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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.

EARTHQUAKES AND DAM CONSTRUCTION AT PANAMA.

An important question affecting the choice of the type of canal to be built at Panama is that of the possibility of seismic disturbances and their probable effect upon the canal. Unlike the Nicaragua district, Panama is practically free from earthquakes of any magnitude; and the indications are that this comparative immunity has existed for a long period. The fact was brought out during the recent examination into conditions at Panama by the Senate Committee, that there exists in an ancient church in the canal zone, a masonry arch, which is so flat that by all the laws of equilibrium it should long ago have fallen in. It is an object of great curiosity among our engineers on the isthmus, one of whom admitted in the Senate inquiry that he was at a loss to understand how a structure, so evidently near the breaking point, should have maintained its stability for hundreds of years. Now this engineering phenomenon is taken, and very properly so, as giving unmistakable evidence that for several centuries Panama must have been free from those more serious seismic convulsions which have wrought such havoc with structures of every kind in other countries of Central America.

At the same time, it is known that Panama is not altogether free from earthquake tremors, and in making our choice between a high-level and a sea-level canal, the possible destructive effects of earthquake disturbances upon the dams and locks of either type must be taken into consideration. Unquestionably the most vulnerable point in either type of canal will be the dams, for upon them will the very existence of the canal depend. A sea-level canal would involve the construction at Gamboa of a masonry dam 185 feet high, besides several smaller dams to control the flow of small streams tributary to the Chagres. A lock canal calls for the construction at Gatun of an earth dam 135 feet high. The masonry dam at Gamboa will consist of a solid wall carried down everywhere to rock foundation and varying in thickness from 100 feet at the base to 30 feet at the water level. The earth dam at Gatun will consist of a mass of closely-compacted sand and clay, 2,500 feet thick at the base, and 375 feet thick at the water level. As far as we know, there are no actual data to go upon in considering the question of the relative effects of an earthquake upon masonry and earth dams; but it is surely reasonable to expect that under the tremor of an earthquake the lofty, comparatively thin, and unyielding masonry wall of the Gamboa dam would be more likely to rupture than would the broad and more or less elastic mass of the Gatun earth dam; particularly when we remember that the masonry wall will be practically dry throughout its whole mass, while the earth dam will be more or less saturated and plastic. Furthermore, a crack in a dry 50-foot masonry wall would be more likely to extend entirely through the mass than it would if it occurred in a great earthen mound, whose average thickness was over a thousand feet.

We are free to admit that when this question is considered in its bearing on the masonry locks, the advantage lies with the sea-level canal, which has but one of these. At the same time, a crack through the walls of a lock chamber would not be comparable in the extent of the delay, or the possibility of disaster, to a fracture of the great dam at Gamboa. Failure of that dam would mean the wrecking of the whole canal; but the failure of a lock chamber would not necessarily mean even an interruption of navigation. For the locks will be built in duplicate, side by side; and, unless the damage extended entirely across the whole system, ships could pass through the uninjured lock while the damage was being repaired. Even if the damage extended entirely across both flights of locks, it is not likely that the whole of the summit water supply would be lost, as it would be. were the Gamboa dam destroyed; for the lock gates would serve to hold back the impounded waters until repairs had been made, and the repairs would not involve anything more serious than grouting out the crack with cement.

However, in any discussion of the earthquake problem at Panama, we must be guided by probabilities, and these indicate that the risk from earthquakes is extremely slight, if, indeed, it may be said to exist at all. Were the canal zone known to be liable to the severe visitations which work such havoc in Central American countries, the United States might just as well give up all idea of a canal at once; for earthquakes of any intensity would undoubtedly wreck the whole enterprise, whether high level or sea level, with locks or without.

A QUART MEASURE IN A PINT POT.

In the matter of the design of the new 16,000-ton battleships "Michigan" and "South Carolina," our Navy Department is just now trying to solve the problem of putting a quart measure into a pint pot. To be more particular, they are trying to prove that 18,500 tons of displacement efficiency can be put into 16,000 tons. But that it cannot be done is proved by the history of warship design, not only in our own but in every important navy of the world.

We do not hesitate to make the statement that there is no art to compare with that of naval architecture, in respect to the amount of "brains and money" that has been devoted to its development. The reason is not far to seek. It has long been understood by all maritime countries in general, and by the greatest maritime country in particular, that the security of a modern nation, if not its very existence, may ultimately depend upon the efficiency of the navy. Consequently the best talent has been sought for the designing and construction of warships; lavish funds have been provided for experimental investigation; and a most careful and jealous watch has been kept by each navy upon the general progress of the art the world over, its results classified, and when they were approved, adopted. It has followed that warship design is the most cosmopolitan and one of the most exact arts of the present day. Out of the maze of theorizing and costly experimentation of the past thirty years, naval architecture has emerged with certain fundamental and firmly established facts and principles of universal acceptance.

The most important fact that has been thus determined is that displacement is the true test (provided there are no glaring errors of design) of a warship's efficiency; that is to say, the bigger ship will be the better ship. The displacement, or total weight of a ship, is the naval architect's working capital, and he will invest it according to his judgment as to where and in what relative quantities it will make the best returns. Thus in the design of the 16,000-ton battleship "Louisiana," the naval constructor allotted 1,500 tons to the guns and ammunition; 4,000 tons to armor, 1,600 tons to motive power, 900 tons to coal, and 7,000 tons to the hull and accessories. Now, it is evident that these proportions might be varied indefinitely, by taking from one allotment and adding to another. Thus, 1,000 tons might be transferred from armor to motive power so as to raise the speed from 18 to 20 knots, or the 1,000 tons might be taken from the hull by using lighter scantling and shaving down slightly on the thickness of shell plating. The final result, however, if the changes were made within reasonable limits, would be the same as far as the total efficiency of the ship was concerned, and the total efficiency would be exactly measurable in terms of the total displacement.

The first duty of a ship is to carry guns and fight them, and naturally the naval architect has exercised his ingenuity in devising means to increase total fire in any given direction without increasing the number of guns carried—in other words, to secure the largest possible arc of fire for each gun. The most serious limitation upon all-round fire is found in the necessity of avoiding "blast interference," that is to say, the harming or hindering of the crew of one gun by the gases from another gun. Our own naval architects made a bold departure in the "Oregon" battleships, in seeking to increase all-round fire by placing the 8-inch guns at a higher level than the 13-inch, and permitting the former to fire across the 13-inch gun turrets. The theory was ingenious and promised flattering results. Yet, when the guns were tried, it was found that the blast from the 8-inch guns, when fired ahead, rendered the sighting hoods of the 13-inch turrets untenable, and stops had to be placed to prevent the 8-inch guns from firing closer than within 13 degrees of the longitudinal axis of the ship. Theoretically, the "Oregon" was more powerfully armed than some foreign ships of 50 per cent more displacement. But when fully loaded her armor belt was nearly submerged; her freeboard was too low to render her fightable in heavy weather; her speed was low, and her coal supply limited. Were she strengthened by the reinforcement of her mountings; were another deck added to her height; another two knots to her speed, and her coal supplies and stores increased by 70 per cent, her displacement would go up from 10,200, to its proper legitimate figure for such an armament, of about 13,000 tons. In a properly designed ship increased displacement always means increased efficiency; conversely, increased efficiency means increased displacement.

Now, in the 16,000-ton, 18-knot battleships, it is claimed that we shall possess ships which are fully the equal of the 18,500-ton, 21-knot "Dreadnought." Our proposed ships are to carry eight 12-inch guns, the foreign ship ten; and the equality of armament is claimed on the ground that, by placing two of the pairs of 12-inch guns at a higher level so that they can fire across the roof of the turrets of the other two pairs, none of the guns will be masked by each other's fire, and an all-round arc of fire will be obtained. In other words, it is proposed to do with the 12-inch guns what was found impossible to do with the 8-inch guns, and fire them across an adjacent turret without hurt or inconvenience to those inside. We think it is extremely improbable that the guns will in practice ever be so fired; in which case the comparative concentration of fire of the "Michigan" and the "Dreadnought" will be two 12-inch ahead against six; eight 12-inch on each beam against eight on each beam with two guns in reserve, sheltered by the turret on the broadside engaged for the time being; and two 12-inch guns astern for each ship, thus giving the ten-gun ship a great superiority of fire.

The method of mounting the guns to fire over the roof of the adjoining turrets was discussed when the plans of the "Dreadnought" were under preparation, and was dismissed as impracticable; and if, as we believe, it will prove to be impossible, because of the shock and the fumes of the gases, to fire the "Michigan's" guns directly across the turret roofs, we shall find ourselves behind the ships that are building by foreign nations in gun power, and behind one of them at least by three knots in speed.

The greatest credit is due to the Bureau of Construction and Repair for the ingenuity of its proposed turret arrangement, and the skill with which constructive problems have been overcome; but with the experience of the "Oregon" and the later double-deck turret craze as object lessons, we believe that the better plan is to increase displacement so as to admit of at least 19 knots speed, with a battery of ten guns so disposed that there can be no interference.

If our experience has taught us one thing above all others in the past, it is that there is no short cut to battleship fighting power; which can be reached only by the broad road of liberal displacement.

WHAT ARE ATOMS, ELECTRONS, AND IONS?

The phenomena of the Crookes tube, of Roentgen rays, and latterly of radium, inexplicable by the chemical theories of a decade ago, have rendered necessary the coining of several new words, which have taken their place in the vocabulary of the modern physicist. We hear so much these days of electrons and ions and their relation to the old-time supposedly indivisible atom that the time seems ripe for a few simple definitions condensed from a recent paper by Prof. Soddy.

The first and oldest conception of the ultimate unit of matter is the *atom*, the smallest particle of an element capable of separate existence. The essential feature of Dalton's conception was that the atoms of the same element are all exactly alike in mass and every other property, but are recognizably different from the atoms of any other kind of element. The statement will be found in text-books of chemistry written long before the recent discoveries were foreshadowed, that if it is ever found possible to transmute any one kind of atom, that is, any one kind of elementary matter, into any other kind, there is little doubt that the same means would be sufficient to transmute or decompose the other elements.

The modern conception of the ultimate unit is the *electron*, and this, although by origin an electrical conception, is in reality a material conception no less than the atom of matter. The electron could be defined as the smallest existence known capable of isolation and of free movement through space. It is a definite amount of "charge" of negative electricity, in a word, the smallest possible amount known to exist; for electricity, no less than matter, has been shown to consist of discrete particles or units, and not to occupy space continuously. Unlike the atoms of matter, only one kind of electron is known, consisting of the same amount or charge of negative electricity with identical properties in all its various manifestations.

It is certain that each atom of matter contains in the normal condition at least one electron, which it is capable of losing, and conversely that it may unite with at least one electron more than it normally possesses without deep-seated material change. An atom with one or more electrons less than it possesses in the normal state is positively charged and is often called a *positive ion.* Similarly an atom with one or more electrons in excess is a *negative ion.*