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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.

THE LESSON OF THE "BENNINGTON" DISASTER.

The awful tragedy on the gunboat "Bennington," due to the explosion of one of her boilers, has shocked the people of the United States more than any naval disaster since the blowing up of the "Maine" in Havana harbor. The loss of so many lives is rendered doubly painful by the conviction that the accident was entirely preventable. This conviction is based on the fact that the construction, inspection, and care of boilers are now so thoroughly understood, that, if proper precautions are exercised, a boiler explosion is practically impossible. In the exhaustive investigation that will be made by the Navy Department, evidence may be offered that will excuse both the engineering force on the ship and the system under which they worked; but the fact that the motive power of this war vessel was in the sole charge of a young officer, whose age rendered it impossible that he should have had the necessary experience to qualify him for such a great responsibility, suggests that the system may be partly responsible for the disaster.

It is a notorious fact that new ships are being added to our navy faster than adequately trained and experienced officers can be found to man them, and we understand that the scarcity is being felt more severely in the Department of Steam Engineering than in any other branch of the service. One of the first duties of Congress should be to make provisions for a considerable increase in the yearly supply of qualified engineers; and at the same time it should settle on a permanent and satisfactory basis the vexed question of the engineers' official rank.

MECHANICAL STOKERS ON LOCOMOTIVES.

The rapid growth in the size of locomotive boilers has added greatly to the labors of the fireman. Just how great this increase has been, will be understood when it is remembered that in 1893, when the famous express engine No. 999 was exhibited at the World's Fair, with its 1,900 square feet of heating surface, the boiler was considered to be of extreme proportions. Yet today a heating surface of 3,000 square feet is quite common, and there are many express engines that have as much as 3,400 and 3,500 square feet. Now, these figures mean that in the course of a decade and a half the heating surface of locomotives has about doubled; for we must remember that No. 999 was a great advance on contemporary practice, in which from 1,500 to 1,700 square feet was considered to be a generous allowance of heating surface. With the growth of heating capacity there has been a corresponding increase in grate surface, and in the labors of the fireman to keep these huge modern boilers supplied with coal. In a run of 150 miles, except in the very lightest trains, the fireman is never seated. When he is not handling the injector, or peering ahead to catch the first glimpse of a railroad signal, he is steadily loading coal into the firebox. The fireman's labors have increased enormously; for the great length of the firebox, which is necessary to provide the big grate surface, calls for increased physical exertion in throwing the coal forward so as to scatter it evenly over the more remote portions of the grate. The matter has reached a point where the question of employing two firemen has come up for consideration by railroad officials; it is being urged by the labor associations; while in more than one legislature an attempt is being made to regulate the matter by law. The railroad companies object to the presence of a third man, partly on the ground of the expense, and partly because it is thought that for reasons which we fail to grasp the efficiency of the lookout might be impaired thereby.

In this connection the question of the use of the mechanical stoker becomes of considerable importance. One or two types of such stokers have been tested with a fair amount of success, and there can be no doubt that the time has come when the matter should be taken up in the same thorough manner in which the recent locomotive tests were carried out by the Pennsylvania Railroad Company at the St. Louis Fair. The mechanical stoker is such a great success in stationary boiler plants, that it is reasonable to expect that, when its form has been modified to meet the special conditions of locomotive practice, it can be made to yield equally satisfactory results. One important advantage of its installation would be that the fireman could give considerably more attention to signals than is possible in his present overworked condition.

SEAWANHAKA CUP RETURNS TO AMERICA.

There has never been a period in the history of international sport in which this country has been concerned in so many important contests as in the present year. We have but to refer to the Transatlantic cup race, the contest for the Henley cup, the Gordon Bennett cup race, the rifle match between teams of the Seventh Regiment and the Westminster Volunteers, the challenge for the Davis tennis cup, and the challenge for the Seawanhaka cup for small yachts. Of these six international events, the first and last named have been won by the American representatives, and as both of these are yachting events, it will be seen how greatly this country is indebted to the noblest of all sports for its successes in what has been for us, in international contests, a decidedly "off" year.

Of the two yachting events, the winning of the Seawanhaka cup has really, in the eyes of yachtsmen, more significance than the winning of the Transatlantic race; for although the competing yachts for the Kaiser's cup were of the biggest size, they were a rather heterogeneous fleet, varying widely in size and age, some of them being racing yachts pure and simple, and others comfortable old cruisers that were never intended for racing of any kind. The contest just concluded for the Seawanhaka cup was, however, of a very different kind, the competing boats representing a highly-developed racing model, in which the yacht designer and the engineer combined their efforts to secure the single object of high speed. In this respect the Seawanhaka contests are, in the class of small boats, what the "America" cup contests are among the 90-footers.

The Seawanhaka challenge cup was won by a Canadian boat just nine years ago, and in every intervening year since it was captured, various American clubs have challenged, built a fleet of yachts out of which to select a representative, and have gone up to the lakes, and sailed a series of more or less hotly contested races, only to go down to defeat. The credit for the lengthy stay of the cup in Canada is due to a young civil engineer, Mr. Duggan, who approached the problem of building a 21-foot racing craft in exactly the same way in which that other engineer, Mr. Herreshoff, has worked out the same problem in the "America" cup defenders. In each case the process has developed a freak, pure and simple, that is to say, a yacht which, when its work of attack or defense is done, has practically no further usefulness to the yachtsman. Just how freakish the Seawanhaka boats have come to be may be judged from the fact that in one series of races Duggan came to the line with what was practically a double-hulled boat; for along the axis of the boat, where ordinarily the keel would be, the hull was rounded up clear of the waterline. This was done to save wetted surface and give the boat a long, fine, canoe-like hull to sail upon, the windward half of the boat being lifted practically clear of the water in a fresh breeze. The double-hulled boat being mutually barred from future races, the Canadians next brought out a broad, shoal craft, designed to sail upon its bilges and provided with two centerboards and two rudders, set normal to the curve of the bilge and, therefore, standing vertically in the water when the little craft was heeled by the wind. The "Manchester," representing the Manchester Yacht Club, was built on these general lines, and she scored a decisive win by taking the three races that were sailed. Take it all in all, there has never been a series of races that has been characterized by such friendly competition and good, clean sportsmanship as these for the Seawanhaka challenge cup.

WEAR OF CAR WHEELS ON CURVES.

An editorial which appeared in our issue of May 27, on the subject of the wear of wheels of cars when moving over curves, has brought several letters to the Editor's desk, asking whether it is not a fact that the tread of a car wheel is turned with a tapered or coned face, for the purpose of overcoming the slipping of one or other of a pair of wheels in running around a curve. In answer to these correspondents we point out that if the tread of a pair of wheels be formed with a taper corresponding to the sharpness of a given curve, they will move around the curve without any slipping; but if the same pair of wheels be run over other curves of smaller or larger radius, one or other of the wheels must slip. Hence it follows that, in actual practice, where the curves vary so greatly, the coning of the wheels can have only a very limited effect in the prevention of slipping. The theory of the coned wheels is that, in passing around a curve, the centrifugal force causes the train to hug the outside or longer rail, and as the diameter of each wheel at the flange is larger than at the edge opposite the flange, the outer wheel on the curve, or the wheel bearing on the outer and longer rail, is running on a larger diameter tread than is the inner wheel. It can readily be seen that if the taper of the tread has the proper ratio to the curvature of the rails, there will be no slip of either wheel on its rail. This is a condition, however, that occurs but rarely in practice.

PROTECTION AGAINST FIRE DAMP.

The problem of safeguarding the lives of the toilers in our mines is one that lends itself to a great deal of experiment, resulting in processes and instruments of more or less value to science and the world at large.

The recent mine disasters in Pennsylvania, the horrors of which are still fresh in our memories, have resulted in some novel and intensely interesting experiments being made for the purpose of guarding against the dread results of accumulations of fire damp, as methane, or marsh gas, is commonly called.

One of the most interesting of these from a scientific standpoint, and the most successful from a practical point of view, is one that has been installed in a large colliery in Pennsylvania after careful and exhaustive trials that have resulted in a most satisfactory manner. This instrument is called a methanometer, and its successful working is based on the principle of the decomposition of methane in the presence of an excess of ordinary air under the influence of a high temperature. The high temperature is secured through an induction spark or an incandescent platinum wire, and the condensation is shown by a change of height in a column of mercury. The instrument consists of two component parts—the analyzers, which are placed throughout the galleries of the colliery, and the receiver or indicator, which is placed in the office under the eye of the superintendent.

The analyzer transmits each hour to the receiver the exact proportion of fire damp, between one and nine per cent, that is mingled with the air in that part of the mine where each analyzer is placed. Thus, when a dangerous proportion of fire damp is recorded in any part of the mine, the superintendent can issue the necessary orders for the ventilation of that part, and the apparatus will enable him to follow the results of the ventilation as indicated in the receiver.

In the analyzer, the burner, mercury column, and pendulum are attached to one side of a heavy bronze plate, while on the other side is attached the clutching mechanism, the whole being inclosed in a tight-fitting case.

The burner or exploder is a little receiver, with a fine platinum wire across its longest axis, and communicating with the mercury column or manometer. Extending from the side of the exploder are two glass tubes, to which are attached India-rubber tubes, one of which extends through the tight-fitting case to receive the air of the mine, while the other extends to bellows actuated by the movement of the sounding apparatus.

It has been conclusively shown by experiment that the manometric indications are always similar under similar conditions. The height of the barometer has little or no effect on the results obtained; temperature has more, but this varies little in the places where the apparatus is used. Suppose the analyzer to work in a gallery where the temperature varies from 30 deg. to 40 deg. The average is therefore 35 deg., to which the instrument is regulated, and the height of the mercury column is determined for a mixture of five volumes of marsh gas to ninety-five volumes of air. This height divided by five gives the height corresponding to one per cent of marsh gas, and by like experiments the different heights of mercury for volumes of marsh gas from one to nine per cent can be determined, and marked on the sides of the tube. Platinum wires should now be fused into the glass tube at each of the nine marks, and the manometer will be ready to act with its exploding chamber.

The nine platinum wires from the manometer are connected with an equal number of platinum plates insulated in ebonite and arranged in the form of an arc. Just below the center of the arc is attached a ratchet wheel furnished with pawls, and carrying a contact rod which passes from plate to plate as the wheel turns. The mercury of the manometer is in permanent contact with one of the poles of the battery, while the ratchet wheel and arc, through an electro-magnet actuating the pawls, is connected intermittently with the other pole of the battery. When the mercury in the manometer rises as high as the first platinum wire, the current is closed, and passes through the platinum connecting wire to the first plate of the arc, thence through the contact rod into the ratchet wheel and its pawls.

The electro-magnet actuating the ratchet wheel is now magnetized, and turns the wheel until the contact rod rests on the second plate of the arc, thus opening the circuit. When the mercury in the manometer reaches the second platinum wire, the above operation is repeated, and so on, until the contact rod reaches the last plate, where a contact arrangement holds the lever actuated by the electro-magnet until the ratchet wheel and contact rod resume their normal position through the influence of a weight.

The receiver, or indicator, which is placed in the office, is somewhat similar in appearance and action, but more simple in construction, inasmuch as the nine plates above described are replaced by a numbered dial indicating from one to nine the percentage of fire damp as analyzed by the instrument in the mine. Just below each number on the dial is a hole in which plugs may be inserted that will make an electrical contact with the pointer. By placing a plug in the hole corresponding to a proportion of fire damp beyond which the mine is not thought safe, continuous ringing of a bell will result. The movement of the pointer is resultant from a contact effected when the contact rod of the instrument in the mine passes from one plate to another.

The mechanisms of the separate instruments of the methanometer are actuated by clockwork, operating the bellows supplying the analyzer with mine air, throwing the platinum wire of the analyzer into incandescence, and performing the other mechanical operations necessary to the operation of the different instruments.

At the time set for an analysis, a circuit is closed that drops a lever across the two tubes leading into the burner, crushing them flat, and thus shutting off the supply of air; a second later a circuit is closed, which brings the platinum wire into incandescence, lasting for fifteen seconds.

After a lapse of one minute, the platinum wire is again thrown into incandescence for another fifteen seconds. Five minutes later, during which five minutes the transmitter is recording the result of the analysis in the receiver, the lever closing the India-rubber tubes is lifted, thus permitting a fresh supply of air to reach the burner. The mercury therefore resumes its normal position, as also does the contact rod and pointer.

The reason for raising the platinum wire twice to incandescence for fifteen seconds, with an interval of one minute, is as follows: The wire being suddenly raised to a very high temperature dilates instantaneously the gas in the burner; one part of this gas escapes combustion, being drawn once more into the manometer during the minute allowed for cooling. During the second incandescence this gas returns to the burner, where its consumption is procured almost entirely.

Owing to the fact that the mechanism is actuated by clockwork, it is possible to connect at least six analyzers with one receiver, by arranging the analyzers to operate at intervals of ten minutes each. By reference to the time, it can easily be ascertained from which analyzer the report is coming.

YELLOW FEVER PREVENTED BY MOSQUITO EXTERMINATION.

Within the past few weeks there has been a gradual increase in the number of new cases and deaths by yellow fever in New Orleans, La., which is of so alarming a character as to cause representatives in adjoining States and in Havana, Cuba, to set up a quarantine against the city.

It is reported about twenty-five plague-infested centers have been located, the first and largest being near the French market, covering an area of forty city blocks. Frightened Italians, who would not consult physicians, scattered among friends in the outer portions of the city, and were there taken down with disease. It was noticed at these outside centers that the spread of the disease was curtailed because the patients were subjected to scientific treatment and kept perfectly screened, while the premises were cleared of mosquitoes. The city authorities favor the thorough cleaning of the streets of dirt and filth as the best means of checking the spread of the fever, but President Kohnke, of the city Board of Health (author of the well-known paper on "Mosquito Fever Propagation" in the SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 1518 and 1519, read before the American Society of Mosquito Extermination last winter) states: "Cleaning up streets and removing dirt from gutters is energy thrown away. You ought to put every man you can get hold of to screening cisterns and draining standing water from premises and ridding the city of mosquitoes."

This is a very quick and practical method of control which, if properly carried out, should aid materially in quelling the epidemic.

In New Orleans the situation as to water supply is different from most cities. In place of an underground pipe system, a double set of cisterns are erected alongside of or back of each residence for the collection of rain water. It is estimated there are 75,000 of these cisterns in New Orleans, which form so many pools of water suitable for mosquito breeding. It is to prevent the escape of the mosquitoes by covering the cisterns with screens that Dr. Kohnke so urgently recommends as one means of checking the spread of the fever.

The success in eradicating yellow fever from Havana, Cuba, is due to scientific methods, especially in preventing the propagation of mosquitoes, and in protecting suspected cases against contact with mosquitoes by suitable screens.

Large engineering plans for draining vast swampy areas are now being carried out in many States, notably New Jersey, for the very purpose of eliminating the sources of mosquito propagation, producing more healthful and comfortable conditions in the surrounding country.

Mosquito prevention is a subject of pressing importance in every locality, and should be treated liberally by all public-spirited citizens and authorities.

HOW THE ANCIENT BABYLONIANS DRAINED THEIR CITY.

BY EDGAR JAMES BANKS, FIELD DIRECTOR OF THE BABYLONIAN EXPEDITION OF THE UNIVERSITY OF CHICAGO.

It is generally supposed that it is only modern man who has perfected a system of drainage and sewerage to carry from his house and city the overflowing rain water and the filth and garbage which accumulate. In the excavation of Bismya, the ancient Sumerian or pre-Babylonian city which flourished 4,500 years ago, a remarkable system of drainage, perfectly adapted to the alluvial plain of the Mesopotamian desert, has been discovered.

Babylonia is perfectly level; from Bagdad to the Persian Gulf there is not the slightest elevation, save for the artificial mounds or an occasional changing sand drift. In most places there is a crust of hard clay upon the surface, baked by the hot sun of summer time, so hard that it resembles stone. Parts of the desert are perfect for bicycle riding. Beneath the crust, which at Bismya is seldom more than four feet in thickness, and in places entirely lacking, is loose, caving sand reaching to an unknown depth.

Drainage in such a country, without sloping hills or streams of running water, might tax the ingenuity of the modern builder. In constructing a house, the ancient Sumerian of more than 6,000 years ago first dug a hole into the sand to a considerable depth; at Bismya several instances were found where the shaft had reached the depth of fourteen meters beneath the foundation of the house. From the bottom he built up a vertical drain of large, cylindrical, terra-cotta sections, each of which is provided with grooved flanges to receive the one above. The sections of one drain were forty-eight centimeters in diameter and sixty in height; others were larger and much shorter; the thickness of the wall was 2.7 centimeters. The tiles were punctured at intervals with small holes about two centimeters in diameter. The section at the top of the drain was semi-spherical, fitting over it like a cap, and provided with an opening to receive the water from above. Sand and potsherds were then filled in about the drain, and it was ready for use. The water, pouring into it, was rapidly absorbed by the sand at the bottom, and if there it became clogged, the water escaped through the holes in the sides of the tiles.

The temple at Bismya was provided with several such drains. One palace was discovered with four; a large bath, resembling a modern Turkish bath, and provided with a bitumen floor, sloping to one corner, emptied its waste water into one. The toilets in the private houses of 6,000 years ago were almost identical with those of the modern Arab house—a small oblong hole in the floor without any seat. Several found at Bismya were provided with vertical drains beneath.

In clearing out the drains, a few of them, whose openings had been exposed, were filled with the drifting sand; others were half full of the filth of long-past ages; in one at the temple, we removed dozens of shallow, terra-cotta drinking cups, not unlike a large saucer in shape and size. Evidently, it received the waste water of a drinking fountain, and the cups had accidentally dropped within.

In the Bismya temple platform, constructed about 2750 B. C., we uncovered a horizontal drain of tiles, each of which was about a meter long and fifteen centimeters in diameter, and not unlike in shape those at present employed. It conducted the rain water from the platform to one of the vertical drains. One tile was so well constructed that for a long time it served as a chimney for our house, until my Turkish overseer suggested that its dark, smoked end project from the battlements of the house, to convince the Arabs that we were well fortified; thus it served as a gun until the close of the excavations.

In other parts of the temple more elementary drains were employed to carry off the surface water from the slightly inclined platform. It consisted simply of a groove constructed of bricks, or arranged by omitting the bricks in the floor; frequently the groove was continued down over the vertical edge of the platform.

The Babylonians of a later period, who buried, instead of cremating their dead, carefully provided their cemeteries with drains. The graves were small house-shaped structures entirely or partly above ground, and whenever they were found upon the sloping side of a mound, they were protected above by a breakwater, while along the sides were square, open brick drains. The result was that some of the graves, although thousands of years old, and constructed of unbaked clay, are still in a perfect state of preservation.

To the student of architecture it may be surprising to learn that the arch, until recently supposed to have been unknown to the ancients, was frequently employed by the pre-Babylonians of more than 6,000 years ago. Such an arch in a poor state of preservation was, a few years ago, discovered in the lowest stratum, beneath the Babylonian city of Nippur. More recently an arched drain was found beneath the old city of Fara, which the Germans have excavated in central Babylonia. The city, although one of the earliest known, was built upon an earlier ruin, and provided with an arched drain constructed of small, plano-convex bricks. It measures about one meter in height, and has an equal width.

While delving among the ruins of the oldest cities of the world, we are thus finding that at the time when we supposed that man was primitive and savage, he provided his home and city with "improvements" which we are inclined to call modern, but which we are only reinventing.

SCIENCE NOTES.

Perhaps it is not wise to prophesy a time when enzymic diseases shall lose all their terror by reason of the discovery of effective antidotes to the poisons to which their ravages are generally due. It is reasonable, however, to look forward to the time when the terror of these diseases, namely, diphtheria, typhoid fever, typhus and kindred scourges shall be reduced to a minimum.

The decade from 1880 to 1890 may be called the golden age of ætiology, for in these years were discovered the hitherto unknown parasitic microbes of typhoid fever, tuberculosis, malaria, Asiatic cholera, diphtheria, and tetanus. The last decade of a century which has well been called "the wonderful," witnessed the discovery of antitoxins by Behring and the beginnings of serum therapy. With the single exception of the changes effected by the acceptance of the theory of organic evolution, there has been no modification of human opinion within the nineteenth century more wonderful, or more profoundly affecting the general conduct of human life, than that in our attitude toward the nature, the causation, and the prevention of disease—that is to say, toward public health science.

The determination of the presence of small quantities of foreign fat in lard is exceedingly difficult, and taxes the skill of the chemist to the utmost. Most fats which are suitable or available for mixing are so similar to lard in their physical and chemical properties that the determinations which suffice to detect their presence when they occur in large amounts or to identify them in their pure state are of little or no value in detecting the small amounts usually employed in adulterated lard. As a result, the chemist must depend to a large extent on certain qualitative or approximatively quantitative tests. Many of these tests are not based on any inherent property of the fat, but depend on some impurity, due perhaps to the method of manufacture, or, with animal fats, to the kind of food upon which the animal has been fed.

The absorptive systems of plants seem to be admirably adapted for their needs from a diosmotic point of view. Diffusion may, therefore, be sufficiently rapid to supply all demands of the absorbing cells or organs. Nevertheless, the assumption that ordinarily diffusion through the cell and plasmatic membrane is sufficiently rapid properly to provide for the translocation of metabolic products from cell to cell is certainly open to further inquiry. Present knowledge of the translocatory processes is insufficient. Plasmatic connections between cells are now known to be of common occurrence, and this fact has given further interest to the above inquiry. Brown and Escombe are of the opinion that the plasmatic connections are eminently adapted for all of those phenomena which they have found to belong, as subsequently mentioned, to multiperforate septa. They claim, further, that with slight differences of osmotic pressure the necessary concentration of gradient for increased translocation would be very simply effected.

The yield of oil and pomace that may be obtained from a given quantity or weight of castor beans varies according to the quality and condition of the beans and the climatic conditions under which they were produced. Beans of good quality contain about 45 per cent of oil, but 32 per cent is, on a general average, about the proportion of oil extracted by the process of manufacture used in the United States. The rather high proportion of about 13 per cent remains unexpressed in the pomace. The weight of imported castor beans as fixed by the United States tariff regulations is 50 pounds to the bushel, and consequently in the eastern mills it is customary to estimate the yield of oil and pomace, respectively, at 16 pounds (2 gallons) and 34 pounds to the bushel. In the West the weight per bushel of domestic castor beans is fixed at 46 pounds, and on this basis the yield of oil per bushel of beans would be 14.72 pounds (1.84 gallons) and of pomace 31.28 pounds.

Commander Peary sailed at two o'clock, July 26, from North Sydney, Nova Scotia, in his Arctic steamer "Roosevelt" on his quest for the Pole.