$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.