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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.

AT LAST A 25-KNOT LINER.

Twenty-five knots an hour has for some time been recognized as the maximum speed which, in the present condition of the shipbuilders' art, it would be possible to secure in a big ocean steamship. Indeed, it was only when the marine steam turbine began to reveal its possibilities, that the creation of a 25-knot liner began to take shape in the mind of the naval architect. Congratulations are due to the Cunard Steamship Company, as being the first to place in service a ship of this maximum speed, particularly when it is borne in mind that to the distinction of being the fastest, the new flyer adds also those of being the largest, the most commodious, and the steadiest ship afloat.

In the "Lucania" and "Campania," now twelve years old, the possibilities of the multiple-expansion reciprocating engine for the development of high speed in ocean liners received a striking illustration, one of these ships having crossed the Atlantic at an average speed of slightly over 22 knots an hour. Then the German companies, with all the valuable data acquired in several years' service of these ships at command, and incorporating such improvements in engines and speed lines as their own undoubted talent suggested, brought out that magnificent quartette of boats, the "Deutschland," "Kaiser Wilhelm I.," "Kaiser Wilhelm II.," and "Kronprinz," the fastest of which added 1½ knots an hour to the transatlantic record, —the "Deutschland" and the "Kaiser Wilhelm II." having averaged 23½ knots an hour for the whole trip across the ocean. In their latest ship, the "Kronprinzessin Cecelie," a sister ship to the "Kaiser Wilhelm II.," the North German Lloyd Company, in spite of the fact that the two new Cunarders were under contract to develop a speed of 25¼ knots, decided, much to the surprise of a large section of the naval architects of the day, to equip their new boat, not with marine turbines, but with quadruple-expansion engines of the same type as those in the "Kaiser Wilhelm II.," of which they are practically a duplicate. The contract speed of the ship is the same as that of its predecessor, and she will be capable of equaling, if not somewhat exceeding, the 23½-knot average ocean speed of the sister ship.

That the "Lusitania" will be a 25-knot boat is now established by telegraphic dispatches from Liverpool, announcing that on the official trial, which lasted forty-eight hours, the ship maintained an average speed of 25¼ knots for a continuous run of 1,200 knots. This is certainly the most severe trial test to which any ship, either in the navy or the merchant marine, has yet been subjected. Considering that the engines are new, and the crew not yet accustomed to the ship, it is reasonable to expect that, after she has made a few voyages, the "Lusitania" will be able to maintain an average speed of 25½ knots under normal conditions of wind and sea. Steaming at 25¼ knots, however, she will bring the transatlantic record for the first time below five days—by just how much remains to be seen.

COLORADO DAM IS PERMANENT.

The sixty-foot dam which last winter was thrown hastily by the engineers of the Southern Pacific Railway across the break in the Colorado River banks, was recently subjected to a prolonged and searching test, through which it has passed most successfully. For over three weeks this work and the levees on either side of it were subjected to the greatest June flood on record, without developing any sign of weakness. The engineers, in spite of the violence of the flood, had no fears for the safety of the dam itself, but they realized that there was a possibility of the water passing around the end of the levee and attacking the canal in the rear. Fortunately, however, the Colorado River itself averted that danger, by deepening its old channel, and swinging it over away from the dam to the Arizona shore. The absolute safety of the dam against overflow was shown by the fact that at the period of highest water, the lowest point of the structure was always seven feet above high-water mark.

In anticipation of emergencies, the Southern Pacific Company, to whose prompt action is due the credit for the successful closing of the river, have built a railroad along the crest, from the head gate to the end of the levee. A telephone runs the entire length, with stations a mile apart. During the time of high water, men patrol the work on gasoline track velocipedes, so that if there is any indication of weakness, they can telephone to the heading, where a trainload of rock stands ready to be rushed to the breach. Although the break of the banks has been thus permanently repaired, water is still flowing into the Salton Sea by way of New River, passing down the Paradones to Volcano Lake, whence a portion of it flows northward through New River to the Salton Sea. This inflow, which is about 1,500 second feet, serves to compensate for the surface evaporation of the sea and causes its level to remain about stationary. The security of the Imperial Valley, with its wonderfully fertile lands and many settlers, is thus assured, and the greatest credit is due to the engineers of the Southern Pacific Railroad for carrying through this hazardous and difficult work in so short a period and with results that will probably stand for all time.

IS RUSTING ELECTROLYTIC?

Among the many valuable contributions to knowledge by the United States Department of Agriculture, one of the most important is that which was made public at the recent meeting of the American Society for Testing Materials, in which were announced the results of an investigation which the society has been carrying on for many years past, to determine the causes of the corrosion of iron. The most radical statement contained in Dr. Cushman's paper is that oxygen is not the primary but merely a secondary cause in the rusting of iron, and that the best protection against rust is the use of chromic acid and its salts for the treatment of the iron—that is to say, one of the most active oxidizing agents known to chemistry will be found to be one of the best preventives of rust. Startling as this assertion is, the experimental work, and the deductions therefrom which have led to this conclusion, have been accepted by the leading specialists in this field of investigation. A notable indorsement of the paper was that by Dr. Charles B. Dudley, who did not hesitate to designate it as the most important contribution of the kind that has been made in the last twenty-five years. The investigation which resulted in this important discovery was undertaken with the object of discovering some method of preventing the corrosion of wire fencing—a subject of most vital interest to the farmers of this country. Hitherto, it has been commonly held that the formation of rust was due to the action of carbonic acid, resulting in the formation of carbonate, which, in its turn, is acted on by water and the oxygen of the air in the formation of rust or red hydroxide, the carbonic acid being set free by this last reaction to carry on again its work of destruction.

According to Dr. Cushman's theory, the first attack on the iron is made by hydrogen in the form of the hydrogen ion, and not, as the text books have taught us, by oxygen. This is in agreement with the modern theory that many substances, when they are dissolved in water, are dissociated into ions, or atoms carrying static electrical charges. Even pure water contains a certain number of these, and the presence of acid impurities multiplies the hydrogen ions and strengthens them in their corrosive effect upon iron. The action is explained as being purely electrolytic, and as involving an exchange of the electrostatic relations between the hydrogen and the iron. Dr. Cushman discovered that active oxidizing agents, such as the chromate and bichromate of potash, prevent rusting by polarizing the iron to the condition of an oxygen electrode, thereby safeguarding it against attack by the hydrogen ion. He found that by immersing the iron in a concentrated solution of bichromate acid, and then washing and wiping it, the metal is rendered passive, so that it becomes capable of resisting electrochemical attack. The action of rusting is completely analogous to that which takes place if iron is placed in a copper salt solution. In this case, copper ions, carrying positive electrostatic charges, are present; iron passes into solution and assumes the electrostatic charge, while the copper plates out and becomes visible. Correspondingly, when rusting takes place, iron passes into solution, while hydrogen plates out. Once in solution, the oxygen of the air oxidizes the iron to the insoluble form of the red hydroxide commonly known as rust. It would be difficult to overestimate the practical value of the discovery here outlined, which will have a most important bearing, not alone upon the structural work of the civil engineer, but also upon many forms of iron and steel construction included in mechanical engineering.

CAUSE AND CURE OF SPLIT RAIL HEADS.

Apropos of our reference to the meeting of the American Society for Testing Materials, mention should be made of the paper of Dr. P. H. Dudley dealing with steel rail sections. Probably there is no one in the United States, if indeed in the world, who speaks with such authority upon this subject. The doctor makes his home in a special car equipped with apparatus for determining the condition of the track over which the car is drawn, and the voluminous records which have been thus obtained are probably the most valuable practical contribution to our knowledge of the action of traffic on track, in existence. Dr. Dudley has ever been an ardent advocate of the use of rails of greater weight and deeper section, and in the paper referred to, he shows how great is the benefit secured from a comparatively slight increase in the height of the rail sections, in the way of giving a better distribution of the concentrated wheel loads. To raise the bearing surface of the rails from ½ to 1½ inches higher above the crossties than that of the earlier sections may seem a small increase, in the sense of dimensions; but when this slight increase is utilized in the design of the sections of rails, with a corresponding increase in the proportions of metal used, the mechanical advantages obtained in the way of enabling the rails to better carry and more broadly distribute the heavier modern wheel loads, represent an increase in the capacity of the rails of from 50 to 200 per cent. The depression of the deeper and stiffer rails, in spite of the increased wheel loads, is only from ⅛ to ⅜ of an inch, as compared with a ⅝ to 1 inch deflection under the earlier light and limber rails. The stiffer rail, moreover, has the advantage of distributing the wheel loads over a wider surface of track. The small bending resistance of the limber rail permitted the effect of the load to pass directly to the tie immediately beneath it, with the result that the crushing down of the tie occurred early in its life. The deep 5 and 6-inch rails, because of their high bending resistance, distribute the wheel loads among several adjoining ties, with a consequent lessening of the cutting action and a prolongation of their life.

Although wheel loads have increased only 100 per cent as against an increase in the stiffness of the rails reaching as high as 200 per cent in some cases, there has been a great increase in the number of breakages of rails in the corresponding period. Dr. Dudley has always attributed, and does so in this paper, the inferior quality of the rails to the hurrying-up, which has taken place in late years, of the process of manufacture, and particularly that part of it which has to do with the "blowing" of the metal in the converters. Sufficient time is not allowed to elapse, after recarburizing the blown metal, for the complete chemical reactions to take place, and for the slag to escape from the body of the metal. The slag, oxides and gases are often entrained instead of being eliminated, the chemical reactions being only partially completed while the steel is setting in the ingot mold. The slag and occluded gases, coupled with the segregated metal, are important factors in causing the heads of rails to split. The split rails develop after shorter or longer periods of service, the life of the rail depending upon the thickness of good metal between the surface of the rail head and the slag and occluded gases contained in the body of the rail. Split heads are not confined entirely to the rails rolled from the top of the ingot, but are found in less numbers in rails which have been formed from the body of the ingot.

Dr. Dudley proves his contention by quoting the composition and processes of manufacture of certain 80-pound and 100-pound section rolled for one of our leading railroads, and giving the excellent results obtained with these rails in service. The composition of these 80-pound rails as rolled for the New York Central was: Carbon 0.55 to 0.60, manganese 1.00 to 1.20, silicon 0.10 to 0.15, phosphorus not to exceed 0.06, sulphur not to exceed 0.07. The copper, which was not specified, averaged in those rails 0.7 to 0.8. The iron was remelted in cupolas, and the temperature of the heat in the converter regulated by 1,800 to 2,000 pounds of scrap, charged before the receipt of the molten iron. The bath was recarburized in the converter and the metal poled in the ladle by thrusting in a green wood pole. It was one or two minutes before teeming of the ingots commenced. The ladle nozzle was 1⅛ inches in diameter, and 6 or 7 minutes was consumed in pouring the 10-ton heat in five ingots, 15 by 15 inches square on the base and of sufficient length for three 30-foot rails. The ingots were charged into horizontal furnaces, rolled direct in 13 passes, 3½ minutes from first blooming to the finishing pass. The hot rails were sawed ½ inch longer than for present practice, and spaced 6 inches apart on the hot beds, and turned after recalescence of the head.

Five hundred thousand tons of rails of that character were made, with the exception that for the 100-pound sections the carbon was raised 5 to 10 points and the manganese about 10 points higher than for the 80-pound rails. To date only 18 specimens are known to have developed what may be termed split heads, or "piped rails," as generally understood by the latter term.

The rails from the ingots were lettered "A" for the top rail, "B" for the second rail and "C" for the third. These letters can be found in the tracks, and as would be expected, the "A" rails have a larger percentage of impurities than the "B" or "C" rails. They wear faster, developing more surface defects, and at several points upon the road, under heavy traffic, after 10 and 12 years' service, have become practically worn out for main line traffic, while the "B" and "C" rails are still good.

RAMSAY'S DISCOVERY OF THE DEGRADATION OF COPPER TO LITHIUM.

Sir William Ramsay has recently made an announcement which, coming from so high a source, must be treated with respect and which, if borne out, must rank with his famous discovery of the transformation of radium emanation into helium. He states that after long experimenting with the effect of various combinations brought into contact with radium emanation, he has observed that copper compounds are transmuted or "degraded," in his own words, to lithium. After a solution of copper phosphate has been treated with the emanation and the copper then removed, the spectrum of the residue exhibits the red line of lithium. According to newspaper interviews, the experiment has been repeated so often with so many precautions, both with copper nitrate and copper sulphate, that there can be no doubt of the correctness of the observation. Other nitrates were experimented with and no lithium line was observed, nor was it possible to obtain the lithium line before the solution of copper phosphate was brought into contact with the emanation. According to Sir William, the only conclusion to be drawn from these observations is that the copper acted upon by the emanation has been degraded to the first member of the group of elements to which it belongs, namely lithium. A full report will be made at the end of August, in the Transactions of the Chemical Society, and until that report is published, it is inadvisable, and indeed impossible, to discuss with any degree of thoroughness a discovery which, if substantiated, must certainly be regarded as one of the most brilliant chemical revelations of this radio-active age.

THE STORY OF AN ANCIENT MINE.

BY HERBERT W. HORWILL, M.A.

The modern graduate of a technical school who has specialized in mining would probably be able to give a satisfactory list of the most important recent publications on his own subject. It is not so certain that he would be ready with an answer to the question: What is the earliest recorded description of mining operations in the literature of the ancient world? He would naturally excuse his ignorance by the plea that the scientific portions of the ancient classics are of no practical service to-day, and that, such as they are, they belong properly to the domain of the philologist or the antiquarian. As it happens, the passage in question does not occur in a technical book or indeed in an out-of-the-way and obsolete volume at all, but in a poetical composition which is easily accessible, which is still read by a large number of persons, and which is supposed to be more or less familiar to every man possessing a fair general education—the Book of Job.

The fact that this most interesting passage is so little known is largely due to the obscurity of its translation in the Authorized Version. One might easily read through the twenty-eighth chapter of Job in that version without the least idea that it contained a detailed account of the processes by which the miner earns his livelihood. The first two verses, it is true, point to something of the kind, but at the third the writer appears to diverge into a not too intelligible panegyric of Divine omnipotence as shown especially in floods and earthquakes. Turn to the Revised Version, and the puzzle at once becomes a picture. From the first verse to the eleventh inclusive we are now able to follow an exact description of the methods employed by the ancient miner, and still pursued in the main wherever there is discovered a deposit worth working.

The key to the whole interpretation is in the meaning of the word "he" in the third verse. In the old version it appeared to denote God; the Revisers apply it to man. Accordingly, the passage refers not to Divine omnipotence but to human enterprise. "Man," we read, "setteth an end to darkness, and searcheth out to the furthest bound the stones of thick darkness and of the shadow of death." Here we see the miner with his lantern bringing light into a region hitherto sealed from man's gaze and searching not only near the surface, but, as "stones of thick darkness" seems to indicate, the very gloomiest recesses of the earth's interior.

"He breaketh open a shaft away from where men sojourn; they are forgotten of the foot that passeth by; they hang afar from men, they swing to and fro." This is severely scientific, but it is poetical also. As Dr. Samuel Cox has said, the writer brings out, in a few deft strokes, "the pathos of the miner's life and occupation—its peril, its loneliness, its remoteness even from those who stand nearest to it." The ancient poet had probably in his imagination the wilderness of Arabia Petræa, but the same feature of distance from crowded cities has usually been a characteristic of the beginnings, at any rate, of a great mine, whether in California, or in Nevada, or in Australia. And even if it is not so utterly remote from human habitation, the casual passenger goes on his way ignorant or oblivious of the burrowing far beneath his feet, where the miner "hangs" or "swings" at his work, having been lowered to the desired spot by some primitive cross-bar slung between ropes or chains.

The picture is now relieved by a suggestive parallel. The earth, on its surface as well as in its recesses, contributes to the welfare of man and supplies a sphere for his industry. "As for the earth, out of it cometh bread: and underneath it is turned up as it were by fire." Man, the worker and magician, both cultivates the soil that it may yield him his food, and pierces far below in quest of its hidden treasure. The second clause of the verse is generally interpreted as a reference to the Egyptian method of removing ore by "fire setting," i. e., by lighting a fire at the base of the rock to be removed so that the heat might split the harder portions and make cracks in which a chisel or pick could be inserted. The value of the miner's finds is next indicated. "The stones thereof are the place of sapphires, and it hath dust of gold," or, as the marginal rendering gives it, "he winneth lumps of gold."

There follows a graphic contrast between the boundless ingenuity of man and the limited sagacity of the brute. "That path"—the road which the miner hews out for himself—"no bird of prey knoweth, neither hath the falcon's eye seen it: the proud beasts have not trodden it, nor hath the fierce lion passed thereby." Man's detection of the secret gems of the earth is keener than the acutest predatory instinct of hawk or vulture. His strength in pursuit of his spoil excels that of the tyrants of the jungle or the forest. For "he putteth forth his hand upon the flinty rock; he overturneth the mountains by the roots."

The last phase of the description reminds us of the cleverness of the underground explorer in preserving himself and his operations from disaster, and of the persistent thoroughness of his investigation. "He cutteth out channels among the rocks; and his eye seeth every precious thing. He bindeth the streams that they trickle not (Heb., from weeping); and the thing that is hid bringeth he forth to light." The miner is here depicted as using mechanical expedients for preventing leakage through the roofs or walls of the passages in which he works, and as cutting canals to drain away water that may have percolated through. An alternative explanation of "he bindeth the streams from weeping" is that a reference is intended to the damming up of the waters in the river while the auriferous alluvial gravel is dug out. In either case the result is that nothing escapes his scrutiny, and that his energy and skill are rewarded by the discovery of the riches he seeks.

The whole passage is thus a striking poetical representation of the art of mining as practised in early times, and, except for the absence of elaborate machinery and powerful explosives, as still carried on to-day. And it is a picture with a purpose—to impress us with the wonders wrought by human enterprise so far exceeding the utmost marvels of animal instinct. As we read further on in the chapter, we find that this exulting tribute to the achievements of man is introduced into the poem that it may emphasize the limitations of even his intelligence. The close of the above description is immediately followed by the question: "But where shall wisdom be found? And where is the place of understanding?" There are some darknesses of which man cannot make an end; some priceless treasures that baffle even his research. Wisdom and understanding, of far greater worth than rubies, are neither to be purchased by the gold the miner discovers, nor are they to be attained by the exercise of his most penetrating ingenuity.

The date of the book in which this remarkable passage occurs is by no means a settled question among Biblical scholars. The traditional view which ascribed its authorship to Moses is now generally abandoned. The majority of modern critics place it somewhere between the seventh and the fourth century B. C., so it may be accepted as of a sufficiently remote period to make its description of the mine one of the earliest, if not absolutely the earliest, to be found in any literature. The four metals mentioned in the beginning of the chapter—silver, gold, iron, and brass (or rather copper, as a more exact translation would render it)—are those which were discovered and worked in the first ages of which we have a record. It is thought that the writer of this book was best acquainted with the mining operations of the Egyptians, who worked gold and silver mines in upper Egypt, and copper and turquoise mines in Arabia Petræa or the Sinaitic peninsula. There were no mines in Palestine itself, which explains the fact that this is the only reference to them in the Old Testament. The Egyptian copper mines in the Sinaitic mountains are known to have been carried on successfully as far back as the times of the early Pharaohs. Shafts, slag-heaps, smelting-places, and other distinct relics of the working of these mines may be seen to this day in some of the "wadis," or channels of dried watercourses. Many of them appear to be in the same condition in which they were left by the Egyptian workmen four or five thousand years ago; "the very marks of their tools," it is said, "being so fresh and sharp in that pure dry atmosphere, that more than one traveler has felt, while looking at them, as though the men had but knocked off work for a spell and might come back to it at any moment."

SCIENCE NOTES.

There is something about a holly hedge that challenges the destructive instinct in mankind. John Evelyn, the diarist, had one of the finest in England in the grounds of his home at Deptford, and Peter the Great ruined it for him. That extraordinary czar, when he came to the docks to learn shipbuilding, took a tenancy of Evelyn's house. Whenever he felt in need of relaxation he sat down in a wheelbarrow and caused a servant to charge with it at the holly hedge as hard as he could go. Also he cut up Evelyn's fine lawn most terribly by "leeping and shewing of trikkes" with his suite. Altogether, he did not do the house or garden any good. But the owner could get no adequate compensation.

There is a passage in Pliny that is usually cited as evidence that something akin to spectacles must have been in use at least in his time. He relates that the Emperor Nero used a precious stone which he calls "smaradgus," generally translated "emerald," through which he was accustomed to gaze on the gladiatorial combats; or rather, this is what he seems to say. There is, however, little doubt that Dr. Magnus, the latest author to examine the passage critically, is right in holding that it means no more than that the emperor was in the habit of gazing upon an emerald which he used to carry with him for the purpose of resting his eyes when they became tired looking upon shows that were interesting to him. This view is rendered the more probable from the belief of antiquity that green has a restful effect upon the eyesight.

M. De Morgan, the eminent French archæologist who has been carrying on excavations at Susa within recent years, made a communication to the Académie des Inscriptions et Belles-Lettres upon the results of the excavations which were undertaken from 1906 to 1907. Some important finds were made in the recent excavations at Susa. Among the objects which were found, we may mention especially a statue of alabaster which dates from a period about 4,000 B. C. It represents the king Manichtusu, and is claimed to be one of the oldest statues found in Asia. At the same meeting M. De Morgan showed a number of specimens of a very handsome variety of pottery which comes from about the same epoch as the statue. He is of the opinion that this pottery, together with the prehistoric pottery of Egypt, is the ancestor of the ceramic art in the Mediterranean region.

Some experiments have been made by A. Blanc, a German physicist, upon the decomposition of radio-thorium. The previous work of Hahn upon radio-thorium taken from the mineral thoriante, showed a diminution of activity, but did not give the rate at which this takes place. The author made his tests upon a preparation which showed an activity 3,000 times as great as the same weight of hydrate of thorium. There were no traces of radium in this compound. It was obtained from the Echaillon deposits by Dr. Angelucci. Measuring the loss of activity from day to day for 251 days, he finds that after a first rapid diminution, the rate becomes nearly proportional to the time. On the 251st day it had reached 71.4 per cent of the normal value. He estimates that an atom of this substance has a duration of 1,064 days, and that half the atoms will be decomposed in 737 days. It is thus found to be the radio-active body for which the activity falls to one half in the greatest time. Polonium, or F-radium, which seemed to have the greatest value, shows a period of 143 days to read half the figure for the activity. The author shows besides that the substance radio-thorium is actually a product of the transformation of thorium, for otherwise we could not explain the constant activity of salt of this body. This opinion is upheld by other scientists.