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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 SAN FRANCISCO EARTHQUAKE AND THE SENATE CANAL COMMITTEE.

The San Francisco earthquake is responsible for the Senate Committee on the Panama Canal having cast its vote, by a narrow margin of one, in favor of a sea-level canal. To those of us who have followed closely the course of the lengthy hearing before this committee, it was evident that there was a growing conviction that the lock canal was the better type to build, and it looked for a while as though there might be a nearly unanimous vote to this effect. The disaster of April 18, however, was bound to awaken solicitude as to the fate of locks and dams at Panama, in case a similar disturbance should visit the Isthmus after the canal was built; and the Senate Committee, by a vote of six to five, has committed itself to the sea-level canal, its decision being largely due to the imaginary dangers of earthquake.

We say "imaginary"; for as a matter of fact, and we wish to say this with all emphasis, the San Francisco earthquake, so far from shaking our faith in massive monolithic structures of the character that will be used for a lock canal at Panama, has triumphantly vindicated such structures, and proved that they can go through the severest earthquake practically unharmed.

For it so happens that there exist in the line of the main earthquake fault several large earth or cement structures of the same character, or built of the class of materials as it is supposed would be imperiled if the lock canal were subjected to earthquake shock. These structures form part of the extensive scheme of works by which San Francisco is supplied with water, and they include several large dams for the impounding of water. The most important of these, Pilarcitos Dam, is a mound of earth 120 feet in height and similar in construction to, though much lighter in its total mass and ability to resist destruction than, the Gatun Dam at Panama. Another important dam is that by which San Andreas Lake is formed, and this is a structure of earth and clay, approximately 100 feet in height above the natural surface of the ground. A third dam which came directly in the line of the earthquake fault was that at Crystal Spring. This is a concrete structure of unusually massive proportions, which extends to a height of 115 feet above the ground.

Now it is evident that the conditions were such that the passage of the main line of disturbance through the valley in which these structures have been erected afforded a colossal testing laboratory, in which the strength both of earth and concrete structures of great size was put to a full-sized test. What concrete and earth endured at these places under one of the severest earthquake shocks on record, they may be depended upon to endure again, and the lessons taught on that early morning of April 18 are good for all time and any place. The best description of the effect of the earthquake in this region is that given by Mr. Charles Derleth, Associate Professor of Structural Engineering at the University of California, whose observations are recorded in a recent article in the Engineering News. The Pilarcitos reservoir he found to be thoroughly intact and full of water, and its great earthen dam was not injuriously affected. Although the main fault line of the earthquake runs through Crystal Spring Lake, it appears to have in no way affected the imperviousness of its bottom, since the reservoir, two weeks after the earthquake, was found to be full of water. The fault line passes directly through the older dam, which separates the lake into two halves, yet the dam was not seriously affected. Again, it was found that though the line of disturbance touches the eastern edge of the San Andreas earth-and-clay dam, which is nearly 100 feet in height, and there is evidence that it was subjected to a most severe shock, it retains the water just as well as it did before the earthquake, and this in spite of the fact that there are cracks running through the ground against which the dam abuts. So again the concrete dam at Crystal Spring, 115 feet in height, shows not the slightest crack, although it was subjected to a series of thrusts and pulls in vertical planes along its axis.

It is impossible to resist the force of the argument that if these earthen dams in California could pass uninjured through the severe shock and wrenching to which they were subjected, the much more massive Gatun Dam, built in a region where shocks are infrequent and of comparatively moderate intensity, might be considered to be practically earthquake-proof. So again it may fairly well be argued that if a dam of simple concrete, 115 feet in height, endured the ordeal of the earthquake without developing a single crack, the 75-foot walls of the Gatun locks, built as they will be, not of simple concrete but of concrete stiffened, toughened, and thoroughly tied together with steel rods, and with a special eye to resisting earthquake stresses, will present no element of danger to the permanence of the canal.

STRENGTH OF THE JAPANESE NAVY.

An estimate of the strength of the Japanese navy, based upon the published statements of the Japanese themselves, shows that the total strength to-day, or one year after the close of the war, is represented by sixty-two ships of a total displacement of 356,871 tons. The general confidence in the accuracy of Japanese figures and statistics is based upon the veracity with which such information was given out during the operations of the war. Although important statistics were frequently withheld, such facts and figures as were made public proved to be remarkably correct.

The strength of the Japanese navy lies in its battleships and armored cruisers. In the former class the navy is represented by eleven ships of a total displacement of 154,268 tons. Among these are the four battleships the "Fuji," "Shikishima," "Asahi," and "Mikasa," which went through the war; five battleships captured from the enemy, namely, the "Iwami," "Sagami," "Tango," "Suwo," and "Hizen," and the two new battleships recently completed in England, the "Kashima" and "Katori," of 16,350 tons displacement, which are to-day the most powerful fighting ships afloat, carrying as they do, four 12-inch, four 10-inch, and twelve 6-inch guns.

The cruisers are divided into three classes, according to size. In the first class of 7,000 tons and upward, are ten armored cruisers, including the "Aso," captured from Russia, and the 13,000-ton "Tsukuba" built in Japan and approaching completion. In the second class are nine ships of from 3,500 to 7,000 tons, including the "Tsugaru," formerly the "Pallada," and the "Soya," formerly the "Variag"; and the third class contains eight third-class cruisers of less than 3,500 tons, making a total of twenty-eight cruisers, aggregating 249,274 tons.

The coast-defense fleet is made up of twelve ships, aggregating 43,191 tons, and in these are included the "Iki," formerly the "Nicolai I.," the "Okinoshima," formerly "Apraxin," and the "Mishima," formerly the "Seniavin." The balance of the fleet consists of seven gunboats, three dispatch boats, and a torpedo depot ship. Besides these sixty-two ships aggregating over 356,000 tons, the Japanese have thirty-four torpedo-boat destroyers and eighty-five torpedo boats.

In addition to the navy as given above, the Japanese have an aggregate of 97,000 tons of new ships either now under construction or to be immediately laid down. This includes two 19-000-ton first-class battleships, the "Aki" and "Satsuma," the former being built at Kure, and the latter at Yokosuka. The armored cruiser class is to be increased by four vessels, each of 13,000 tons, two of which have been launched, while the other two are under construction. Three third-class cruisers are also being constructed, each of which will be of 2,500 tons displacement and high speed. A significant fact in connection with the future development of this navy is that the Japanese now consider themselves to be independent of foreign shipyards, all of the new construction being built in Japanese yards.

DENATURIZED ALCOHOL.

The recent passage by Congress of the bill to remove the tax on alcohol for technical uses, is expected to prove of enormous value to almost all the industries of the country. To render unfit for drinking or other purposes alcohol which is intended for commercial or industrial utilization, the liquid must be "denaturized" by the addition of various substances which make it impossible of consumption in beverages.

Consul-General Thackara, of Berlin, writing on the use of denaturized alcohol in Germany for technical purposes, says that the subject was ably and exhaustively treated by his predecessor, Consul-General Mason, in various reports on the subject. He gives the following extract from one of Consul-General Mason's reports regarding the methods in use in Germany for the denaturization of alcohol:

For most industrial purposes alcohol is used in Germany duty free, after having been "denaturized" or rendered unfit for drinking purposes by admixture, in presence of a government official, with a prescribed percentage or proportion of one or more of several different substances prescribed in the very elaborate statue which governs the complicated subject in Germany. There are two general classes or degrees of denaturizing, viz., the "complete" and the "incomplete," according to the purposes for which the alcohol so denaturized is to be ultimately used.

Complete denaturization of alcohol by the German system is accomplished by the addition to every 100 liters (26½ gallons) of spirits: (*a*) Two and one-half liters of the "standard denaturizer," made of 4 parts of wood alcohol, 1 part of pyridin (a nitrogenous base obtained by distilling bone oil or coal tar), with the addition to each liter of 50 grammes of oil of lavender or rosemary; (*b*) one and one-fourth liters of the above "standard" and 2 liters of benzol, with every 100 liters of alcohol.

Of alcohol thus completely denaturized there was used in Germany during the campaign year 1903—4,931,406 hectoliters denaturized by process (*a*), as described above, and 52,764 hectoliters which had been denaturized by process (*b*). This made a total of 26,080,505 gallons of wholly denaturized spirits used during the year for heating, lighting, and various processes of manufacture.

Incomplete denaturization, i. e., sufficient to prevent alcohol from being drunk, but not to disqualify it from use for various special purposes, for which the wholly denaturized spirits would be unavailable, is accomplished by several methods, as follows, the quantity and nature of each substance given being the prescribed dose for each 100 liters (26½ gallons) of spirits: (*c*) Five liters of wood alcohol or one-half liter of pyridin; (*d*) 20 liters of solution of shellac, containing 1 part gum to 2 parts alcohol of 90 per cent purity (alcohol for the manufacture of celluloid and pegamoid is denaturized); (*e*) by the addition of 1 kilogramme camphor or 2 liters oil of turpentine, or one-half liter benzol to each 100 liters of spirits.

Alcohol to be used in the manufacture of ethers, aldehyde, agarcin, white lead, silver bromide gelatins, photographic papers and plates, electrode plates, collodion, salicylic acid and salts, aniline chemicals, and for a number of other purposes, is denaturized by the addition of (*f*) 10 liters sulphuric ether, or 1 liter of benzol, or one-half liter oil of turpentine, or 0.025 liter of animal oil.

For the manufacture of varnishes and inks alcohol is denaturized by the addition of oil of turpentine or animal oil, and, for the production of soda soaps, by the addition of 1 kilogramme of castor oil. Alcohol for the production of lanolin is prepared by adding 5 liters of benzine to each hectoliter of spirits.

The price of denaturized alcohol varies in the different States and provinces of the Empire in accordance with the yield and consequent market price of potatoes, grain, and other materials. At the present time alcohol of 95 per cent purity, which is the quality ordinarily used in Germany for burning, sells at wholesale from 28 to 29 pfennigs (6.67 to 6.9 cents) per liter (1.06 quarts), and at retail for 33 pfennigs (7.85 cents) per liter.

SOME FACTS ABOUT PORTLAND CEMENT.

The use of cement runs back to antiquity. There is no exact known date when mankind first used calcined limestone in connection with masonry. It is known to have been used anciently by the Chaldeans, Egyptians, Greeks, and Romans. The most ancient form of cement was simply burnt limestone, more or less pure, used very much as we use ordinary lime at the present time. The Romans were the first to adulterate lime by adding certain clay soils and slate for the purpose of making a cement of a hydraulic nature, i. e., one which would set or harden under water. Pliny, who lived in the first century B. C., describes the method of modifying ordinary burnt limestone and converting it into a form of hydraulic cement.

It was anciently believed that the best cement was made from the hardest rock, and this opinion was not modified from the time of the Romans down to the eighteenth century. However, John Smeaton, the man who built the second Eddystone lighthouse, in the course of examining the various hydraulic cements for use in the foundation and masonry, made the important discovery that the quality of hydraulic cement depends upon the amount of clay in the limestone. This is conceded as the most important discovery in the art in nearly twenty centuries.

On the island of Portland in the south of England there are certain quarries of limestone which have been worked for many years, anciently producing building stone. In 1824 an Englishman named Joseph Aspdin, of Leeds, patented a process for mixing and burning lime and clay. The product looked so much like the Portland limestone that he called it "Portland cement," from which the commonly known name given to nearly all kinds of hydraulic cement was derived. From Aspdin's time to 1880 many mills were erected in England and on the Continent for making Portland cement, which was mostly poor stuff and of limited use.

The first Portland cement made in the United States was made by the Copley Cement Company, Copley, Pa., in 1875; their annual rate of production was 2,000 barrels.

It is not necessary to go into details here with reference to the manufacture and chemical composition of Portland cement, more than to state that the substance known as Portland cement consists largely of limestone with the addition of some silicate such as clay in certain proportions. In the process of manufacture these substances are crushed, introduced into rotary kilns under high temperature, and burnt together. The resulting clinker is taken and ground in some sort of ball or Griffin mill. It is necessary to grind cement to a very high degree of fineness, and its strength depends largely upon the degree of care with which this is done. It may be said that the modern cement mill is equipped with the machinery to do this suitably, as the requirements of engineers demand various tests before allowing cement to go into any work of importance.

The growth of Portland cement making in the United States has been rapid. In 1875 the annual production was 2,000 barrels per year; in 1890 (fifteen years later) it was 335,500 barrels; in 1900, 8,482,020 barrels; and in 1903 it was 22,342,973 barrels.

The importance of cement in the business world to-day is so great that not only have the different governments throughout the world taken up the matter of standardizing the tests determining the quality of cement, but it has also been done by various great engineering societies. Probably the standard work for testing cement is the publication issued by the Corps of Engineers United States Army entitled "Professional Papers 28." This pamphlet has been reprinted many times by private firms and translated into many languages.

The cost of Portland cement has annually decreased as the production increased, coming down from about $2.30 per barrel in 1890 to about $1.60 per barrel in 1900.

EHRLICH'S REMARKABLE STUDIES OF CANCER IN MICE.

The inoculation of mice with cancer is being practised on a very large scale by Prof. Ehrlich, of the Frankfurt Institute for Experimental Therapeutics.

The principal forms of malignant tumor are carcinoma, or true cancer, and sarcoma. Carcinoma occurs only in epithelium, the most important constituent of the glands and the outer layers of the skin; sarcoma only in connective tissue, which is found throughout the body. In man, mixed tumors (part sarcoma and part carcinoma) are very rare, and in mice they have never been known to occur spontaneously. But at Frankfurt a carcinoma that had remained true to type through nine inoculations, began to develop. The microscopical structure of sarcoma in the tenth mouse inoculated, became converted into a pure sarcoma in the fourteenth, and so remained during fifty subsequent inoculations. In another case a like change occurred suddenly, the characteristics of a mixed tumor appearing only in a single generation, the sixty-eighth. In a third case the mixed type seems to be permanent.

According to current theories carcinoma cells cannot change directly into sarcoma cells. The most plausible explanation of the transformation is that chemical changes in the carcinoma cells cause, through irritation, sarcomatous degeneration in the connective tissue and that the original carcinoma is crowded out by the more rapidly growing sarcoma.

Tissues and cells, whether normal or morbid, can be transplanted with success only from one animal to another of the same species or a species which forms hybrids therewith. Mouse cancer, for example, can be transmitted, permanently, to mice only. Nevertheless, if a rat is inoculated with very virulent cancer from a mouse, a tumor is produced which attains large size in a week, then diminishes, and usually vanishes entirely within three weeks after inoculation. Inoculations made from this tumor at the time of its greatest development have no effect on other rats but develop cancer in mice.

These facts cannot be explained by the assumption of a natural or "passive" immunity due to the preexistence of antitoxins in the rat's body, for such antitoxins would destroy the germs of mouse cancer on their introduction and the temporary swelling would not occur. An "active" immunity is certainly produced by the formation of antitoxins after, and because of, the inoculation, for a second inoculation fails to cause even temporary swelling. But this hardly suffices to account for the absorption and disappearance of the tumor, in view of the fact that the latter retains sufficient virulence to infect mice inoculated with it.

Ehrlich therefore has been led to the conception of "atreptic" immunity, or immunity due to starvation of the cancer cells. He assumes that the cell of mouse cancer requires for its growth, in addition to the general nutriment which is furnished in abundance by the rat as well as the mouse, a special nutriment which is found only in mice. The small quantity of this substance which is transferred to the rat, together with the cancer cells, in the act of inoculation maintains the growth and multiplication of those cells for a short time, but when the nutriment thus introduced has been consumed, the growth of the tumor necessarily ceases. After this moment, therefore, inoculation of a second rat with cells from this tumor can have only a negative result, because more of the special nutriment remains to be transferred with the cells, but a similar inoculation produces a rapid cancerous growth in a mouse, the body of which contains the special nutriment in abundance.

This theory also explains the often observed fact, that in a mouse in which a large tumor has been produced by inoculation a second tumor cannot be produced by inoculation from the first one. For, as the first tumor has grown rapidly and is well provided with blood vessels, it has so nearly exhausted the supply of the specific nutriment contained in the blood of the animal that the second inoculation falls, so to speak, upon barren soil.

Ehrlich explains the growth of tumors, according to the modern cell theory, by assuming that the morbid cells surpass the normal cells in the power to seize and appropriate food. Now comparatively few of the tumors which occur spontaneously in mice are transmissible to other mice by inoculation. The cells of most varieties of tumors, therefore, have no such advantage over the ordinary cells, and the spontaneous occurrence of a non-transmissible tumor is due, not to an increase in the assimilating power of the cells of which it is composed, but to a diminution in the assimilating power of the ordinary cells, that is to say, to the general debility of that individual mouse. This view is in perfect accordance with the facts learned by experience, that human cancer is most prevalent in advanced age, when the entire organism is debilitated, and that hereditary and constitutional peculiarities are also important factors in its causation.

The tumors of mice show great differences in virulence, as appears from the ease, difficulty, or impossibility of transmitting them by inoculation. Most spontaneous cases of carcinoma in mice cannot be transmitted at all, but the most virulent cases often give 100 per cent of successful inoculations. Ehrlich has proved, however, that inoculation from an ordinary, non-transmissible tumor, though it does not reproduce that tumor, has the remarkable effect of making the inoculated mouse immune to subsequent inoculation with tumors of the most virulent type. This result makes it possible to make any mouse immune to carcinoma by repeated inoculations with non-virulent growths and it has been proved that this immunity is not specific, but includes every variety of malignant tumor of either epithelial or connective tissue that has been propagated at the Frankfurt Institute. It would, of course, be premature to draw from these very interesting discoveries the inference that an effective cure for human cancer is within reach, but these results indicate that the experimental investigation is tending in a direction which provides a more hopeful view of the solution of the cancer problem than has been afforded by all previous study of the subject.

CONCRETE: ITS RISE AND ITS APPLICATIONS.

The history of concrete dates back to the Roman period, and its growth seems to have followed and is proportional to the growth of the Portland cement industry. The word "concrete" to engineers and contractors has a very definite meaning, but to those not familiar with the subject, the word "concrete" often suggests a "tar sidewalk." Concrete is a substance composed of broken stone, sand, and cement, or sand, gravel, and cement mixed together with water in certain well-defined proportions determined by experience. The resulting mixture is a pasty, jelly-like substance, which can be placed in excavations or box-like forms and allowed to harden or "set," as it is called. In the course of twenty minutes or a half hour it will have undergone what is called the "initial set." In other words, it changes its physical condition from that of a semi-fluid to that of a solid, and while it is not then hard it is a solid. The hardness of the "permanent set" will depend on many things. With good cement this hardness will grow with age, and there are some cements which show from tests a continual growth in strength and hardness for many years. There are many cements called "quick-setting" cements, which take on a permanent set in a short time and show a high strength; but it has been determined by experience and tests, however, that quick-setting cements are not so good or stable in the end as the slow-setting article, which grows in strength indefinitely.

With the increased production of Portland cement the use of concrete has been rapidly growing, and to-day it is simply a question of expense, as concrete masonry can be built for very much less than stone masonry, the result being the marked displacement of the latter. It is used at the present time for making dwelling houses, factories, chimneys, dams, water tanks, railway ties, and fence posts. In fact, it is hard to name a structure in the present day that has not been built of concrete. The introduction of armored or reinforced concrete has still more widened its field of usefulness.

FLUID LENSES.

A report from Consul-General W. A. Rublee, at Vienna, states that after experiments extending over a number of years a Hungarian chemist has succeeded in producing optical lenses by a simple and cheap process, that are not only quite as good as the best massive glass lenses at present used, but that can be manufactured of a size three times as great as the largest homogeneous glass lens heretofore made.

The importance of this invention in the field of astronomy is obviously very considerable. The largest glass lens heretofore manufactured out of massive glass for astronomical purposes has a diameter of about 1.50 meters (4.92 feet), and it required several years to make it, while the price was several hundred thousands of marks (1 mark = 23.8 cents). Such a lens can be manufactured by the new process in a few weeks at a cost of 2,000 or 3,000 marks. The price of a glass lens of the best German manufacture, with a diameter of 25 centimeters (9.84 inches), is now about 7,000 marks, whereas the price of a similar lens made by the new process is about 150 marks. Lenses of smaller diameter for photographic purposes, for opera glasses, reading glasses, etc., can be produced at correspondingly smaller cost. The lens consists of a fluid substance inclosed between two unusually hard glass surfaces similar to watch crystals, in which the refractive power and other characteristic properties are so chosen that the glass surfaces not only serve to hold the fluid, but also combine with the fluid to overcome such defects as are scarcely to be avoided in ordinary lenses. It is for this reason also that the lens is achromatic.

The fluid contained in the lens is hermetically sealed, so that no air can enter and exercise a damaging effect. The fluid does not evaporate, and its composition is such that its properties are not affected by time or by temperature. The coefficient of expansion, both of the glass and of the fluid, is approximately the same between the temperatures of 15 deg. of cold to 60 deg. of heat. Another advantage of the lens is that, on account of the fact that the fluid is not dense and the glass crystals are thin, the whole lens combination through which the light must penetrate is very slight.

RESISTANCE OF THE HUMAN BODY TO AUTOMOBILE ACCIDENTS.

The remarkable increase in the number of heavy and high-speed automobiles has not been without its effect upon the number of casualties which the newspapers daily chronicle, and which the comic papers seem to find so amusing. Dr. E. M. Foote, of New York, has unconsciously added fuel to these numerous fires by the preparation of an elaborate paper on accidents occasioned by wheels, particularly by wheels provided with elastic tires. If a sportsmanlike chauffeur has any yearning to run down human beings without actually killing them, he has but to study Dr. Foote's paper.

Dr. Foote's investigations were undertaken after a rather remarkable accident. An automobile delivery truck weighing about two tons passed over the trunk of a ten-year-old child without occasioning death. An investigation conducted by Dr. Foote for determining the cause of this abnormal result, led him to consider in a human body extended on the ground a line which he terms the "line of mortal pressure." The position of this line is dependent upon a host of factors, such as the weight of the vehicle, the width and elasticity of the tire, the speed of the vehicle, condition of the ground, clothing of the victim, mechanical resistance of the bones, contraction of the muscles. If the wheel of a vehicle strikes that line, death will probably result.

WHY DO STARS SEEM RAYED?

An attempt to account for the familiar rayed or starlike appearance of the stars when seen by the naked eye is made by W. Holtz in an article on the "Appearance of Stars," which appeared in Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse. He finds that all stars show precisely the same rays, but that in the case of the brighter stars the rays are plainer and somewhat longer. It is further remarked that the rays seen by the left and right eyes differ, and that if the head be turned the rays are rotated in a corresponding manner. It is thus concluded that the source of the rays is not in the stars but in the eye itself, the middle of the retina being not perfectly homogeneous in its sensitiveness.