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THE BATTLESHIP OF THE FUTURE.

A comparative study of the designs of the new battleships which figure in the naval programmes for the year 1900 shows that naval constructors, both in our own and foreign navies, are rapidly tending toward a common type, which, without exaggeration, may be defined as a complete reversal of the ideas of battleship design and construction that have been prevalent during the last ten or fifteen years. In the last of the eighties and in the early nineties of the century, the typical battleship was essentially of what we may call the bulldog type, compared with which the battleship of the opening years of the twentieth century will be a greyhound in speed and activity, while still retaining not a little of the bulldog's fighting power.

The bulldog type, for want of a better expression, is characterized by a hull of bulky model, short and broad; a slow speed of say from 14 to 16 knots; armor of excessive thickness, ranging from 21½ inches in the French "Baudin" and the Italian "Duilio," and 24 inches in the British "Inflexible," to 18 inches in our own "Indiana" and "Oregon;" and an offensive battery of a few heavy, unwieldly and slow-firing guns, which weighed as much as 110½ tons apiece in the British "Benbow" and the Italian "Duilio" type.

During the past fifteen years there have been three important developments in naval material which have served completely to revolutionize battleship construction. The first of these is the advance that has been made in the methods of armor-plate construction, by which increased resisting power has been obtained with a great reduction in weight. The next is the improvement in the manufacture of guns and explosives, which has been so great as to enable us to secure equal penetration with a gun weighing only half as much as those of the earlier type. The third development has been in the design and materials of boilers and engines, the improvements in which have enabled us to secure a great reduction in engine and boiler room weights, and, at the same time, obtain an increase of from 40 to 50 per cent in the speed of the ship.

A mere recital of the leading particulars of the notable battleships of the British navy of the past two decades tells the story of this development. The "Inflexible" of the year 1881 was clothed with 24 inches of armor, carried four 16 inch muzzle-loading 80-ton guns, and attained a speed of 12·8 knots with 6,500 horse power. The "Camperdown," of 1889, carried 18 inches of armor, mounted four 67-ton guns in her main battery, and attained a speed of 16 to 17 knots with a horse power of 11,500. The "Majestic," designed in 1892, carried 9 inches of armor on her side, was armed with four 12-inch 50-ton guns in her main battery, and attained a speed of over 18 knots with about 13,000 indicated horse power. The "Ocean," completed in the present year, has 6 inches of armor on her belt, carries a main battery of four 50-ton guns, and has attained a speed of 18½ knots with about 14,000 indicated horse power. In the above statement no mention has been made of the fact that with the decrease in the weight of the main battery there has been a notable increase in the secondary battery of rapid-firing guns, the "Ocean" carrying twelve 6-inch guns of this type, in addition to eighteen smaller quick-firing guns. In the new battleships of the "Duncan" class, now building for the same navy, the side armor is only 7 inches in thickness; the battery is the same as that of the "Ocean," and the speed has been raised to 19 knots an hour with an indicated horse power under natural draught of 18,000.

With this last-named vessel it is interesting to compare our latest battleships of the "Georgia" class, which carry 11 inches of armor on the sides and are armed with four 52-ton guns in the main battery, eight 18-ton guns in the intermediate battery, and twelve 6-inch rapid-firing guns in the secondary battery, while a speed of 19 knots is to be obtained with 19,000 indicated horse power.

Other ships than those mentioned above show that the tendency to decrease the weight of the main battery is very marked, the two British battleships of the "Barfleur" type carrying a main battery of 10-inch 30-ton guns, and the latest battleships of the German navy relying upon 9½ inch 27-ton guns for their main armament.

The designs for the new battleships to be laid down this year are of particular interest because they doubtless are intended to embody many of the lessons which were taught by the naval engagements of the Spanish-American war. We have pointed out on various occasions, when discussing the results of the Santiago engagement, that the heavy 12 and 13-inch guns contributed very little to the destruction of the Spanish fleet, the number of hits secured being less in proportion to the number of guns engaged than those credited to any other weapon engaged. Indeed, if one is governed solely by the actual effects produced on the Spanish ships, one is driven to the conclusion that the best armament for a battleship is that which will pour into the enemy a storm of smaller armor-piercing shells, rather than one which will depend upon the great damage wrought by the less frequent but individually more effective shots from the heavier guns.

In view of the fact that the latest battleship designs are provided with armor of from 6 to 9 inches in thickness, and that to secure destructive effects it is sufficient that a shell shall merely penetrate the enemy's armor, it begins to look as though the 12-inch 50-ton slow-firing gun is at once too powerful and too slow for the work which it will be called upon to do. It becomes a question whether the destructive effect of a given number of 12-inch shells would not be exceeded by four times the number of 8-inch shells, any one of which would be capable of penetrating the armor of the latest type of battleship. It is evidently these considerations which have led to the design of the new battleships for the Italian navy, which, on a displacement of 8,000 tons, and with armor of a maximum thickness of 6 inches, are to carry no gun heavier than the 8-inch; the main battery consisting of twelve of these very effective weapons carried in pairs in six separate turrets, disposed on the same plan as that adopted in our own battleship "Iowa." The secondary battery consists of twelve 3-inch rapid-fire weapons. These 8-inch guns are to be of extremely high velocity, and their rapid-fire mechanism will enable them to fire at the theoretical rate of five shots per minute. Another remarkable feature in these ships is that they are built with very fine lines, and sufficient engine power to drive them 23 knots an hour. Possessing such great speed and maneuvering ability, a vessel of this type could steam swiftly within a range at which the enemy's armor would be penetrable by her 8-inch guns, where she would be able to concentrate no less than eight of these weapons, and pour in a storm of armor-piercing projectiles which might well demoralize the crew and wreck the gun positions of the enemy before his heavy armor-piercing guns could get in a disabling shot. It must be remembered, moreover, that two of these 8,000-ton vessels could probably be constructed for but little more than the cost of one of the 15,000-ton battleships of the kind that our own and the British governments are now constructing. It is probable that the predominant type of the next decade will approximate more to the latest Italian battleships than it will to any existing type to-day.

ELECTRIC FURNACE LITIGATION—AN IMPORTANT PATENT DECISION.

On June 9, 1885, two patents were granted to E. H. and A. H. Cowles for electric smelting furnaces, which embodied the first noteworthy improvements in the electric reduction of metals from their ores that had been made since the day when Sir Humphrey Davy succeeded in producing potassium and sodium by the electric current. Before the invention of the Cowles brothers, electric furnaces consisted either of two carbon terminals between which the substance to be heated was placed, or of an incandescent rod of highly resistant material, such as carbon, which acted as a heating-core. Although the heat obtained by these methods was more intense than any which had been previously produced, it was not intense enough for the purposes of the electrochemist. The Cowles brothers discovered that by mixing granulated carbon with the ore to be treated, the temperature was very considerably raised, that the current was uniformly distributed throughout the mixture and was not confined to a central point, and that more metal was reduced, since the carbon was consumed in the oxygen of the ore.

The possibilities of the electric refinement of ores created by this discovery seemed almost boundless. Experiments were made with numerous metallic ores. Finally, the Cowles endeavored to produce rock crystals by fusing sand in the intense heat of their furnace. Grains of carbon were arranged in a core about which common sand was heaped. When the furnace was opened, beautiful, clear crystals were found, which Alfred Cowles thought were pure silicon reduced from the silicon oxide of the sand. The crystals were exhibited as curiosities (for never before had silicon been reduced from its compounds), and were finally deposited in a metallurgical museum and forgotten. The Cowles brothers abandoned further experiment and began the electrical reduction of aluminium.

In the meantime another investigator, Mr. E. G. Acheson, had been experimenting with the electrical furnace, and, for five years before the Cowles patent was issued, had been endeavoring to produce artificial diamonds and abrading substances. In one of his experiments he mixed coke with clay and obtained greenish-purple crystals harder than diamonds, which crystals he regarded as compounds of aluminium and carbon, and named "carborundum." Accurate analysis showed that the crystals were really silicon carbide.

A company was started and a plant erected for the purpose of making carborundum. The process of manufacture was improved. The coke and clay were no longer indiscriminately mixed; but a core of coke-kernels was employed, together with a powdered charge, containing the silicon in the form of sand and a proportion of granulated coke, salt, and sawdust.

The crystals of carborundum which were exhibited at Chicago in 1893 were recognized by Alfred Cowles as identical with those which he had regarded as pure silicon. An infringement suit was immediately begun; and for six years the courts were engaged in deciding who was the inventor of carborundum.

The first trial was decided against Cowles. It was held by Judge Buffington that Acheson's process presented such radical differences from Cowles' that the charge of infringement could not be sustained. He stated that Cowles' object was reduction; Acheson's, composition. One reduced a substance already known; the other by synthesis produced a compound not known in the arts. A more vital distinction between the two inventions is the difference in the methods employed. In Cowles' furnace the charge constituted the core; in Acheson's process, on the other hand, coke alone was used as the core and the charge was banked about the core. In the one case an excess of carbon in the charge was necessary; in the other, no excess was required, nor was any used.

Despite the diverse lines on which Cowles and Acheson worked, an appeal taken from Judge Buffington's decision resulted in a reopening of the case. The decision which has been handed down by Judge Bradford in the new case is contrary to that originally rendered, and, if sustained, may possibly cripple an industry which has become one of great importance in America. Not only the Carborundum Company but also other manufacturers who employ the electrical furnace will be affected. Judge Bradford has confined himself chiefly to a discussion of the relative arrangement of the carbon and the substance to be treated. The Cowles brothers, he finds, conceived the broad idea of mixing the granulated carbon with the silicon or other metal to be treated.

Admitting that the idea of producing a mixture of granular carbon and ore originated with Cowles, it must be confessed that the improvements devised by Acheson are such as to distinguish his process so clearly from his rivals that he seems to be cleared of the charge of infringement. To us it appears that Cowles' method consists merely in producing a mixture of carbon and ore which was electrically reduced, and that Acheson's process consists essentially in mechanically aiding the work to be performed by the current, by methodically arranging the charge containing the ore to be reduced about a central core of carbon.

There is, indeed, an analogy between this case and the Bessemer-Kelly controversy of a few years ago. The evidence presented at the time suggested that Kelly had stumbled upon the great secret, possibly without fully appreciating its value—certainly without the ability to give it proper mechanical expression. Bessemer not only discovered the principle of decarbonization by blowing air through molten iron, but also (a far greater task) invented the converter with which the process was rendered possible on a commercial scale. Cowles produced in a laboratory experiment a substance whose sphere of usefulness, as decided by himself, was a shelf in a metallurgical museum. Acheson set out to make a commercial product on a commercial scale, and succeeded so well that his carborundum has already proved itself of the greatest value in many of the industries and arts.

AN EXPERIMENT ON THE ROMAN CAMPAGNA WITH THE MALARIAL MOSQUITO.

Two physicians, Drs. Sambon and Low, of the School of Tropical Medicine, are to live in the most malarious section of the Roman Campagna, the expenses being borne by a grant from the British government. They are to occupy a mosquito-proof hut, in order to demonstrate that malaria is contracted only through inoculation by the mosquito. If by October they have not had the fever, they will prove, in a practical manner, the truth of a theory, the results of which may save thousands of lives. Scientific men have long held this view as to the spread of malaria, but the public must also be convinced of it. The hut is to be provided with wire gauze door and window screens and other devices, for rendering it mosquito-proof. The observers and their servants will live in this hut. They will go where they like during the day, but for an hour before sunset until an hour after sunrise they will remain in the hut. The roof overhangs the walls for about three feet around the entire building, and reaches to within eight feet of the ground. The window openings are thus protected from the rays of the sun, and to guard against the mosquitoes there is a permanent wire gauze screen of no fewer than seventeen meshes to the inch. There is a space about eighteen inches deep left open around the entire house immediately under the overhanging eves. This opening is fitted with wire gauze similar to that provided for the windows, and every precaution against the entrance of the mosquito is taken by having similar wire gauze fitted into the ventilating panels let into the ceilings of all the rooms. There are double doorways to the house. The floor is composed of tongued and grooved boards. The outer walls are covered with felting, and are boarded on the outside with rabbeted planks. The roof is constructed of tongued and grooved boards covered with woven wire roofing-felt. It is not only waterproof but airtight, and prevents the escape of cool air, which at night will find its way into the air tank created by this form of roof. The physicians will not take any quinine or other precautions against the dreaded malaria. It is their intention to mix freely with the inhabitants. In Italy two million people have malaria every year, and of this number, fifteen thousand die. If the experiment proves successful, it is probable that similar houses will be built in Africa and India.

The mosquito always exists in malarial regions, as far as has been investigated. If patients suffering from malaria come into the region, then the mosquito becomes infected and spreads the disease. Whether the insect can acquire the parasite from any other source than man has not been settled as yet. It is not probable, however; so far as it is known, malaria has never been acquired primarily in uninhabited regions. Thus explorers after passing through a country that would naturally be supposed to be malarious seem to be immune until they reach the coast, where the mosquitoes are abundant, and the insects are able to obtain the parasites from those suffering from the disease. An example of this is shown in Reunion Island, where there was no malaria until 1869. In that year a party of colonists came from India, and some of them suffered from malaria. The result was that the disease became very prevalent upon the island. The malaria spreader is the anopheles mosquito. It is a curious fact that they rest on a wall with their bodies at right angles to the surface, instead of flat against it as is the case in the ordinary mosquito. The anopheles mosquito lays its eggs in stagnant water. If all the pools of stagnant water were removed, the pest would not breed.

Dr. Low has discovered that the terrible tropical disease of elephantiasis is directly traceable to mosquito bites, and not, as has always been held, to drinking impure water.

CURIOUS THINGS IN CLOUDS.

BY GEORGE J. VARNEY.

There are many actions of kites, when either well up in the sky or in the process of mounting, that are both surprising and puzzling to most observers. For instance, when one of those white-topped, peaked and bulbous masses of summer cloud, the cumulus, passes over a kite, the latter rises and follows after it as far as the string will permit, and high fliers even pass up through these, and may soar hundreds of feet higher.

Sometimes in midsummer the cumulus extends to a height of eight or nine thousand feet, while its base may be two or three thousand feet above the ground. In spring and autumn these clouds, are very much lower, and their depth is not half so great; while in the winter the cumulus rarely exists, because of the cold.

As soon as a kite enters one of these clouds, it begins to gather moisture. In the chillier atmosphere above the snow-like peaks and domes the moisture freezes; and if the kite is quickly drawn down, its surface will have a beautiful covering of extremely small ice crystals. This will sometimes happen also with the nimbus. The experiment helps us to understand better the structure of clouds and the formation of rain and snow.

A block of ice, as it is taken to the icehouse, generally shows two or more layers differing in color and texture, having been frozen at different times and under different conditions of temperature and wind. Similarly, there are layers or strata of atmosphere, one above the other in the sky, marked by different temperatures and other features. A stratum of the atmosphere is usually about a thousand feet deep, sometimes much more. Generally, too, the air of these various strata is flowing in different directions, which we may note by the movement of the clouds peculiar to these elevations.

In the region next above the cumulus another form of cloud, the stratus, has its home. In these the colder, denser vapor is extended horizontally in long masses, more or less thin and splintery.

Far above the stratus floats frequently a cloud of more ethereal appearance, the cirrus. It is always somewhat in the form of a brush of long plumes, or of long, untrimmed horse tails tossed by the wind. These clouds are composed of exceedingly delicate feathery crystals. As the cirrus is the highest of the clouds, so the nimbus, or rain cloud, is the lowest, its usual altitude being from five hundred to a thousand feet.

The different elevations of the several kinds of cloud depend chiefly upon the variations of the temperature in the atmosphere; all kinds being generally lower in winter than in summer. Indeed, in winter the nimbus may almost drag on the ground; being observed as a dense mist, often descending in the form called "drizzle" and "Scotch mist."

The beams of stratus lie horizontally, often piled beam upon beam, of various lengths; and, if not too far above the horizon, individual clouds appear as though at different levels; while the cumulus may spread out in thick fleece-like masses, and, instead of towering like mountains, approach the stratus form. Both these kinds of cloud sometimes lie in wavy lines, indicating in the respective stratum a rolling-wave movement of the atmosphere; while more frequently they will have an appearance that suggests a water surface broken by gusts of wind.

To determine the height of clouds, an observer at each of two stations a mile or more apart measures the angle and altitude of some point of a cloud, the identity of which is ascertained from conversation by telephone; while synchronism in the observations is secured by the beating of electric pendulums. This is the method used at the celebrated observatory at Upsala, in Sweden.

Another method for obtaining the elevations, practised at Blue Hill Meteorological Observatory, near Boston, Mass., is (if the cloud is a low one) to measure its angle from the observer, and ascertain the distance of its shadow on the landscape by a local map of large size; the angle of the sun being obtained usually from astronomical tables. Thus the elements of a triangle are in hand, and by these the height of the cloud is readily determined. Its velocity may be learned by timing the passage of its shadow from point to point of known distance.

Another Blue Hill method of measuring the height of low clouds at uniform elevation is to send up kites into and through them. The length of the kite line, and its angle at the moment when the kite disappears in the cloud, give approximately the height of its lower surface; and the records of the barograph (the recording barometer) and hygrograph (the recording hygrometer), both connected with a diminutive clock, the instruments carried up by the kites, mark the upper limit of the clouds; and thus their depth is made known. This is found to vary, in different kinds of clouds, from hundreds to nearly three thousand feet. Still another method that is frequently convenient for determining the altitude of the nimbus, low stratus, and the lower limit of the cumulus, is the noting of their height on the side of a mountain. For learning the altitude of very high and uniform cloud strata, the only practicable method is furnished by their illumination at night, as by brilliantly lighted cities. The angle of a straight line from the observer to the brightest spot of the stratum, the distance of the source of illumination being known, we may readily ascertain the length of the vertical side of the right-angled triangle.

The mean height of the loftiest form of cloud, the cirrus, is found to be about twenty-nine thousand feet, though it has sometimes been observed at an elevation of forty-nine thousand feet—nearly nine miles. The mean altitude of cumulus clouds is about four thousand six hundred feet; but the top of the cumulo-nimbus, or thunder shower cloud, is rarely more than twenty-three hundred feet, while these often sink to six hundred feet when they enswathe hills of no great height, sometimes leaving their tops quite dry.

The average velocity of cirrus clouds is about eighty-nine miles an hour, while in winter they have sometimes been known to travel at the rate of two hundred and thirty miles for the same time.

EXPERIMENTAL FORMATION OF THE FLUORIDES OF SULPHUR.

Messrs. Henri Moissan and P. Lebeau have presented to the Academie des Sciences an account of their experiments in the formation of the fluorides of sulphur; these they have been successful in producing by the use of glass vessels, as Moissan has previously shown that glass is not attacked by fluorine gas when perfectly pure. A glass tube closed at one end is filled with fluorine by displacement, and after closing the end with a glass plate it is turned into a mercury trough. The fluorine acts but slightly on the mercury, forming a layer at the surface.

Into the atmosphere of fluorine is passed a fragment of sulphur, supported by a platinum rod. As soon as the sulphur comes into contact with the gas, it takes fire, being surrounded by a livid flame, and the mercury rises in the tube. The gas remaining after the combustion of the sulphur is not absorbed by water, and only partially by potash solution. The portion of gas remaining, after treatment with an alkaline solution, is very stable and is acted upon only by sodium vapor, etc.

In the preliminary experiments at least two new compounds were obtained; first, a gaseous body not acted upon by water, but absorbed by potash solution; second, a gas not absorbed either by water or by alkaline liquids, but decomposed by sodium vapor. The experiment was repeated a number of times to observe whether both gases were produced, but the result was always the same, no matter what proportions of sulphur and fluorine were used.

One of the gases has been separated by treating with potash solution, and its composition and properties have been studied. The gas is a perfluoride of sulphur, as is shown by analysis. To obtain a considerable quantity of the gaseous mixture containing the perfluoride, a small copper vessel containing 5 to 6 grammes of sulphur is placed in a copper tube whose ends are closed by screw-caps. The tube communicates on one side with the electrolytic fluorine apparatus designed by M. Moissan, and on the other to a copper tube spiral for condensing the gas, this being surrounded by a freezing mixture of carbonic anhydride and acetone, giving a temperature of -80° C. The other end of the spiral passes into a glass flask, in which circulates a current of nitrogen, this being passed into the apparatus for some time before the experiment. The current of fluorine is then passed for about two hours, after which the sulphur has almost entirely disappeared from the vessel, the copper not being attacked; the sulphur has combined with nearly all the fluorine. The spiral condenser is taken off and a copper tube attached to it, whose other end plunges into a mercury bath. When the temperature of the spiral rises, the mixture of fluorides, which has been liquefied or solidified, takes the gaseous from and is collected in a flask above the mercury.

A liter of the mixture is placed with a concentrated potash solution for several hours, thus absorbing all but the perfluoride of sulphur. This gas has the formula SF_6, and is colorless, inodorous and non-combustible. It solidifies near —55° C. to a white crystalline mass. The gas is but slightly soluble in water or alcohol. Although rich in fluorine, it appears to be very inert, and its properties resemble those of nitrogen. It is not decomposed by potash in fusion, nor by chromate of lead; it is decomposed by the electric spark, and upon mixing with hydrogen and treating by the spark in a closed vessel, the volume is diminished with the formation of a solid which deposits upon the walls of the vessel.

The action of various bodies upon the gas has been observed. Chlorine or iodine have no action upon it; oxygen, under the action of the spark, decomposes it with the formation of woolly masses of a brown color, this being a mixture of the products of decomposition; if the spark is less strong, an oxyfluoride is produced. Sulphur at the temperature of fusion has no action upon it, but if superheated in a bell-glass, it decomposes it into products containing less fluorine; selenium has an analogous effect. Phosphorus and arsenic have no action upon the gas, nor have boron, silicon or carbon heated to redness.

Of the metals, sodium has no action, and its brilliancy is not tarnished in the gas, but at its boiling point the surface takes a grey layer and when the sodium vapor is produced in abundance, the combustion takes place with brilliant incandescence and the gas is rapidly absorbed. Calcium is only tarnished by the gas; magnesium takes a white layer upon exposure to it. The experimenters are continuing their researches upon this new product, and will take up the study of the second gas produced by the reaction.

DEATH OF DR. PAUL GIBIER.

Dr. Paul Gibier, the head of the Pasteur Institute in the United States, was killed in a runaway accident at Suffern, N. Y., on June 9. He was born in France in 1851, and after graduating from the medical university at Paris, became Assistant-Professor of Comparative Medicine. In 1885, the French government sent him to Spain to study the outbreak of cholera there; and in the following year he was sent to the south of France to study the same disease. In 1888, the same government sent him to Havana to study yellow fever. On his way home he stopped in New York. He returned the next year, 1890, and started the Pasteur Institute in this country, a specialty of which was originally the preventive treatment for hydrophobia. The anti-toxines were all within its scope.

AN ACETYLENE GAS EXPLOSION.

A Brooklyn inventor had been engaged for some time in building an acetylene gas tank to supply light to his home. After it was completed he turned on the gas and lighted a match to locate leaks. An explosion took place, he was lifted off his feet and hurled across the room, and he died a few hours later. The tank was blown through the ceiling and roof, leaving a hole about six feet square. This is one of the most serious accidents which has occurred in some time in the use of acetylene gas, and emphasizes the fact that amateur generators should be carefully tested before they are put to practical use. Too much care cannot be taken on this point.