Scientific American.
ESTABLISHED 1845

MUNN & CO., - - - EDITORS AND PROPRIETORS.
PUBLISHED WEEKLY AT
No. 361 BROADWAY, - - NEW YORK.

TERMS TO SUBSCRIBERS
One copy, one year, for the United States. Canada. or Mexico........ $3.00
One copy. one year. to any foreign country. postage prepaid. £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS.
Scientific American (Established 1845)............................$3.00 a year.
Scientific American Supplement (Established 1876) .... 5.00 "
Scientific American Building Edition (Established 1885). .... 2.50 "
Scientific American Export Edition (Established 1878).......... 3.00 "
The combined subscription rates and rates to foreign countries will be furnished upon application.
Remit by postal or express money order. or by bank draft or check.
MUNN & CO., 361 Broadway, corner Franklin Street, New York.

NEW YORK, SATURDAY, JUNE 23, 1900.

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