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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

NAVAL BUREAU CHIEFS AND THE SUBMARINE BOAT.

The submarine is one of those devices which have suffered from the zeal of its friends, and the naval world is just now experiencing the first stages of that reaction of sentiment which was bound to follow, sooner or later, as the result of the terms of exaggerated praise in which the submarine has been spoken of, and the claims for unlimited powers of destruction which have been made for it.

Although the submarine has always been more or less in the air, if we may use such a phrase, it was not until the last decade of the nineteenth century, when the French navy began its series of elaborate and very thorough experiments, that the type was brought into the extraordinary prominence which it now holds. To the naturally sanguine Gallic temperament the performance of the "Narval" and her sisters presented a great opportunity for doubling the offensive and defensive power of the French navy at a stroke and for a relatively small outlay of money. England, it was argued, might add battleship to battleship and cruiser to cruiser, at a cost of four or five million dollars a ship, but of what avail was it when France, for an expenditure of a tenth part of that sum per vessel, could people her own and the enemy's harbors and roadsteads with a swarm of death-dealing underwater craft. In the enthusiasm of the new movement it was natural for newspaper correspondents, more or less, and generally less, qualified to write on naval matters, to magnify every performance and minify every defect of the new craft.

Ultimately the submarine fever reached this country, with the result that we have now some seven or eight of these boats, built or building; and even Great Britain, skeptical as she has always professed to be of the value of the submarine, has now under construction some half dozen, two or three of which have by this time been launched and tried. Germany, indeed, seems to be the only first-class naval power that has steadily refused to be drawn into submarine construction. She has none afloat, nor have any been authorized.

It was only a question of time when the inherent, and what would almost seem to be the ineradicable, defects of the submarine would become clearly manifest; and to-day we can see a marked reaction from the temporary extravagant favor with which they have been regarded. It is but fair to say, just here, that the Naval Board of Construction has always been very conservative in its attitude toward the submarine; and its members, collectively and individually, have always urged that we move slowly in adopting a device so radical and largely untried. The fact that we have half a dozen submarines already in the navy is due to the desire of Congress to have some of these vessels included in our fleet. For purposes of experiment and further improvements, perhaps, it is as well that we possess them; but when it comes to a question of building thirty additional submarine boats of the Holland type, as is proposed in the bill before the House, it is certainly time for someone who has technical knowledge and authority to call a halt. This has been done by several of the Chiefs of the Bureaus who are opposed to the purchase at this time of any more of these craft. Rear-Admiral O'Neil, Chief of the Bureau of Naval Ordnance, refers to his opinion on submarine boats in general, expressed by him over a year and a half ago, and he states that he still regards them as experimental craft, whose utility for efficient service has yet to be demonstrated. He considers that the Holland boat does not fulfill all the necessary requirements of a successful instrument of warfare; and he furthermore believes that the whole science of submarine navigation is yet in its infancy, and has not even passed the experimental stage. What we have now to do is to develop submarine boats having fewer limitations than the Holland boats, and this the Admiral thinks can only be done by throwing the door open to other inventors. Nothing more is needed at present than that the government give such encouragement as will awaken interest in the subject, and induce competition among designers and builders in the production of the best craft of the type.

Another strongly dissenting voice is that of Rear-Admiral Bowles, Chief of the Bureau of Construction and Repair, who has submitted a written suggestion to the effect that "the Secretary of the Navy be authorized to procure four or more submarine boats of the most approved design, either by purchase or by construction under contract, or in navy yards, provided that not more than one of these boats shall be procured from or built upon designs of the same individual or company." It is furthermore suggested that before purchasing or contracting for any boat, the Secretary of the Navy must be satisfied that such a boat is, or will be, more effective as a weapon of war than any of the submarine boats heretofore procured or now under construction for the navy. It is proposed that a sum of five hundred thousand dollars be appropriated for this purpose.

The wisdom of the course outlined by these two Chiefs of Bureaus is obvious. The statement of Admiral O'Neil to the effect that the submarine has not yet left the experimental stage, is fully borne out by such tests as have been made with our naval boats of the Holland type; and we therefore sincerely hope that Congress will pass a bill embodying the suggestions made by the Chief Constructor. In speaking of the present submarine as experimental, it is not necessary to particularize. If asked to do so, we would refer to the one important fact that all submarines are "blind." When at the surface, the craft can see; but when it is submerged to its working condition, it is as impossible for the craft to see as it is for it to be seen by the enemy. Among the many problems awaiting complete solution in the submarine, this one of "blindness" is certainly the first. If the bill suggested by the Bureau Chiefs be passed, we venture to say that the experimenting that will follow both by naval men and civilians will be directed first and last to this most crucial point.

A DARING INVESTIGATION OF MONT PELEE.

Interesting reports come to us from Martinique. Prof. Angelo Heilprin, president of the Philadelphia Geographical Society, who has made two ascents of Mont Pelée, has just made known the results of his investigations. Several important discoveries have been made which throw light on the nature of the eruption, and which expose many of the wild exaggerations that always follow a terrible catastrophe. The first ascent of the mountain was made on May 31, and the second on June 1. On the first expedition, when the edge of the old crater was reached, the party was overtaken by a terrific thunderstorm. Clouds of rain and steam from the volcano so completely enveloped them that they were able to see only a few feet. Further progress was impossible, for on account of the electrical disturbances their compass refused to work, varying as much as twenty degrees to the eastward. With great difficulty they groped their way down the steep ridge, slipping at every step; for the rain-soaked ashes afforded a precarious footing and threatened to hurl them down the yawning gulfs at each side. The terrific detonations heard were supposed to be of volcanic and not electrical origin, for when the River Fallaise was reached it was found to be filled with steam and mud indicating a fresh volcanic disturbance. The party reached Acier, caked with mud and much disappointed. However, on the next morning, Prof. Heilprin was ready for another encounter with Mont Pelée. We cannot but admire the bravery and devotion of this man who, with his followers, twice climbed the angry volcano and who once, by a sudden dash during a lift in the clouds of vapor, reached the very lip of the crater, from which point stones could be dropped into the white-hot mass, 200 feet below. Standing on the very brink of the crater, he was witness of a most awful, yet fascinating scene. As was to be expected, the principal output of the crater was steam, and but for a favorable shift in the vapor clouds the party could not have made the valuable observations that they did. So far as known, steam is always found in volcanoes, and seems to be the main cause of the eruption. Scientists divide volcanoes into two classes: The quiet, characterized by a flow of lava, and the explosive, characterized by the blowing out of fragments. Prof. Heilprin states positively that no lava has flowed from the crater of Mont Pelée. One of the main characteristics of the explosive volcano is what is called the "cinder-cone." This is formed of material which is cast out and which drops back around the orifice from which it was thrown, forming a cone. Prof. Heilprin, however, states that no such cone was found in this volcano. What was taken to be a cinder-cone proved to be but a pile of ejected rocks with no central vent. Of course, in the present condition of Mont Pelée it is impossible to state absolutely that there is no cinder-cone, for it was possible to see down only about 200 feet, and it is believed that the crater is much deeper than this. In shape, the new crater appears like a great gash in the mountain, running north and south and expanding into a bowl. The fissure runs transversely to the old crater, and appears to have nearly rifted the mountain. In the first reports of the eruption statements were made that the mountain had been reduced to one-third its original height. This is now shown to be utterly untrue, for from a number of observations taken with an aneroid barometer it was found that the height of the mountain had remained unaltered and that no important topographical changes had taken place. The exaggerated reports may have had their origin in the fact that a dense cloud of steam normally covers the top of the mountain, which might lead to the supposition that the mountain was much reduced in height. From the investigations made, Prof. Heilprin considers violent eruptions improbable. Mont Pelée has freed itself of interior pressure, and while small disturbances may continue to occur, they will probably decrease in frequency and power. However, no one can prophesy with certainty on subjects of this sort. Volcanic action is very little understood; new and unexpected phenomena are continually occurring. The explosion of flaming gases is unprecedented, so far as known, and was probably the main cause of the terrible loss of life. The electrical phenomena were also new, though they probably did not play an important part in the destruction of the city. Specimens collected by Prof. Heilprin show that the lightning bolts were small and very intense, penetrating the walls of the houses. No other volcano was ever so rapid in action, and never before has such a loss of life resulted directly from a volcanic eruption.

THE COMMERCIAL PROSPECTS OF AFRICA.

The declaration of peace in South Africa, which is to be followed by the reopening of the greatest gold-producing mines of the world and presumably by a general revival of business in that greatest consuming section of Africa, lends especial interest to a monograph on Commercial Africa in 1901, just issued by the Treasury Bureau of Statistics. The commerce of Africa, according to this authority, amounts to over $700,000,000, of which $429,000,000 represented the value of the imports. About three-fourths of the imports of Africa are through the ports of the extreme north and south of the continent, those at the north being for the consumption of the more densely populated regions bordering on the Mediterranean and considerable quantities going to the interior by caravans —a large part across the Sahara to the densely populated regions of the Soudan. At the south, a large share of the imports is, under normal conditions, for use at the gold and diamond mines, which lie a few hundred miles north of the Cape, and are reached by railway lines from Cape Colony and Natal at the south and from ports of Portuguese East Africa on the southeast.

A very large proportion of the trade of Africa is with England. There are numerous reasons for this, the most important, however, being that her colonies —Cape Colony and Natal—on the south are the avenues through which pass most of the goods for that section, and that a very large share of the growing trade is also carried by British vessels; while the bulk of the mining, as well as the stock raising and general development of that section, is in the hands of British colonists or capitalists. In the north, a large share of the trade of Egypt is given to Great Britain, whose influence in the management of Egyptian affairs is well recognized; while in Algeria, which has a large trade, a very large proportion is with France, the governing country.

The total recorded imports into Africa, aggregating in the latest available year $429,461,000, were distributed as follows: Into British territory, $157,575,000; French territory, $92,004,000; Turkish territory, $77,787,000; Portuguese territory, $20,795,000; German territory, $8,336,000; and in the Congo Free State, $4,722,000. Of this importation of $429,461,000, about 5 per cent was furnished by the United States, the total for 1901 being $25,542,618. Our total exports to Africa have grown from $6,377,842 in 1895 to $18,594,424 in 1899, and $25,542,618 in 1901. This rapid increase is largely due to the fact that orders sent to the United States for mining machinery and other supplies so much in demand in South Africa are promptly filled with goods of the latest pattern and most acceptable character.

Africa occupies fourth place in the list of the grand divisions of the world in its consuming power in relation to international commerce, the imports of the grand divisions according to the latest available figures being as follows: Europe, $8,300,000,000; North America, $1,300,000,000; Asia, $900,000,000; Africa, $430,000,000; South America, $375,000,000; and Oceanica,

$325,000,000. Of this total of $11,630,000,000, the United States supplies 5 per cent in the case of Africa, 10 per cent of the imports of South America, 10 per cent of those of Asia and Oceanica, 14 per cent of the imports of Europe and 40 per cent of the imports of North America, exclusive of the United States.

Railroad development in Africa has been rapid in the past few years, and seems but the beginning of a great system which must contribute to the rapid development, civilization and enlightenment of the Dark Continent. Already railroads run northwardly from Cape Colony about 1,500 miles and southwardly from Cairo about 1,200 miles, thus completing 2,700 miles of the proposed "Cape to Cairo" railroad, while the intermediate distance is about 3,000 miles. Including all of the railroads now constructed or under actual construction, the total length of African railways is nearly 12,500 miles, or half the distance around the earth.

That the gold and diamond mines of South Africa have been and still are wonderfully profitable is beyond question. The Kimberley diamond mines, about 600 miles from Cape Town, now supply 98 per cent of the diamonds of commerce, although their existence was unknown prior to 1867, and the mines have thus been in operation but about 30 years. It is estimated that $350,000,000 worth of rough diamonds, worth double that sum after cutting, have been produced from the Kimberley mines since their opening in 1868-69, and this enormous production would have been greatly increased but for the fact that the owners of the various mines there formed an agreement to limit the output so as not to materially exceed the world's annual consumption.

Equally wonderful and promising are the great Witwatersrand gold fields of South Africa, better known as the Johannesburg mines. Gold was discovered there in 1883, and in 1884 the value of the gold product was about $50,000. It increased with startling rapidity, the product of 1888 being about $5,000,000; that of 1890, $10,000,000; 1892, over $20,000,000; 1895, over $40,000,000; and 1897 and 1898, about $55,000,000. Work in these mines has been practically suspended during the war in progress in that section within the past two years. The gold production of the Rand since 1884 has been over $300,000,000, and careful surveys of the field by experts show beyond question that the gold in sight probably amounts to $3,500,000,000, while the large number of mines in adjacent territory, particularly those of Rhodesia, whose output was valued at over $4,500,000 last year, gives promise of additional supplies, so that it seems probable that South Africa will for many years continue to be, as it is now, the largest gold-producing section of the world.

CHEMICAL INDEXING BY THE PATENT OFFICE.

BY MARCUS BENJAMIN, PH.D.

During the meeting of the National Academy held this year in Washington, several of the visiting chemists examined with much interest the system of indexing chemical literature now in use in the classification division of the United States Patent Office, and their appreciation of its value was so great that a brief description of that work seems desirable.

The system is a simple one, and in a general way follows the plan used originally by Richter in his Lexicon of Carbon Compounds, and later in the well-known indexes of the Berichte of the German Chemical Society, although it is proper to say that it was worked out by Mr. E. C. Hill, of the Patent Office, without any knowledge of either of these works and is less complex.

It is pertinent in this connection to add that Mr. Hill has already in a somewhat lengthy paper* explained his system and described how it is an improvement over the method used by Richter and by Jacobsen and Stelzner in the Berichte. In this paper Mr. Hill advocated the idea of a central bureau in Washington, to have for its purpose the supervision of the index of chemical literature, and he contends that "some such plan properly matured and carried out to a successful completion would be work worthy of the greatest scientific institution of the national capital, founded expressly for the dissemination of useful knowledge, and would be directly in line with their publication in past years of the indexes to the literature of specific chemical bodies, which has so much redounded to its credit." It is obvious that he has referred in this quotation to the Smithsonian Institution.

The usual library cards are employed, and there are two series of these. The most important one is that giving the formula, and the arrangement of these is governed by the following general rules in the order here given:

1. The number of carbon atoms in carbon compounds.

2. The number of hydrogen atoms in carbon compounds.

3. The alphabetical arrangement of the symbols of the remaining elements (including hydrogen in other than carbon compounds).

In order to make the treatment perfectly clear, let me illustrate the system by taking the compound diphenoldiacetonehydrazone, of which the constitutional formula is $C_{12}H_6(OH)_2[N_2HC(CH_3)_2]_2$. Arranging the atoms according to the foregoing rules we will have as the empirical formula $C_{18}H_{22}N_4O_2$, which is then written at the top of the card with the reference below. In this case the reference happens to be Part 6 of the third volume of Roscoe and Schorlemmer's Treatise on Chemistry, where that compound is described as crystallizing "in rhombic plates, melting at 200 deg., which are insoluble in alcohol and ether, sparingly soluble in ammonia, but readily in caustic."

The value of this index is clearly apparent. An inventor describes a compound of which the empirical formula is as above possessing properties as described, and its identity is established at once. A long and tedious search among the many volumes of chemical literature is unnecessary, for in five minutes the card tells the exact facts in the case. These formula cards begin with compounds containing one atom of carbon and extend through many thousands until an end is reached with the formula $C_{867}H_{1363}CuN_{223}O_{258}S_4$, representing one of the blood pigments, known as homocyanin.

The second series of cards comprises those on which the name of the compound is given with a cross reference to the formula; thus, for instance, there is a name card for "acide acetique" with reference to the formula $C_2H_4O_2$, i. e., acetic acid. The chief value of these cards is to catch special or uncommon names that might otherwise escape the attention of the examiner.

The books already indexed are nearly fifty in number, and include such important works as Roscoe and Schorlemmer's valuable Treatise on Chemistry, the various text books by Ira Remsen, the SCIENTIFIC AMERICAN Cyclopædia of Receipts, Notes and Queries, the several indexes to chemical literature published by the Smithsonian Institution, and many special works on technology, as well as the letters patent issued from Class No. 23, on chemical, and Sub-Class No. 24, on carbon compounds of the United States Patent Office. Many of these books have been indexed page by page, while cards from the others have been made up from the indexes only.

Work is now being done on the collective indexes of the Chemical Society of London, and on the collective and annual indexes of the Society of Chemical Industry. Already more than 200,000 cards have been made, and it is easy to see that the references will reach into millions before the work is brought up to date.

It is a special pleasure to call the attention of the readers of the SCIENTIFIC AMERICAN to this valuable work, which was undertaken by Mr. Edwin C. Hill some three years ago, and to whose active interest and belief in its utility the world at large owes a debt of gratitude. Mr. Hill has been fortunate in receiving the hearty co-operation of his immediate superior, Mr. Frank C. Skinner, chief of the classification division, and Commissioner of Patents Allen, who is constantly on the alert to introduce improved methods in the Patent Office, has given this index his cordial support.

* On a System of Indexing Chemical Literature; adopted by the classification division of the United States Patent Office. Journal of the American Chemical Society, xxii, 1900, pp. 478-494.

SINKING A SHAFT BY FREEZING.

An interesting experiment with the freezing system of shaft sinking is being carried out at the Washington Colliery in the North of England. This process, the patent of Messrs. Gebhardt and Koenig of Nordhausen, has been found indispensable for sinking a shaft where the peculiar conditions of the soil, such as sand or sliding clay, prevent the shaft being sunk in the ordinary way. At this Washington Colliery, when operations were commenced for sinking the shaft, it was discovered after the surface earth had been removed, that the next geological stratum consisted of wet and "quick" sand. Had attempts been made to bore the shaft through such a stratum as this by conventional means, the water would have penetrated into the hole, and the sides would have fallen in, endangering the lives of the artisans below. Also, if pumping had been tried, the pumps would have brought away sand as well as water, and thus have caused a still greater collapse. The bed of sand is 80 feet in thickness, and is followed by 30 feet of bowlder clay.

The "freezing" process consists in freezing the sand around the shaft ring until it becomes perfectly solid. When the site of the shaft was decided upon, a ring pierced with twenty-two holes was bored in the ground, the diameter of the ring being 22½ feet. Into each of these holes an iron pipe was placed, having within it a copper tube, with a perforated bottom. A freezing mixture comprising brine of chloride of magnesium 26 per cent, cooled by means of the liquefaction of ammonia, was run into the copper tubes, passed through the perforated bottoms into the iron tubes—which were closed at the ends—and passed back to the tanks, so that a constant circulation was kept up. The temperature of the brine was 20 degrees below zero, and this had the effect of freezing the ground around the pipes so solid that the result was a circular wall of frozen sand as hard as rock. The excavators then removed the soft sand inclosed by the frozen wall, chipped the wall in to the form of a perfect circle, put up a temporary "tubbing," and so proceeded downward. The ground took seven weeks to freeze.

The wall was approximately 10 feet thick at the end of seven weeks' freezing, and 4 feet of this is being chipped away, leaving 6 feet remaining. As the hole deepens, the pipes are carried down with it, and the wall, once frozen, is to be maintained in this condition until the stone head is reached. Then it will be replaced by a brick wall, or rather by two brick walls, with a brine mixture between them. By the employment of this method, pumping is dispensed with. No water can get through the frozen area, and it is as safe from collapse as if it were the solid rock. The opening of the shaft is completely covered up, and trap-doors are provided for the passage of the excavated earth and workmen. The interior of the shaft at the working face is illumined with electric light, and the cold is intense.

PRELIMINARY WORK ON THE $3,000,000 GOVERNMENT CONTRACT IN THE PHILIPPINES.

BY A. W. CLAPP.

The government contract awarded a short time ago to the Puget Sound Bridge and Dredging Company for the improvement of the harbor of Manila and the building of a complete coaling station at Cavite is one of the largest contracts of its kind ever given to a single concern. Three contracts in number, aggregating about $3,000,000, were awarded. That of the improvement of the harbor comprises two contracts amounting to $2,500,000, while the third and smaller one is for $600,000.

Harbor improvements comprise the dredging of that portion of Manila Harbor at the mouth of Pasig River, 4,500 feet wide by 8,011 feet in length; in other words, the removal of over 5,000,000 cubic yards of material; the building of 8,000 feet of stone breakwater, the top of which will be finished with a capping of concrete; the building of 4,500 feet of rough stone with no finish along the front of the walled city, following the contour of the famous Malacan drive.

The smaller contract is for the construction of a coaling station located at Ianglei Point in the vicinity of the arsenal at Cavite. The principal work here is the building of mammoth steel coal bunkers, for which 4,500 tons of structural steel, 3,500 piles, 500,000 feet of lumber, 50,000 barrels of cement and a large amount of rock from the quarries will be used.

The preliminaries for this work, before a yard of rock can be laid or a foot of earth dredged, are fair-sized contracts in themselves. First the company has established headquarters at Manila, near which are the company's ship yards. Here will be built a fleet of a dozen scows and a steel launch which will be used to tow the stone from the quarries across the bay. These barges will be 125 feet in length. The dredge will be shipped from the United States and put together at the yard. It will be a suction dredge built of steel.

Across the bay, 30 miles distant, are the quarries, where a large plant has been constructed. An aerial tramway, with a 1,000-foot span, extends across a small stream, by which barges are loaded. The tramcar can transfer 1,000 tons of rock every 24 hours. In all, 240,000 tons of rock are to be taken from this quarry and towed a distance of 30 miles across the bay to Manila.

A large wharf has been built at the quarry, at which vessels can land. Besides this, roads have been constructed and a water supply established. These improvements, with drilling, hoisting and engines, will cost in the neighborhood of $400,000.

The plant for work on the coaling station will cost about $75,000. Here will be established a ship yard, where more scows will be built as well as a small tug.

In the construction of the wharves, barges and ship yards and work of all kinds, a million and a half feet of lumber have been used, besides many thousands of piles. All lumber and piling is of Douglas fir, and was shipped from Seattle. All hardware and groceries for the subsistence of the two camps have also been shipped from that point. The company will also have all coal used on the entire contract shipped from the United States.

When all preliminaries are completed work will be pushed as fast as possible. With the building of the breakwater in Manila Bay, which was commenced by the Spanish government and left half finished, the harbor will be one of the finest in the Orient. As the Pasig River is crowded when heavy storms are raging, as well as the bay, the breakwater constructed will give a refuge to all ocean-going craft of the world.