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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.

JAPAN'S LOSSES ON THE SEA.

As the result of the most successful and artistic way in which the Japanese government has managed to conceal the exact extent of its naval losses and damage, it is difficult to say with any certainty just what these amount to. It is claimed by the Russian government that altogether half a dozen battleships and cruisers have been lost beyond recovery, and the indications are that this estimate is not too large. It is known that the battleship "Hatsuse" was sunk by a mine ten miles off Port Arthur, in deep water from which she cannot be recovered. There also appeared a few weeks ago, in the dispatches from Tokio, an acknowledgment, which was said to be official, that the battleship "Yashima" was struck by a mine off Dalny last summer and lost. Subsequently there has been some contradiction of this report; although the consensus of opinion to-day is, that she too has been wrecked beyond recovery. The Japanese also acknowledge the loss of the protected cruisers "Yoshino" and "Miyako," and the cruiser "Sai-Yen," formerly the Chinese "Tsi-Yuen," and also the "Hei-Yen," another old coast-defense vessel captured from the Chinese, and the gunboat "Kaimon." These, with the exception of the "Yoshino," which was sunk by collision, all fell victims to the deadly mine. The "Chiyoda" was also struck by a mine. It is claimed by the Russians also (and their estimates of naval damage have generally been since verified) that they have altogether, in the course of the war, damaged or sunk sixteen destroyers and torpedo boats. It is significant that one of the eight armored cruisers of the Japanese has not been mentioned for several months in the dispatches, and it is possible Japan is short of the services of one of these vessels. If this is the case, she can now put in the fighting line four battleships and seven armored cruisers of modern and thoroughly up-to-date construction. Against these Russia can put in her first fighting line four very powerful and well-protected battleships of the "Borodino" type, and two older battleships of doubtful value. These vessels form the principal elements of the Baltic fleet. If repairs have been completed on the armored cruisers "Rossia" and "Gromoboi," now at Vladivostock, these vessels may also be counted in; but they will only be available in the event, either that they can escape from Vladivostock and effect a junction with Rojestvensky's ships, or that the Baltic fleet can reach Vladivostock, before the encounter with Togo's fleet takes place. Meanwhile the Japanese admiral has been reported as passing Singapore with a fleet of twenty-one vessels.

A SEA-LEVEL CANAL AT PANAMA.

A distinguished European engineer, after visiting this country to study the secrets of our industrial success, stated, as the result of his observations, that we owed much of our rapid advancement to the free use which we make of the scrap heap. The observation was that of a shrewd observer; for there can be no doubt that the readiness of the American people to sacrifice machinery, plant, and buildings, just as soon as it is realized that the substitution of later and more improved methods and construction will more than pay for the cost of making the change, has been one of the most fruitful sources of our industrial progress. There are some fields of work, however, and notably those which fall within the province of the civil engineer, to which the above considerations do not, or should not, apply. Both the common dictates of prudence and the dearly-bought experience of the past, teach us that, in the construction of railways, canals, reservoirs, and all heavy and costly works of a similar character, everything should be planned with a strict regard for the demands, not merely of the immediate future, but of that remoter time, of which, in the construction of works of less importance, no thought would be taken. There are some national works which, like the national constitution, should be planned for all time.

These considerations apply with special emphasis to that great engineering problem to which the United States has committed itself in the construction of a ship canal across the Isthmus of Panama. From whatever standpoint we look at it, the conviction is brought home to every thoughtful mind that this is destined to become in due time, and rather sooner than later, the most important artificial waterway in the world. Therefore, it should be constructed with a view to rendering it available for all the shipping and for any size of vessel, that may wish to pass through; moreover, it should be so constructed as to offer the minimum of risk and the speediest transit possible, to the great and ever-increasing tonnage that will make use of it.

There can be little doubt that it is considerations of this nature that have produced the growing sentiment among engineers and in Congress, in favor of the construction of a sea-level canal rather than of one with locks and a summit level; and the feeling has been strengthened by the opportune report recently made to the Isthmian Canal Commission by their Engineering Committee, in which it is shown that recent developments at the Isthmus indicate that a sea-level canal can be constructed in from ten to twelve years, at a cost not to exceed $230,500,000. This is only $52,462,000 more than the estimated cost of a canal with locks, with a summit level of 60 feet above mean tide. Moreover, the sea-level canal would take only from two to four years longer to construct; if completed on the generous dimensions proposed by the engineers, it would be sufficient to accommodate the largest ships that would be built for many years to come; and it would present the great advantage that deepening and widening of the canal could be carried on at any time without the least interference with navigation.

The recommendations of the committee call for a sea-level canal, with a bottom width of 150 feet and a minimum depth of water throughout of 35 feet, with twin tidal locks at Miraflores to accommodate the rise and fall of the tide, the locks to be 100 feet in width and 1,000 feet in length. The total estimated cost of $230,500,000 includes an allowance for administration, engineering sanitation, and various contingencies amounting to $38,450,000; but makes no allowance for interest during construction, expense of zone government, and collateral expenses. It is recommended that the Chagres River be controlled by a dam at Gamboa built to a height to crest of 200 feet, the surplus waters of the lake thus created to be carried off to the sea by means of tunnels through the divide. The work on the foundations of the dam will require from one to one and a half years, and in the opinion of the committee, it should be begun at once.

It is satisfactory to know that the estimate of cost is based upon the probable cost of excavation of the Culebra cut, which in a sea-level canal would constitute the main obstacle to be overcome. For the cost of operation in the cut has been accurately determined in the work of excavation with American machinery and methods that has been carried on by the government for several months past. It has been found that the entire excavation can be done at a cost of fifty cents a cubic yard. The former Isthmian Canal Commission estimated this cost at eighty cents a yard. This reduction amounts to a total for the whole work of $15,000,000; and it is this great reduction in a class of work which will constitute by far the largest element of cost in the sea-level canal, that is given by the committee as a justification of the larger scheme. Furthermore, it is pointed out that the results thus far obtained in the Culebra cut have been reached under disadvantageous conditions of organization of both plant and force; and the Chief Engineer estimates that with one hundred steam shovels installed, and with a complete system of tracks to serve them, a yearly record of 30,000,000 cubic yards of excavation may be reached, without requiring a greater output per steam shovel or greater speed in working than has already been attained.

Finally, by way of emphasizing the necessity for building the canal with ample dimensions, that may be readily increased at any time in the future without interfering with navigation, we may mention that there are two transatlantic steamers now under construction, which are to have a draft of 35 feet and a total length of just under 800 feet. Twelve years from this time, when the canal is opened, there will be vessels afloat exceeding even these dimensions.

THE TIDES AT COLON AND PANAMA.

The great difference in the amount of rise and fall of the tides at the two ends of the Panama Canal has been a source of considerable surprise to many persons unacquainted with the facts.

At Colon, the Caribbean terminus, the mean range is 0.6 foot, while at Panama, the Pacific terminus, it is 12.6 feet. This is the official record of the Coast and Geodetic Survey. Rear Admiral Chester, of the U. S. navy, who has spent several years on and near the Isthmus, gives the difference of tide as 8 feet and 32 feet on the Atlantic and Pacific sides, respectively. Gen. Peter C. Haines, U. S. army, in a recently published article on the Panama Canal, says the rise and fall of tide at Panama, or the Pacific side, is 20 feet, and at Colon, the Atlantic side, one foot; so that while the mean level of the two oceans is precisely the same, the level at Panama is 10 feet higher at high tide and 10 feet lower at low tide, than it is at Colon; and of course this occurs twice every day.

It is here proposed to briefly state how this condition is brought about.

In the first place, it may be said that the tidal oscillation, whose period is one day, will not be considered. The extreme fortnightly range of this oscillation is about 1.2 feet at either Colon or Panama. We are here concerned with the ordinary semi-daily tides.

The semi-daily tides along the outer coast of the United States from Martha's Vineyard to Cape Canaveral, Florida, occur at nearly one and the same time. The average range of tide generally lies between 3 and 7 feet for this coast. The simultaneous occurrence of the tide at once suggests the existence of an area containing a stationary wave, and extending southeasterly from the United States toward the opening between eastern Brazil and western Africa. By the term "stationary wave" is meant an oscillation, or periodic movement, of a body of water, as when it is high water at one point, it is then high water over a large portion of the body, and correspondingly low water over the remaining portion. The lines bounding the middle portion of the area between the limits of greatest rise and fall are called nodal lines. Thus, near such lines the rise and fall is slight, but the horizontal movement across them is considerable. As a simple, practical illustration, let a basin which is partly filled with water be oscillated vertically; the water will rise on one side of the basin as it falls on the other, while in the middle portion of the body of water there will be scarcely any vertical movement. Now, applying this to the case in hand, it will be seen that on the line before referred to as extending southeasterly from the Atlantic coast of the United States, when it is high water on the said coast, it will be low water in the region northeast of Brazil, while halfway between these limits there will be a stationary wave. That is to say, at halfway points, or along the middle of the line referred to, there will be little rise and fall, and hence small ranges of tide.

Observation shows that at St. Thomas Island, a little east of Porto Rico, the range is only 0.3 foot, and the range is small for all of the Leeward Islands. Thus we are enabled to say with considerable certainty that a stationary wave exists extending southeasterly from the United States, and with its first nodal line ending in the Leeward Islands. This circumstance is very important, because it explains why it is that the Atlantic Ocean tide does not enter the Caribbean Sea with sufficient range to cause a fair-sized derived tide at Colon. The tide at Colon is chiefly due to the tide produced in the Caribbean Sea by the direct action of the tidal forces, and is nearly independent of the tides of the Atlantic. Its range and time of occurrence correspond well with this assumption. If there were a considerable tide along the Lesser Antilles and other adjacent islands, it would find ample space between the islands to enter the Caribbean Sea, and would of course be almost if not equally strong at Colon; but as it is, the Caribbean Sea is left to itself, so to speak, and responds but feebly to the moon's attractive force.

The relatively high tides at Panama are due chiefly to a stationary wave or oscillation contained, for the most part, in a large triangular area which constitutes the whole of the North Pacific Ocean.

It is known that in triangular areas, the angles usually have large ranges of tide. If again, for a simple illustration, one will oscillate vertically a basin of triangular form, partly filled with water, this will be sufficiently demonstrated. Panama lies at one of the grand Pacific angles, the Gulf of Alaska marks another, and the eastern coast of the Philippines marks the third. Moreover, there is a gradual shoaling from the mouth to the head of Panama Bay, and this increases the range somewhat. The conformation of the land, or the curve of the shore line to the southward from Panama, is another element in the case, for it tends to form an angle and a bay favoring the higher rise of tide. The tides along the Pacific coast of Panama and Central America occur at one and the same time, very nearly. This suggests a stationary wave. But the diminution of the range of tide from 12.6 feet at the port of Panama to 1.2 feet at Acapulco, Mexico, gives further evidence of this stationary wave. Other evidence is obtained from different parts of the Pacific Ocean. Thus, in the immense basin of the Pacific, the tides are high at the points or angles of the great triangle before indicated, and slight at other intermediate points or at what are technically denominated nodal lines. Those desiring a further discussion of the subject, should consult the Reports of the Coast and Geodetic Survey for the years 1900 and 1904; but enough has been given here to show in a general way how it happens that the tides at the two termini

of the canal differ so greatly in their amount of rise and fall.

In the maps taken from the survey report for 1904 it is noticeable that the cotidal lines converge or crowd together in the vicinity of the Leeward Islands as in a locality just west of Acapulco, Mexico, which indicates a rapid change in the time of tide across the nodal lines of the stationary waves described above. By cotidal lines, as the term itself indicates, is meant an assemblage of points where tides occur at the same absolute time. The maps also show that the time of tide changes but little in going along the Pacific coast of Central America or in going from the United States to the Bermudas or even to Porto Rico. For the facts upon which this article is based we are indebted to the courtesy of the Coast and Geodetic Survey.

AN ELECTRICAL ANALOGUE FOR RESPIRATION.

Hæmoglobin, the coloring matter of the red corpuscles of the blood, is remarkable for the facility with which it unites with oxygen to form oxyhæmoglobin, which, in turn, parts as easily with the oxygen thus acquired and becomes reduced back to hæmoglobin. It is this property that fits the substance for the part which it plays in the respiration of warm-blooded animals. It absorbs oxygen in the lungs and, after having been distributed through the body in the form of oxyhæmoglobin, gives up the oxygen which it has brought with it. Even outside the body hæmoglobin absorbs oxygen from the air and readily gives it up to reducing agents—for example, to the hydrogen evolved at the cathode of a galvanic cell. It may therefore take the place of manganese dioxide as a depolarizer in a zinc and sal ammoniac battery.

A rod of gas retort carbon is painted with several coats of an aqueous solution of hæmoglobin and immersed, with a rod of zinc, in a solution of sal ammoniac and common salt, in which hæmoglobin is insoluble. The electromotive force remains constant for a short time after the circuit is closed, then falls off suddenly as the last of the oxyhæmoglobin is reduced, but it may be restored to its initial value by leaving the circuit open a while or, more rapidly, by blowing air into the liquid. The cell, therefore, produces energy from the consumption of atmospheric oxygen, as the living body does, through respiration.

The analogy goes even further, for if the cell is placed in an atmosphere containing carbonic oxide it does not recuperate in the manner described above. It is poisoned, and by the same substance that poisons animals under like conditions—the very stable compound carboxyhæmoglobin.

Long experience has proved this peculiar battery to be very suitable for bell-ringing and similar purposes, if it is set in the open air. The cost of maintenance is very small.

THE BRITISH NAVAL PROGRAMME FOR 1905.

BY OUR LONDON CORRESPONDENT.

The serious and far-reaching alteration in the balance of naval power in Europe, caused by the destruction of the Russian Pacific fleet by the Japanese, has manifested itself in the naval estimates of Great Britain for the coming year. So great is this influence, that not only has the amount of money allotted for naval purposes been appreciably reduced, but several war vessels authorized in the 1904 programme have been definitely abandoned, while for the first time in twenty years the personnel of the navy is to be diminished. Such a radical departure from progression on the part of the British government serves to throw the effect produced by the destruction of Russia's navy into significance, since had there been no war in the East, Great Britain would have been compelled to maintain the policy which has been carefully followed each successive year for many years past.

Another fact that has affected the British naval plans is the reorganization of the navy carried out by Sir John Fisher upon his accession to the premier post of the Admiralty. By his scheme all the less valuable and obsolete vessels in the British navy have been eliminated. Over one hundred vessels have been removed by his drastic measure, with the consequence that the navy has been rendered more heterogeneous and efficient, and is now a better fighting force than ever.

The sum estimated to fulfill the requirements of the British navy during the coming year is $166,945,000, as compared with $184,445,000 required for 1904, showing a reduction of $18,500,000. Of this sum $47,830,000 is to be devoted to new construction, representing a decrease of $10,440,000 upon the amount expended for this purpose last year. Of the programme authorized last year, it is intended to abandon the construction of one armored cruiser and a number of destroyers. Exactly how many of the latter it has been decided to forego is not divulged, however.

During the coming year the following vessels are to be laid down—one battleship, four armored cruisers, twelve coastal destroyers, six ocean-going destroyers, and eleven submarines. No details, however, are forthcoming of these new ships. During the past year the present fleet has been augmented by four battleships—"King Edward VII.," "Commonwealth," "Swiftsure," and "Triumph"; one armored cruiser; four third-class cruisers; twelve submarines; nine destroyers; four torpedo boats, and one river gunboat. There are now in course of construction 62 vessels, comprising 8 battleships, 15 armored cruisers, 1 second-class cruiser, 1 third-class cruiser, 8 scouts, 18 destroyers, and 11 submarines.

With regard to the destroyers, in the course of the development of this class of fighting unit, two qualities have successively predominated, namely, speed and sea-keeping power. Their study of the tactical and other questions involved has led the Department to the conclusion that two classes of destroyers are requisite, one especially for ocean-going operations, and the other for use in the narrow seas. The Naval Board has accordingly decided to combine the qualities of speed and sea-keeping power in a special type of ocean-going destroyer which will be expensive, and of which therefore the number must be comparatively few, and to design a new type of coastal destroyer which will be comparatively cheap, and of which consequently a large number can be obtained.

The policy of sending ships to private yards has proved completely successful, and the arrears in the repairs of the fleet have been completely overcome. It is not therefore necessary to provide during the coming year for repairs of any ships in private yards. It is intended to utilize the government yards for the purpose of keeping the present vessels in complete repair rather than to employ them for new constructional work. The building of new vessels has been demonstrated by actual experience to be carried out with greater economy in private than in the government yards, while on the other hand, repairs can be more cheaply effected in the latter than in the former.

It is intended to continue the experiments with oil fuel, but it is now quite certain that oil has firmly become established as part of the fuel in the navy, and every arrangement is being made for its supply, storage, and distribution. In connection with this point, it may be stated that already huge reservoirs are in course of erection at Portsmouth dockyard for the storage of the oil, and suitable apparatus is being installed for the transfer of the latter to the compartments intended for storage in the holds of the battleships with facility and celerity.

During the coming year a large number of heavy guns are to be constructed, to meet the armament requirements of the vessels now in course of erection. These weapons comprise 12-inch 45-caliber and 9.2-inch 50-caliber weapons for the battleships, and 9.2-inch and 7.5-inch 50-caliber guns for the first-class armored cruisers.

Exhaustive experiments have been carried out with night sights, with the result that a good optical sight has been obtained, which is to be adopted in the more important gun mountings. A new type of armor-piercing projectile, from which greater penetration can be obtained, has been satisfactorily tested, and is being introduced for all guns of 6-inch and higher caliber. Improvements in submerged discharges and torpedo rooms are being effected, to enable more rapid loading to be carried out. A new torpedo with increased range and speed has been designed, and severe and prolonged trials are now in progress with it upon the torpedo range at Portland. Searchlights have been improved by the general introduction of automatic lamps. Experiments are also in progress at sea with electrically-controlled projectors.

Another important feature, and one which will commend itself to engineers, is the policy of standardization that has been adopted. By co-operation with the machinery manufacturers it has been found practicable to make almost the whole of the main and auxiliary machinery and boilers fitted in ships of the same class, of similar design and interchangeable. In the six first-class armored cruisers of the "Duke of Edinburgh" class, this principle has been brought into effect, and it is now in process of development for the machinery of ships of the "Lord Nelson" and "Minotaur" types. By dealing with vessels in classes, progress is not retarded by such standardization. Admiralty representatives have been associated with the various sub-committees of the Standards Committee, and Admiralty and commercial practice have been assimilated in many features with benefit to each.

The First Lord of the Admiralty states that the fleet has "never been in more perfect state of repair than it is at the present moment," which is most satisfactory, and is due in no small measure to the rigorous policy of the department during the past two or three years, and the wholesale elimination from the fighting strength of all those vessels which do not coincide with modern naval requirements, and which could only be rendered efficient and up-to-date by the expenditure of large sums of money. It is also intended to inaugurate a policy by which, while fewer ships will be in course of construction simultaneously, the time occupied in such work will be considerably expedited. At the present time the building of a battleship, from the laying down of the keel to its actual commission, varies from 30 to 36 months. This work, however, under the new scheme is to be appreciably accelerated.

SCIENCE NOTES.

An important discovery of a new mineral has been made in Ceylon by Prof. W. R. Dunstan in the course of a mineral survey. The discovery, which has been named thorianite, is richly impregnated with the rare earth thoria, the proportion being approximately 75 per cent. What is of commercial importance, however, is the fact that the mineral is not combined with silica.

In a paper recently read before the Académie des Sciences, M. Victor Cremieu describes a series of researches upon liquid drops suspended in a mass of liquid of the same density, with which they do not mix. The drops are thus free from the action of gravity and their mutual attraction is counterbalanced by the pressure of the liquid. If the distance which separates the drops is considerable with relation to their diameter, the capillary forces are quite negligible. Nevertheless, he observed that the drops approached each other slowly, whatever might be the ratio of their diameter and distance apart. In the present experiments he operated with a mass of liquid kept at a constant temperature and free from all disturbances. The liquid was a mixture of distilled water and alcohol, and the drops were formed of pure olive oil. The mixture, which has the same density as the oil, is placed in a vessel four inches high and six inches in diameter, covered with a glass plate. The oil drops are introduced by means of a capillary tube. The jar is surrounded by a metal cylinder to protect it from radiation from the observer, and the vertical and horizontal movement of the drops is observed by means of slits in the cylinder. It is found that the drop always rises in the liquid, as it is impossible to have an exact equality of the density, and a very slight chemical change also occurs which modifies the initial density. With a single drop, it is found that it always rises in a straight line, starting from any point in the vessel. But with two drops the effect is different. The drops were from one to five millimeters in diameter and placed twenty-five millimeters from the sides. They were one hundred millimeters apart at first. Two hours' readings were made of their position, and it was found that they rise in a slight curve, so as to approach each other. Adding a third drop causes a deviation in that direction, and the latter also rises in a curve. These experiments are difficult to carry out, and only six observations were obtained in two months, but they gave very constant results. The author is now studying the effect of solids suspended in a liquid in the same way.

M. Le Roux has carefully studied low temperatures upon phosphorescence, using liquid air. Some previous researches show that the phosphorescence is weakened or extinguished at low temperatures. In the present case he uses a light blue calcium sulphide whose light varies with the temperature when at about the heat of the human body. He places the sulphide in small sealed tubes and excites them together by magnesium light. When one of the tubes is placed in liquid air the phosphorescence is completely extinguished. On taking out the tube the light returns at the end of a few seconds, and its intensity has a maximum value when the tube comes back to the temperature of the air. It appears somewhat higher than that of the check tube according as the cooled tube has remained more or less in extinction. This is explained at once by the hypothesis that the cooling only suspends the phosphorescence, without destroying it, even partially. The phosphorescence is preserved in the potential form. Therefore when the tube returns to the same temperature as the check tube, it is brighter, since it resumes its former value, while the check tube has already weakened. A second question may be asked. When the body is initially at a temperature where the luminous energy which it acquired would become continually latent, may it acquire such energy in the latent form alone? The experiments show that such is the case. A tube of sulphide, made inactive by placing it for a long time in the dark, was plunged in a bath of liquid air while still deprived of light. The whole was taken into the light and together with a check tube was excited by magnesium light. On bringing it again into the dark room, the immersed tube showed no light, as might be expected, but when taken out of the bath and allowed to heat, it became luminous and brighter than the check tube as before. It is to be remarked that the acquired luminous potential energy has always been the maximum which the light could produce upon the body. The conclusion may be reached that the maximum luminous potential energy which a given light can give to a certain body is independent of the temperature. The temperature factor only has an influence upon the speed of transformation of the potential luminous energy into actual luminous energy.

A weighing machine, said to be the most powerful in the world, is being made in Birmingham. It is capable of registering a load of 220 tons.