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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.

RAILROAD CONNECTIONS WITH MANHATTAN ISLAND.

There are two great engineering schemes, both vitally affecting the interests of Manhattan Island, which, thanks to one of the greatest railroad companies in this country, appear to be within measurable distance of construction. The greater of these is the proposed railroad bridge across the North River from Hoboken to Twenty-third Street. The other scheme is the proposed Long Island Railroad tunnel, which is to extend beneath the East River from the Thirty-fourth Street terminal of the Long Island Railroad Company to a terminal which will be located conveniently to the proposed terminus of the bridge. The construction of a 3,000-foot span, eight-track railroad bridge across the North River, with its costly approaches and terminals, is such a heavy financial undertaking that no private company would be capable of raising the necessary $60,000,000 or more for its construction. It has also been realized, especially during the last few years, that unless the North River Bridge is indorsed by one or more of the great railroad companies which have their terminals in New Jersey, the chances of its being built are slight. It has recently transpired, however, that at least one of the leading officials of the Pennsylvania Railroad is a director of the North River Bridge Company, and there are evidences that this powerful corporation has now taken hold of the scheme with the intention of putting it through.

The proposed tunnel beneath the East River will give the trains of the Long Island Railroad system a terminal station on Manhattan Island; and as the Long Island system has lately passed under the control of the Pennsylvania Railroad Company, it will be seen that the completion of the bridge and the tunnel will place the company in a very advantageous position as regards terminal facilities on Manhattan Island itself. In this connection also, it should be borne in mind that the company has purchased the franchise of the New York Connecting Railroad Company, which has the right to construct a railroad from a point on the main line of the Long Island road across Ward's Island and Randall's Island to a terminus within the Borough of the Bronx. Almost simultaneously comes the announcement that actual construction has commenced on a line of railroad which will connect Staten Island with Brooklyn, the line passing beneath the Narrows by means of a double tunnel. Although the Pennsylvania Railroad Company is not quoted as being directly interested in this scheme, a glance at the map will show that a connection between the main line of this road and Staten Island by a bridge across the Kill von Kull would provide an all-rail route from Philadelphia to Boston by way of Long Island and avoid the present ferriage from Jersey City, by way of the East River, to the station of the New Haven Road upon the Harlem.

There seems to be a consensus of opinion among those who are practically interested in the distribution of freight at the port of New York, that there would be no advantage in bringing freight trains across the river for distribution by rail on the Manhattan water front. It is claimed that by the present system of car floats the distribution is accomplished more speedily and with less interruption in the general traffic of the city than it could be if freight trains were brought over the Hudson by bridge and handled in the manner proposed by the New York and New Jersey Company. The new Twenty-third Street bridge will be used almost exclusively for passenger traffic. So large is the number of passengers now carried both on suburban and long-distance trains, and so rapid is the increase, that the capacity of the proposed bridge, enormous as it will be, may prove to be none too large by the time the great structure is opened.

AMERICAN LOCOMOTIVES IN ENGLAND.

Amid the considerable amount of discussion which has been aroused by the recent report upon the American locomotives on the Midland Railroad, the best statement has come from the pen of Mr. Charles Rous-Marten, than whom there is no better qualified critic upon the comparative efficiencies of various types of locomotives. Mr. Rous-Marten is well known in every part of the world where locomotives are to be found. He makes it his specialty to ride upon the foot-plate or in the cab of almost every new locomotive that has qualities of novelty or efficiency that render it worthy of special comparison with the standard locomotives already in use. This gentleman recently communicated to The Engineer an article which we reproduce in the current issue of the SUPPLEMENT. As the paper contains the observations of a man who is perfectly familiar with the work of both English and American locomotives, and who is noted as an unbiased observer, its conclusions have particular value in the present discussion.

In the first place, we gather that the test was most carefully carried out by Mr. Johnson, the Locomotive Superintendent of the Midland Railroad; that it extended over a period of six months; and that it was instituted specifically to learn what the respective merits of the two types, American and English, would prove to be under the same conditions. A superior economy was shown on the part of the English engine of twenty per cent to twenty-five per cent in fuel; fifty per cent in oil; and sixty per cent in repairs as the result of the six months' trial. At the same time the Superintendent reports that the "foreign engines worked their trains satisfactorily." Mr. Rous-Marten emphatically condemns the attitude of the non-technical press of England in taking the results of the Midland trial as proving that American locomotives, as such, are broadly inferior to those of British make. In reply to the question, "Is it not a fair comparison to have both engines made as nearly as possible of practically identical power and then to try them together on identical work?" Mr. Rous-Marten, who, by the way, is an Englishman himself, replies: "No, it is not; unless it be clear that each class of engines is the one that would be used ordinarily for the same work in the land of its origin." The Midland freight engine is the outcome of Mr. Johnson's many years of experience in judgment as to what is the best type of engine to haul a 560-ton coal-train over the Midland line; and it does the work at a low cost for fuel, oil and repairs. Now, although the American locomotives were ordered to be built of the same power as the Midland standard freight engines, "it must be noted," says Mr. Rous-Marten, "that the order to the American firms was not that the locomotives were to be of the class and power that would be employed in America to do the work required;" and just here comes in the disadvantage under which the American locomotives were laboring. If the maximum load to be hauled had been stated in the contract, and the American locomotive builders been allowed a free hand as to the size and power of locomotives which they would offer to do this particular work, they would have turned out, according to Mr. Rous-Marten, very different machines than those which were actually sent over. Thus, instead of locomotives with 18 x 24-inch cylinders and 1,200 to 1,300 square feet of heating surface, and 160 pounds of steam pressure, the American builders would probably have sent over an engine with from 1,750 to 2,500 square feet of heating surface and 180 to 200 pounds steam pressure. In other words, according to the author of the paper, American locomotive practice is based upon the principle of allowing a liberal margin of power, whereas the English locomotives, in this case at least, were designed to do just the exact amount of work specified in the contract. The argument is summed up in the statement: "Therefore the recent Midland trial only proves that identical dimensions for identical work will not suit engines of totally different designs and modes of construction."

The fact of the matter is that the question stands where it was before this trial. It is fully admitted by American builders that as a piece of high-class workmanship, the English engine cannot be improved upon for the work it has to do on English roads. But while it is granted that the English engine is longer lived, it is a question whether there is any ultimate advantage in prolonging the life of a locomotive beyond its actual period of usefulness. Here in America we have learned that the conditions of transportation change so rapidly that the ideal locomotive of one decade may have outlived its usefulness in the next. The English always aimed at a high theoretical performance in their locomotives, and unquestionably they have secured it; but they have secured it at the expense of certain elements which go to make up successful railroad operation. If there were less expensive finish on the engines, and less successful effort to prolong their life beyond the period at which, in this country, they would be sent to the scrap heap, it is quite possible that the shareholders of the English railroad companies and the traveling public themselves would be gainers.

HEIGHT OF OCEAN WAVES.

There has been a good deal written lately about the height of ocean waves. An article in our contemporary Knowledge has been largely quoted, in which the writer gives some very interesting figures regarding observations made in the South Indian Ocean, between the Cape of Good Hope, and the Isles of St. Paul and New Amsterdam, this being a region where westerly winds prevail almost without a change the year around. It was in this locality that the highest waves on record, according to the writer, were observed, the measurement of thirty waves at various times during the day showing an average height of 29.63 feet, the largest of observed waves being 37.53 feet in height. Lieut. Paris, who made the observation, had to climb to the twenty-second rung of the shrouds before he obtained the level of the crest.

In these days of colossal steamers, with towering superstructures, it is not necessary to do any climbing of the shrouds to observe the height of the waves. Going from deck to deck, the passenger, with a little experience, can find a position in which sitting or standing the crest of the highest waves will just coincide with the line drawn from his eye to the horizon. He can probably ascertain from one of the officers of the ship what is the height of the deck on which he is standing; adding to this the distance from the deck to his eye, he can obtain a fairly approximate estimate of the height of the waves. In making an estimate of this kind, however, care should be taken to make the observations when the vessel is in the trough between two big seas, and on a fairly even keel, the observer standing amidships and as near as possible to the center line of the vessel. The upper deck of the biggest of the Atlantic steamships is from 30 to 32 feet above the normal waterline, and it is very rarely, even in the heaviest Atlantic storms, that the crest of a wave will reach the height of the observer's eye. When it does, it is probable that the ship herself is moving over one of the cross seas which frequently intersect the regular line of Atlantic rollers.

Perhaps the most accurate gaging of the height of ocean waves ever carried out was that which was recently discussed in a paper before the Institution of Civil Engineers of Great Britain by William Shield, who gave the results of observations made during a storm at Peterhead, North Britain, when the wind varied in velocity from 50 to 90 miles an hour. The method of observation was as follows: Sights were taken along the breakwater with a view to ascertaining the height of the waves as they ran into the bay between the breakwater and the opposite shore. The water along the line of the sights was from 60 to 63 feet in depth. The sights, which were 6½ feet in height, were placed at intervals of 120 feet along the coping of the breakwater, the level of which is 22 feet above low water. As the tide-gage registered 9 feet at the time the observations were taken, the line of sight must have been 19½ feet above still-water level. According to Mr. Shield, wave after wave passed by carrying an unbroken crest at least 3 feet above the line of sight and, therefore, 22½ feet above the still-water level. The wave-period varied from 13 to 17 seconds, and the length of the waves between 500 and 700 feet. Assuming that the troughs of the waves were as far below the still-water level as their crests were above it, the height of the waves would appear to have been 45 feet; but it is recorded that the flatness of the trough curve as compared with the curve of the crest seemed to indicate that the height of the crest above and the depth of the trough below the still-water level were not identical. It was considered by the author of the paper that the crests of the waves were to some extent raised by the friction of the sea-bed. Hence, it was estimated that, on the ground that the volume of water above the still-water level must correspond with that of the trough below it, the height of the waves from trough to crest closely approximated to 40 feet. These figures, it will be observed, are greater than those recorded as having been observed in the South Indian Ocean and elsewhere, due allowance being made for the tendency of the waves to become steeper and loftier as the friction of the sea-bed tells upon them.

SELENIDES OF COBALT.

M. Fonzes-Diacon has been carrying on a series of experiments relative to the combinations of selenium and cobalt, and has succeeded in forming a number of new compounds, the selenides of cobalt, which are analogous to the series of selenides of nickel recently described before the Academie des Sciences. The only previous preparation of the selenide of cobalt is that of Little, who formed a melted protoselenide by the action of selenium upon cobalt heated to redness. The protoselenide was the first body obtained by M. Fonzes-

Diacon, who was, however, unable to produce it in the crystalline state. The action of selenium vapors upon cobalt causes the metal to become covered with a gray deposit which is easily detached and corresponds to the formula CoSe; it is an amorphous body. The oxide of cobalt is also transformed to the same compound by the action of hydrogen selenide at a bright red heat. The sesquiselenide of cobalt was the second of the series formed by the experimenter. At low redness, hydrogen selenide reacts upon anhydrous chloride of cobalt and transforms it to sesquiselenide; this body has the form of a gray melted mass, and analysis gives it the formula Co_2Se_3. Another selenide having the formula Co_3Se_4 is obtained in the crystalline state by heating chloride of cobalt to low redness in a tube and passing over it a current of hydrogen selenide drawn through by a current of nitrogen charged with vapors of hydrochloric acid. At the end of the operation a brilliant crystalline mass is obtained, of gray-violet color, which under the microscope appears in fine octahedra, isolated, of the cubic system. The crystals have the formula Co_3Se_4 and are thus isomeric with the mineral linneite, having the same composition. Its density at 15 degrees C. is 6.54. The biselenide of cobalt was next found by the reaction of hydrogen selenide upon anhydrous chloride of cobalt considerably below a red heat, and the latter is transformed into a brittle mass of gray-violet color, having the composition $CoSe_2$. It easily loses selenium by the action of heat. The different selenides mentioned are partially reduced when heated to bright redness in a current of hydrogen and a silver white and brilliant mass is formed, which has the formula Co_2Se, being a subselenide. The experimenter then describes the properties of the new selenides. When reduced to powder they are slowly attacked by hydrochloric acid vapor at low redness, and the strong acid has but little action, even at the boiling point. Bromine water dissolves them easily; when heated in a current of oxygen they give rise to selenious anhydride and oxide of cobalt. Hydrogen, at a red heat, transforms them to subselenide, which by a prolonged action loses a further proportion of selenium. The oxyselenide is another new body formed in the experiments; seleniate of cobalt heated in a current of hydrogen is at first partially dissolved with loss of selenious anhydride and water, then at a higher temperature, below redness, a reduction takes place with the formation of a greenish-gray powder containing variable quantities of selenium and cobalt and also of oxygen. If the reduction takes place at a low red heat a black magnetic powder is formed, which is a mixture of metallic cobalt and its selenide. Lastly, at a white heat a gray and porous mass is obtained, which consists of metallic cobalt containing small quantities of selenium. As a result of these experiments it is found that cobalt will combine with selenium, forming four different bodies according to the conditions of temperature—$CoSe_2$, Co_2Se_3, Co_3Se_4, CoSe. At a high temperature these bodies are transformed by hydrogen into the subselenide Co_2Se. The seleniate of cobalt, reduced by hydrogen, gives oxyselenides or mixtures of selenide and metallic cobalt, according to the temperature.

COKE AS A SUBSTITUTE FOR ANTHRACITE COAL.

BY ALTON D. ADAMS.

Deposits of anthracite coal, thus far worked in the United States, are of smaller extent and much more concentrated geographically than are those of the bituminous varieties. Statistics of coal production show the influence of these conditions, in an annual output of bituminous fully three times as great as that of anthracite coal for the entire country. The average value of the bituminous coal at the mines is only about one-half as great per ton as that of the anthracite. Moreover, the annual supply of bituminous coal is capable of a much larger increase, without raising the price per ton, than is the case for anthracite. Over a large part of the country the uses to which the two varieties of coal are applied are in large measure distinct. Anthracite generally has the decided preference for residences and in city buildings, while bituminous coal is much more extensively used in industrial operations. Railway locomotives consume large amounts of both hard and soft coal, some roads using one and some the other variety, but the anthracite is much the more satisfactory, because of the great reduction of smoke and cinders where it is used. The limited area and amount of anthracite coal deposits, the difficulty of the mining operations, over those of soft coal, and industrial conditions that frequently result in strikes on the part of the miners, all tend to render the supply of anthracite coal to some extent uncertain. Considering the comparatively high price of hard coal and the elements of uncertainty in its supply, it seems that some substitute for it, free from these objections and also from the disadvantages of soft coal, would be of great advantage to the public. It is evident at the start that any substitute for anthracite that is to have extensive use must be derived from bituminous coal, since natural gas is only available over a limited area and is failing in quantity, while the supply of petroleum is too small in total amount and its price too high, to admit of its general application to fuel purposes. As is well known, soft coal suffers by comparison with hard, because the former is not as readily burned in ordinary stoves and furnaces, and unless special precautions are taken gives off on combustion a dense black smoke. If these undesirable properties can be removed from soft coal or its products, without too much expense, a cheap and desirable substitute for hard coal may be provided. The different results attained in the combustion of anthracite and bituminous coals are mainly due to their chemical compositions. Good anthracite coal consists, on an average, of about 88 per cent fixed or solid carbon, 4 per cent volatile matter, in the form of hydrocarbons, and 8 per cent ash. An average value for the composition of bituminous coal is approximately 60 per cent fixed carbon, 32 per cent volatile matter and 8 per cent ash. The main difference between hard and soft coal, is thus the presence in the former of a much larger proportion of fixed carbon and but a fraction of the volatile hydrocarbons that are found in the latter. It is the presence of this large per cent of hydrocarbons in bituminous coal that interferes with its satisfactory combustion in ordinary stoves and furnaces, besides producing the black smoke and soot that are mixed with the air in most places where soft coal is extensively used for fuel. The fact that the hydrocarbons found in soft coal can be driven off by heat, leaving the fixed carbon in solid form, is taken advantage of for two distinct purposes, the production of coke for metallurgical uses, and the supply of illuminating gas. The distillation of bituminous coal in each case produces both gas and coke, but where the main object is to obtain coke, the gas is usually wasted, while in the manufacture of illuminating gas the by-product coke is somewhat inferior in quality for metallurgical uses. A good grade of coke is a very satisfactory fuel for general use in almost all kinds of stoves and furnaces, as well as for special purposes in the industrial arts. As coke is even more nearly composed of pure carbon and ash than is anthracite coal, its employment entirely avoids the smoke nuisance. A sufficient supply of good coke at competitive prices would render private consumers, large city buildings, and such railways as require a smokeless fuel, to a large extent independent of anthracite coal. Such a coke supply would not do away with the use of anthracite coal, but would divide the market with it, and expand in use whenever the production of hard coal was restricted by any unusual cause. While there is an almost unlimited field for the solid product of the distillation of bituminous coal, the gas developed seems equally certain to find a demand beyond any probable production for many years to come. It is quite certain that the present use of illuminating gas for fuel and power is held in check by the comparatively high prices of energy from this source. A large reduction in the present rates for gas would result in a great increase of its use for heat and power.

One ton of fairly good gas coal may be taken to yield, when treated in retorts, 10,000 cubic feet of gas and 1,300 pounds of coke on an average. About 300 pounds of coke, when used as fuel for the retorts, are required to distill one ton of coal, so that the net products of gas and coke are 10,000 cubic feet of the former and 1,000 pounds of the latter per ton of coal. In addition to the coke and gas, each ton of average coal yields about 120 pounds of tar and 200 pounds of ammonia liquor. The accounts of quite a large number of gas companies show that more than one-half of their total outlay for coal is recovered by the sale of coke, tar and ammonia. Allowing that only one-half of the cost of the coal consumed is received for the residual products of gas manufacture, the net outlay for coal to produce a thousand cubic feet of gas is obviously very small. For example, if gas coal costs three dollars per ton, and one-half of this amount is recovered for the by-products, the net charge for coal against the 10,000 cubic feet of gas obtained from one ton is $1.50, which corresponds to fifteen cents per 1,000 cubic feet.

The wide difference between this last figure and the current charges for gas includes the cost of enrichers, the various items in manufacture, such as labor, interest, depreciation, repairs, distribution charges and profits. If the gas is not enriched, the entire cost of oil, some of the plant equipment and a part of the labor item are saved. The result is a gas of about ten per cent smaller heating capacity than the enriched product usually distributed, but of a much larger reduction in cost. It seems evident from these facts that a large plant, producing coke and simple coal gas, would be able to offer both the gas and coke at prices decidedly lower than are charged by existing plants that operate primarily for the manufacture of enriched illuminating gas, a product that necessarily can find only a comparatively limited demand, at the rates for which it must be sold. Such cheap gas and coke would supply much of the demand now met by anthracite coal.

SCIENCE NOTES.

A Dublin firm has produced a typewriter writing Irish characters.

It is said that the trials of the flying machine which has been under construction for some time by Denny Brothers have been satisfactory, showing that the principle is all right but the motive power is inadequate. The machine is 40 feet from tip to tip of the wings, and the weight, including that of the two aeronauts, is about 600 pounds.

The density of population in foreign countries has recently been computed. Great Britain takes the lead with 132 inhabitants per square kilometer, which is equal to 0.3861 square mile; then comes Japan, 114.4; Italy, 106.6; the German Empire, 104.2; then comes Austria, 87; Hungary, 59.6; France, 72.2; Spain, 35.9; the United States, 8.4; Russia, 5.9.

Twenty thousand dollars has been collected for a statue of Virgil at Mantua, Italy, his birthplace. This city formerly had a statue of him, but it was destroyed in 1397, so that for over five hundred years the great Latin poet has been without a monument. A portrait of him was discovered in Tunis two years ago, so that the monument of Mantua ought to be a correct representation of the author of the "Æneid."

Dr. H. S. Gaylord, of the University of Buffalo, states that cancer is caused by an animal parasite which has been identified and isolated. He has been investigating the cause of cancer for two years as head of the New York State Pathological Laboratory. He has inoculated animals with cancer germs, and cancer afterward developed in the animals. Cultures of these organisms have been injected in the abdominal cavities of other animals and they recovered, having apparently grown in the serum of the animal.

An instance of the inexplicable conservatism and arrogance of the Turkish customs authorities was recently evidenced by the prohibition of the importation of typewriters into the country. The reason advanced by the authorities for this step is that typewriting affords no clew to the author, and that therefore in the event of seditious or opprobrious pamphlets or writings executed by the typewriter being circulated it would be impossible to obtain any clew by which the operator of the machine could be traced. A large consignment of 200 typewriters was lying in the custom house at the time the above law was passed, and as there is no apparent possibility of the authorities repealing their ridiculous decree, the machines will have to be returned. Efforts are being made by the various embassies to induce the authorities to assume a more reasonable attitude. The same decree also applies to the mimeograph and other similar duplicating machines and mediums.

The American branch of the Society of Psychical Research of Boston has issued a circular for the sentiment of people regarding a future life. They are desirous of obtaining statistics on this subject. The questions which they ask are, first, would you prefer to live after death or not; second, do you desire future life whatever its conditions may be? If you do not prefer to live after death, what would the character of the future life be to make the prospect seem tolerable? Would you, for example, be content with a life more or less like your present life? Can you state what elements in life were felt by you to call for its perpetuity? Third, can you state why you feel this way, as regards questions one and two? Fourth, do you now feel the question of a future life to be of urgent importance to your mental comfort? Have your feelings on questions one, two and four undergone change? If so, when, and in what way? Sixth, would you like to know for certain about the future life, or would you prefer to leave it a matter of faith?

Ordinary gypsum is brittle, porous, hygroscopic and by the absorption of water becomes a good electrical conductor, but in the hardened condition it is useful for parts which do not require to withstand powerful tension or high and sudden changes of temperature. Gypsum may be hardened by the following methods: (*a*) The powdered gypsum is intimately mixed with 2 to 4 per cent of powdered marshmallow root and with 40 per cent water kneaded to a paste. After an hour the mass is so hard that it may be filed, cut, or bored; an addition of 8 per cent marshmallow root powder makes it thicker. Marshmallow root powder may be replaced by dextrin, gum arabic or glue. (*b*) Gypsum, 6 parts, is mixed with freshly slaked lime, 1 part, and when the required shape is made it is moistened with a concentrated solution of magnesium sulphate. (*c*) The gypsum, after burning, is digested with 10 per cent solution of alum and after drying again burnt; on the addition of water the gypsum crystallizes to a marble-like mass, the so-called marble cement.—Pharm. Centralh., 41, 779.