduit and the man-holes and hand-holes for the insulators, and perform the various other operations incidental to the change, without any serious interference with the regular schedule of the line. The work has now been in full swing for several weeks, and considerable sections of the road have been completed without any further inconvenience to traffic than a lowering of the running speed in the more crowded sections of Broadway. The preliminary work was done two years ago, when the cable conduits were laid in place throughout the whole road, the present work being confined to the relaying of the steel and the necessary changes in the substructure of the line to provide for the electrical conductors.

The first step was the removal of the old rail, which weighed 85 pounds to the yard, and the insertion of the new 107-pound rails in its place. While this was being done a gang of men were engaged in drilling through the concrete and cutting open the sheet iron tubing of the cable conduit to make way for the manholes and hand-hole boxes. The insulator hand-holes occur at intervals of 16 feet; they are set upon a bed of concrete, a form is placed around them, and the concrete rammed into place. On every 200 feet there has been built beneath the track a brick cross conduit, in which is carried the electrical connections to the main cables. As soon as the hand-hole boxes were bolted to the track rails and to the slot rails and concreted, and the brick conduits built, the Belgian block paving was relaid and the street restored to its normal condition.

The superiority of the new and extremely heavy rails —heavier than the heaviest rails on the steam railroads—over the old rail, as shown in the improved riding of the cars, will be greatly appreciated by the public. The old rail was found to be in excellent condition except at the rail ends, where the weakness of the old splice bars, which were not over 20 inches in length and were unprovided with bottom flanges, allowed the joints to sag under the heavy traffic, until the heavy "pounding" of the cars had become a positive nuisance. The new rail is being spliced with what are probably the heaviest "fishplates" ever employed in steam or street railway traffic. The angle bars are 3 feet in length and 8 inches in depth. The bottom flange extends laterally to the edge of the rail base, where it is turned down vertically to a depth of 3 inches below the rail. The bottom edge, moreover, is heavily bulbed. This gives the needed girder depth, and places the metal where it will do its best work. The permanence of the joint is further assured by providing no less than eight 15/16-inch angle bolts; and the whole character of the construction is such that the "fishplate rail joint," if it ever had an opportunity to show its maximum efficiency, will surely have it now.

A similar change is being carried out on the Lexington Avenue cable line, and when this is completed all that will be necessary will be to insert the T-rail conductors through the man-holes, and bolt them to the insulators. It is proposed by the company to make the final change in power in one night, by stringing out a large force of men along the tracks, who will simultaneously lift the conductors into place, bolt them up and make the necessary electrical connection

AMERICAN AND BRITISH ENGINEERING COMPETITION.

Among the industries which, because of the impetus and specialization which they have received in this country, may be classed as distinctively American, is that of structural steel work, in the designing and manufacture of which we have made enormous strides during the past few years, both as regards the variety of shapes placed upon the market, and the cheapness and high quality of the product. The cause of our supremacy is to be found in two particular branches of engineering work, in which also we have achieved distinction, namely, bridge and roof work and the erection of tall buildings of composite construction. The bond between the bridge builder and the structural steel mills has been one of mutual helpfulness. The demand for bridge steel, and in later years for structural material for steel buildings, has stimulated and encouraged the manufacture of the special shapes required; while the great steel works of the country, in their turn, by specializing this particular class of work, have been able to afford the builders the choice of a wonderful variety of shapes at a cost which is lower than that in any country in the world.

The eighth article of the extremely interesting series on American Engineering Competition, originally published in The London Times and now running in the SCIENTIFIC AMERICAN SUPPLEMENT, is devoted to this subject of structural steel. The observations of The Times correspondent are based upon his investigation of three of the largest structural steel concerns in the country, namely, the Keystone Bridge Works, the Pencoyd Works, and the Berlin Iron Bridge Works, and some of the most striking features of the plant and organization of these world-famed establishments are dwelt upon by the writer, of whom it will be admitted, by the way, that in the whole of his pilgrimage among the industries of this country he has shown a ready appreciation of the distinctive features of American methods and practice. Thus: "The energy with which Americans 'make' business is remarkable. Steel-makers are always trying to force people to use steel; they manufacture markets out of nothing. An architect says he cannot put steel in place of wood— the steel manufacturer employs an expert to show that it can be done. He does not sit down and abuse the architect for his want of enterprise, but sets to work to force his hand." As an instance of the creation of markets, the pressed steel car industry is quoted. Three years ago the pressed steel car was unknown. At the present time there are over fifteen thousand in use. This business, which started in 1889 in a small way, has grown in one decade until the various establishments of the company can produce 130 cars per day, their output being limited only by the difficulty in obtaining steel.

As an Englishman, The Times correspondent is naturally interested in the Pencoyd Works, where the memorable Atbara Bridge was constructed. By the head of the firm he was assured that there was nothing unusual in the so-called rapid filling of the order, and that it was not true, as was stated in England, that a bridge already in course of construction had been diverted from its original destination and shipped to the Soudan. The writer was attracted to the Berlin Iron Bridge Works by seeing in Berlin proper, that is, in the German capital, a large iron foundry which had been made at the Connecticut works and shipped across the Atlantic. The Germans themselves know something about steel-making and how to make it cheaply, "and I was, therefore," says The Timess correspondent, "a good deal interested in seeing works which could manufacture such a heavy thing as an iron foundry, pay railway freight on it from the middle of Connecticut to a sea port, pay freight across the Atlantic, and then again further freight from Hamburg to Berlin, and yet compete successfully with the German makers." Asked how it was possible to perform such a feat in a State which is not a steel-making State, the manager of the works attributed their success to making a close study of the needs of the customer. Thus, one particular department is under the control of an expert foundryman, who is engaged solely in designing iron foundry buildings, the result being that if the company are told how many castings of a given type are to be produced, they will supply a foundry specially laid out for the purpose.

This individual case is a typical one of the plan of employing experts for designing special plants, special factories, special tools; and it is undoubtedly one of the secrets of our successful competition. It gives us a great advantage over Great Britain, where the expert specialist is comparatively unknown, at least in many lines of engineering work. In a certain well-known street in Westminster are to be found engineers by the dozen who will design a whole railway system: roadbed, bridges, ties, track, locomotives, cars, signals, and station buildings. Such a system undoubtedly produces versatile men of wide experience, but it stands to reason that in some particular lines they are quite unable to compete with a specialist whose whole training and life-work has been limited to one special branch of engineering. What is true of the engineers is true in a less degree of the contractors and, as we have seen, of the manufacturers; and there seems to be lacking that common interchange of ideas and hearty co-operation, which mark the relations of these three classes in this country.

CRYSTALLINE IODIDE OF MERCURY.

M. F. Boudroux has recently made a number of experiments, in which he forms the crystalline iodides of mercury directly, by the wet process, and has presented his results to the Académié des Sciences. Mercuric iodide in the crystalline form is usually formed by dissolving the amorphous form of this body in a solution of iodide of potassium or in hydrochloric acid. The solution is concentrated by boiling, and, on cooling, deposits octahedral or quadratic prisms of a brilliant red. Its yellow modification is prepared in two different ways: by sublimation, which gives it the form of orthorhombic prisms, or by the wet way, when an excess of water is added to a solution of mercuric iodide in alcohol. M. Boudroux finds that when a small quantity of iodide of ethyl or of methyl is left in contact with a great excess of a mercuric salt at its maximum concentration point, there results a production of mercuric iodide. The formation of this compound is due to double decomposition, which is favored by the feeble solubility in water of the organic iodide, and the mercuric iodide, being formed very slowly in the liquid, is deposited in certain cases in large crystals. This experiment succeeds with chloride, nitrate and sulphate of mercury, but it is with the acetate that the finest crystals are produced. The method of operating is as follows: In a flask is placed 200 parts distilled water, containing 10 parts, by weight, of acetate of mercury, to which is added 5 parts iodide of methyl. After agitating for a few moments, the whole is allowed to rest. At the end of twenty or thirty minutes small crystals appear on the walls of the vessel and at the surface of the liquid. These are at first of a yellow color, then follow flat red crystals in increasing number. At the end of twelve hours the bottom of the vessel is covered with fine red crystals. In this way flat transparent crystals are obtained of a brilliant color. These are in some cases two-fifths of an inch long. This body has the chemical properties of mercuric iodide. The yellow crystals which form at the first stage of the deposit are transferred slowly, under the action of light, to the red iodide, of which it appears to be a modification. Having obtained these results, M. Boudroux applied the same reaction to the mercurous salts in the hope of obtaining the crystalline form of mercurous iodide, Hg_2I_2. This body has already been obtained in the crystalline form in the dry way, by heating in a sealed tube a mixture of iodine and mercury in the proper proportions, and in the wet way by boiling for several hours an excess of iodine with a saturated solution of mercurous nitrate and cooling slowly. The experimenter obtained the desired reaction by adding to a cold saturated solution of mercurous nitrate a very small proportion of methyl or ethyl iodide and agitating the mixture; at the end of one or two minutes a slight cloud was formed, which rapidly increased, then brilliant yellow crystals were formed abundantly and deposited on the walls of the vessel or collected at the surface. This compound, whose appearance resembles that of lead iodide crystals, is the mercurous iodide. Light decomposes it gradually, and iodide of potassium connects it into mercuric iodide. When heated in a capillary tube, it turns red near 70° C., and melts at 290° to a black liquid.

EXPERIMENTS OF M. MOISSAN.

M. Henri Moissan has lately succeeded in forming two new borides of silicon, having the formulæ $Si\ B_3$ and $Si\ B$. The experiments were made with the aid of M. Alfred Stock. A silicide of carbon has been formed by Schutzenberger, in an amorphous state, having the formula $Si\ C$, and the same compound, prepared by Mr. Acheson, was the point of departure for the carborundum industry. M. Moissan has already shown that the boride of carbon, CB_6, can be prepared in great quantities in the electric furnace. The silicide and boride of carbon have similar properties with respect to resistance to reagents and hardness; the former will scratch the ruby, but not the diamond, while the boride will in some cases scratch the face of a diamond. The analogy existing between carbon and silicon makes it possible that a like compound exists of boron and silicon. The experimenters tried at first to prepare the boride of silicon by a direct union of these elements, but the combination is only effected at a very high temperature, and the first attempts, with the electric furnace, were unsuccessful, as under these conditions the material of the containing vessel comes in to complicate the experiment. If a carbon crucible is used, boride and silicide of carbon are formed, and, besides the various gases, carbonic oxide and dioxide, nitrogen, etc., react upon the boron and silicon at this high temperature. Accordingly, a special disposition was needed; a tube of refractory earth was taken, 8 inches long and 2 inches diameter, whose ends were stopped by plugs of the same material, through which passed two carbon electrodes of 1 inch diameter. The distance between the electrodes at the center was 5 inches, and the tube had an opening in the side for putting in the mixture, consisting of 5 parts crystallized silicon and 1 part of pure boron. To assure the passage of current at first, the ends of the carbons were united by fine copper wires. The side opening was closed by a cover, and the whole well luted with refractory clay; the apparatus was then placed in a sheet iron box, surrounded by dry sand. An alternating current of 45 volts was used. This could be regulated at will. The heat lasted from 50 to 60 seconds, with a maximum current of 600 amperes. The electrodes were advanced as they burned off, to avoid forming an arc. The borides of silicon were thus formed in a bath of silicon in fusion, using the latter to conduct the current.

After cooling a melted mass is found, which is then broken into small pieces; these present the appearance of melted silicon. This substance is treated with a mixture of hydrofluoric and nitric acids, which dissolve silicon; the residue is washed with water and dried. From the mass, blackish crystals are separated by sifting, and these are placed in a silver crucible with melted potash, heated at the fusing point for half an hour; this dissolves out all the amorphous substances. After again washing and drying, the crystals are obtained in a pure state. These are blackish and quite homogeneous, with brilliant luster. They contain two different compounds of boron and silicon, as the experimenters have proved after a long analysis. One or the other of these may be dissolved out by the proper reagent; thus by treating the mixture with a great excess of boiling nitric acid, the form $Si\,B_3$ remains. If the mixture is melted with potash, this time quite free from water and at a high temperature, the former compound is destroyed, leaving the other, $Si\,B^6$. These two new compounds belong to the series of bodies formerly mentioned, and of which the silicide and boride of carbon have hitherto been the only representatives. Like these, they are very hard, and will scratch the ruby. The boride $Si\,B_3$ has a density of 2·52. It occurs oftenest in plates of rhombic form, black in color, which, when very thin, are transparent, with a yellow or brown tint. On the contrary, the boride $Si\,B_6$ is always found in thick crystals, opaque, and with rather irregular faces; its density is 2·47. These two bodies are conductors of electricity; when heated slightly they are attacked by fluorine with brilliant incandescence; chlorine attacks them at a red heat, but less degree, and bromine acts but slowly at a high temperature. Heated in air or oxygen, they oxidize with difficulty; nitrogen has no effect at 1,000° C. They are not attacked by the halogen acids and very slowly by boiling concentrated sulphuric acid. Nitric acid attacks rapidly the form $Si\,B_6$ and the other form more slowly. Anhydrous potash, when melted, attacks the form $Si\,B_3$ with great energy, sometimes with incandescence; the other form is decomposed slowly and at a higher temperature.

PARIS EXPOSITION—ELECTRICAL CONGRESS.

BY THE SPECIAL CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The International Congress of Electricity was formally opened on the 18th of August in the Palais de Congrès of the Exposition. The large hall contained an assembly of prominent electricians and engineers from all countries. The different governments had sent official delegates, as did the various scientific and technical societies, such as the Société Française de Physique, the Société Internationale des Electriciens, the Chamber of Commerce of Paris, the Elektrotechnisches Institut of Carlsruhe and the Berlin Electrotechnical Society, the British Institution of Electrical Engineers, the American Institute, and others. Upon the platform were the delegates and members of the committee. The opening address was delivered by M. Mougeot, Sub-Secretary of State in charge of the Postal and Telegraph Department. M. Mascart, the eminent French electrician, as President of the Organization Committee, delivered the principal address, of which the following is an abstract:

The Committee wishes to express its thanks for the manner in which the members have responded to its invitation; it is to be hoped that this Congress, in bringing together the different members will contribute to strengthen the relations which may have been formed in the past and create new ones. M. Mascart passes in review the work of the early scientists, Volta, Ampère, Faraday, Arago, and dwells on the prosperity which the science and industry has reached at the present time and the work it accomplishes in its various branches; the utilization of the forces of nature for the production of electric energy, the transmission of power to long distances, the revolution in the means of transport, the important work accomplished by the electric furnace in the production of rare metals and alloys, and the outlook for the future in this direction; he speaks of the electric light and the wonderful effects which have been produced at the Exposition, the telegraph and telephone, with the new systems of multiplex transmission, aerial telegraphy, and the applications of electricity in physiology and medicine; the new discoveries relating to radiations from Crookes tubes and from different substances promise to throw new light upon the constitution of matter. It is in this extensive domain that the deliberations of the Congress are to take place. At the first Electrical Congress, held at Paris in 1881, were united the scientists of all countries; among those present, whose loss is now to be regretted, were Helmholtz, Kerchof, Wiedemann, Hopkinson, Hughes, Siemens, Ferraris, and others. M. Mascart brings out the fact that important results accomplished by the first Congress were due to the spirit of good-will and of conciliation which prevailed, and hopes that the present Congress will carry on its work in a similar spirit.

After this address, which was warmly applauded, the list of officers was presented and adopted. M. Mascart was made President of the Congress and the list of Vice-Presidents included Messrs. Moissan, Kohlrausch, Sir William Preece, Prof. Perry, etc., and from the United States Messrs. Carl Hering and Kennelly. The Congress was divided into five sections, with a president for each: 1. Scientific methods and measuring apparatus; M. Violle. 2. A. Mechanical production and utilization of electricity; M. Hilairet. 2. B. Electric lighting; M. Fontaine. 3. Electro-chemistry; M. Moissan. 4. Telegraphy and telephony; M. Wünschendorff. 5. Electro-physiology; M. d'Arsonval. M. Mascart read a telegram from Lord Kelvin, regretting that ill health prevented his attending the Congress. Besides the five sections named, a commission has been formed of the government delegates which will examine questions of international interest. An extensive programme of visits and excursions was arranged. Prince Roland Bonaparte invited the members to a reception at his residence.

After the announcements had been made, Prof. Ayrton, delegate from the British government, expressed the thanks of the foreign delegates for their reception by the French government. This was followed by a similar address from Prof. Dorn, representing the German Empire.

MARCONI'S LATEST DEVELOPMENTS—SYNCHRONIZED MESSAGES.

At the annual gathering of the British Association for the Advancement of Science, in 1899, Prof. Fleming of University College, London, addressed the gathering upon Wireless Telegraphy, and incidentally mentioned that while transmitting messages from Boulogne to Dover they were read at Chelmsford some 118 miles from the point of transmission. This, undoubtedly, was a remarkable performance, but it also emphasized very forcibly one drawback which has long occupied the unremitting attention of Marconi. That is, the possibility of one or more stations reading a message intended for another. Such a circumstance naturally destroys the privacy of the message, and although it is not a very significant matter in the ordinary way, yet it would be a very serious drawback, in case of war, for one belligerent to be able to intercept and to read a message that was being transmitted between the vessels of the other belligerent. Marconi quickly realized the serious nature of this disadvantage, and at his station at Poole, in Dorsetshire, England, he has been endeavoring for a long time past to successfully synchronize his messages—that is, to construct a transmitter, the message sent from which can be only received by the apparatus which has been tuned to receive it.

He has successfully solved the problem, by means of variable conductors and capacities, by the use of which certain instruments can only receive certain messages. By his latest system, Marconi can dispatch from a certain point any number of messages, and each message will be received only by that receiver that has been synchronized to the transmitter, so that jamming of words and confusion of messages upon the various receivers are obviated.

Marconi has set up his station at Poole, because that place is so remote and he is safe from interruption. Twenty odd miles away across the Solent is another station at the southwestern corner of the Isle of Wight. Between these two points messages are being transmitted throughout the day, almost without cessation, and this is how several important discoveries and improvements have been made by the inventor. While experimenting with his sychronizing system, Marconi had several opportunities of proving the capabilities of his device. At Portsmouth the English Admiralty were carrying out experiments with wireless telegraphy in connection with the fleet, and naturally several of these ether waves crossed Marconi's line of transmission between Poole and the Isle of Wight, the effects of which upon his instruments the inventor regarded with the utmost satisfaction, since they proved that he had finally surmounted the most perplexing disadvantage of his system.

Marconi has also made some other important discoveries. He now utilizes cylindrical tin cans, about five feet in height, in lieu of the vertical wires, since they furnish more convenient capacities and radiators. He is lengthening the distance over which messages may be transmitted, and although his experiments at Poole can be conducted only on a limited scale, yet he is confident that when he works upon a larger station, they will be equally successful, and there is no doubt but that many important developments in ether telegraphy will be divulged in the near future.

At the present moment Marconi has a sufficiency of work on hand. The North German Lloyd Steamship Company are having one of his systems installed at Berkum (Germany), to be used in connection with their fleet of vessels. Apropos of this, Marconi has been carrying out many experiments with a view to applying the system practically to shipping, so that greater safety may be assured to vessels at sea. Then the International Company of France are having the coast of that country, metaphorically speaking, lined with his installations, so that communication may be maintained between the vessels of the French Navy and any point of the mainland, which would play an important part in case of a war between England and France, since by this means the latter nation could manipulate their troops according to the information received from their battleships, and thus be able to work the land and sea forces hand in hand. Then six stations are being set up in the Hawaiian Islands and will soon be in working order. Many vessels in the English Navy are also having the system installed.

EXPLOSION OF A NAPHTHA LAUNCH.

The recent explosion on a naphtha launch at New Rochelle, N. Y., in which two persons lost their lives and a third was severely if not fatally injured, again emphasizes the need of greater care both on the part of the boat-builder and the boat-owner. The launch in question was built on the usual lines of small, vapor-motor boats. In the stern the engine was placed, to which naphtha was fed by pipes leading from a storage-tank in the bow. For some time this tank had been in a leaky condition; and the oil that escaped was a source of constant danger to the occupants of the boat. A time at last came when the vapor from the leaking oil happened to mingle with the air in the lockers or recesses in just the right proportions to explode, if the proper degree of heat, say, from a lighted cigar or a match was presented. Whether the explosion at New Rochelle was thus caused, it is at present impossible to ascertain; but that the catastrophe would have been averted if the storage-tank had been repaired in due season, seems reasonably certain. Although launches, as a rule, are constructed with great care, a due regard for the safety of negligent purchasers should induce boat-builders still further to reduce the danger of explosions. In launches in which the vaporized naphtha is led back and condensed at the source of supply, the storage-tank is inclosed in a water and air-tight compartment. Although there may be apparently no reason for similar precautions in launches of the non-condensing type, and although the leakage of a properly-made storage-tank is of rare occurrence, the water-tight compartment should, nevertheless, be employed, for reasons which the New Rochelle explosion have brought home forcibly enough.

ACCUMULATORS WORKING UNDER WATER.

The municipal electric plant of Munich furnishes the remarkable case of a battery of accumulators which continued to work when submerged under water. The station is situated on an island formed by the Isar, and during the inundations of last year was partially submerged. The batteries of accumulators, which were on the ground floor, were first reached, and were soon entirely covered. One of the batteries was used on the city lighting circuit, and the other was connected in parallel with the dynamos for the traction system. As the tramway service had to be discontinued, the second battery was removed from the circuit, and it was thought that the batteries for the lighting circuit would also have to be cut out, as the fly-wheels of the engines were half under water, except two. Nevertheless, as it was almost indispensable to light at least the principal streets of the city, it was decided to try to operate the submerged battery. The attempt was successful, and the battery, which had been constructed to give 6,000 ampere hours with a 600-ampere discharge, was able to furnish 4,000 ampere hours during the night; the remainder was lost in discharges in the water. Encouraged by this success, the engineers charged the battery on the following day, and the discharge was repeated under the same circumstances. Two days after the water had lowered sufficiently to give access to the battery rooms; it was found that the density of the acid had fallen, but not to a very great extent; from 22° B. it had fallen to 20° B. only. It is thus seen that there was scarcely any diffusion. Outside of a layer of mud a quarter of an inch thick upon the top of the plates and the connecting rods, the inundation had left scarcely an appreciable trace. It was supposed at the beginning that it would be necessary to replace the acid of the batteries, which represented a considerable expense, as they contained more than 30,000 gallons; but as the acid held its strength, as shown above, a slight strengthening was all that it required.