The three-phase alternating current system of transmission was adopted, as this was considered to be the most economical for this plant. At present it will be operated at a potential of 6,800 volts, but ultimately, as the demand increases, the voltage will be raised to 16,500. The generators, Fig. 3, are of the inductor type, with stationary armatures and rotating pole pieces. They consist of two stationary armature rings which are connected both mechanically and magnetically by the outside cover or frame. The rings are built up of laminated plates and carry the coils by means of projecting teeth. The inductor ring is cast in sections and bolted to a massive spider which is keyed on the main shaft. Fifty-five pole pieces of a general yoke shape are carried upon the periphery of the ring.

The generators rest on a floor of concrete immediately above the water tanks of the turbine. The generator shaft, as already mentioned, is connected to the turbine shaft by means of a flange coupling which is welded on the inductor wheel, being keyed to a boss near the center of the shaft. The great size of the generator may be judged from the fact that the outer cast iron frame is 22 feet 5 inches in diameter. It consists of four separate castings, each of which has two standards or feet which rest directly upon the cement floor of the engine room. The frame is divided horizontally into two parts which are bolted together.

The turbine wheels on the lower part of the shaft weigh altogether thirty-five tons and the inductor wheel and the upper shaft weigh twenty tons, making a total of fifty-five tons in all. This, of course, necessitates a very solid support. It consists of two semicircular castings and is 15 feet in diameter. Its outer edge is carried by an annular bed plate let into a cement foundation on the concrete floor. To save the great waste of power due to the friction of this load, oil is pumped into the bearing under pressure of 350 pounds to the square inch. The oil, which is forced to the inside, runs through the vertical bearing and keeps it clean. That which is forced outwardly is collected for use again. The normal output of each dynamo is about 720 killowatts and the efficiency is calculated at 92 per cent. The machines are excited by three 150 horse power rotary transformers. Transformers are also used for lighting the power house and the surrounding grounds. Five of the generators will be set aside for lighting and the other fifteen are intended for power and for electrochemical works. The poles for the high pressure feeder are shown in Fig. 7. The insulators are built to withstand a working pressure of 16,500 volts. The three large insulators on one side of the pole are for the lighting mains and the three on the other side for the power mains. The mains are of bare copper, and silicium bronze wires of smaller diameter will be used for the telephone wires and testing wires, which are placed below the guard nets shown by dotted lines in the figure. Charge for current for lighting purposes will be about ten cents as a maximum per unit, with a scale of discount varying from 5 per cent, if the average demand extends over 500 hours, to 80 per cent if it extends over 6,000 hours per year.

It is hoped that the construction of this fine plant will transform the district of the Upper Rhine into a manufacturing center of considerable note. The company has acquired considerable tracts of land on both the Baden and Swiss sides, which it is hoped will in time be utilized for the erection of manufacturing plants.

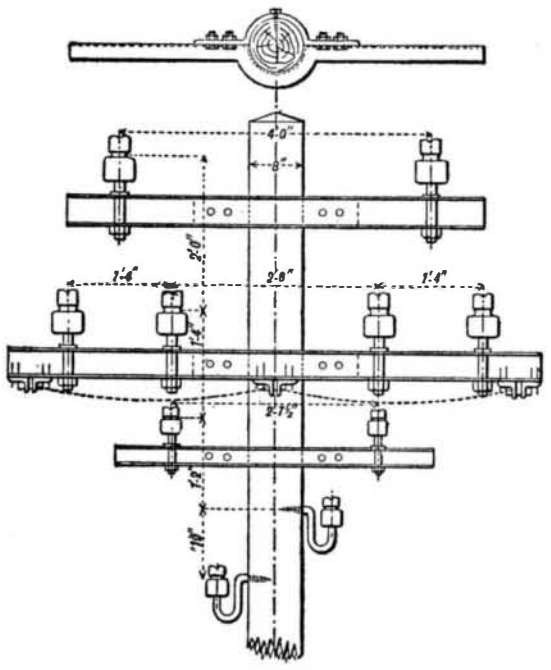


Fig. 4.—POLES FOR THE ELECTRIC TRANSMISSION.

Arctic Life in Glacial Times.

Recent critical studies on the fossil fauna and flora of the Arctic regions tend to make one hesitate in accepting the conclusions of Heer that the climate of the polar regions was tropical up to the time of the glacial period. Mr. J. W. Gregory, in Nature, brings together testimony which goes to show that the vegetation and animal life has always, from the earliest geological times, not been tropical, and that the earth's climate, even from the beginning, was not entirely uniform. Nathorst, on examining Heer's type specimens from the tertiary Disco beds of West Greenland, finds that his conclusions, as stated in every geological text book, were "based upon specimens too fragmentary to be of any value," and that half of the genera and species must be suppressed. Thus no palms, the plant most indicative of a tropical flora, occur; but big leaved trees whose leaves resemble those of the plane, maple, and lime did occur; but botanists distrust the evidence of leaves alone. Robert Brown examined the plant beds at Disco and found that in no case were the leaves attached to the stems, and quoted and apparently approved Steenstrup's remark, that "perhaps they (the leaves) were blown by the wind to their present locality." So Brown, says Nature, saw no evidence that the West Greenland plant beds mark the site of ancient forests. Gregory then goes on to suggest that the Disco deposits might have been drifted from warmer regions. He claims that the quantity of driftwood cast upon the Arctic shores is "enormous." Many raised beaches are strewn with pine and larch logs. Most of the Arctic driftwood consists of logs of pine and larch from the Siberian forests, but blocks of mahogany from Central America sometimes occur, and West Indian beams are not uncommon. However this may be, the evidence brought out by Heer strongly leads us to suppose that the tertiary vegetation of Greenland, if not tropical, was probably temperate, like that of the Middle States and California. Fossil coral reefs have also been asserted to have existed in Silurian and Carboniferous times in the Arctic regions, but in reality, says The Independent, no true reef builders exist there; and at the present time isolated cup corals are still living in the polar seas, at considerable depths. Gregory then concludes, on examining the evidence derived from our knowledge of six fossil faunæ from the Silurian to the Cretaceous, that: 1, They are often rich in individuals but poor in species; 2, crustacea, trilobites, polyps, etc., are proportionately common and often large in size; 3, compound corals are scarce, and occur in nodules instead of in reef building masses; 4, sea urchins and sea lilies are extremely scarce; 5, there is a striking poverty in new or special types. These are, in the main, the characteristics of the existing Arctic fauna, and it seems reasonable to conclude that all through geological time the polar flora and fauna have been more barren than those elsewhere. In Jurassic times there were probably climatic zones, which appear to have been parallel to the equator as now; so in tertiary times—for from whatever direction we approach the pole, the fossil floras "become sparser and more boreal in aspect, as we may see by a comparison of the plants of Disco Island and Grinnell Land, of the Great Slave Lake and Prince Patrick Land, of Iceland and Spitzbergen, and of Saghalien and New Siberia."

LIGHT DRAUGHT GUNBOATS FOR THE NILE EXPEDITION.

In view of the military expedition which the British government is conducting in the Upper Nile country, the illustration which is herewith presented of one of the new gunboats which have been built for river service above the cataracts will possess special interest. These vessels, which have been constructed by Messrs. Yarrow & Company, of London, who have kindly furnished the photograph and particulars, are 145 feet in length by 24 feet 6 inches beam. The hull proper is 6 feet deep, and carries a superstructure, as shown in the illustration. The draught is 2 feet when carrying a load of 35 tons. The hull is built in eleven floatable sections, which can be easily put together while afloat, thereby avoiding the difficulties and delays incidental to riveting together and launching, and also avoiding the necessity for a large number of skilled hands. The machinery consists of two pairs of compound surface condensing engines, supplied with steam by two Yarrow straight-tube water tube boilers. The vessels are propelled by twin screws. The speed on trial was between thirteen and fourteen miles an hour.

The design illustrated was got out at the request of the Egyptian government by Sir William White, and it will be seen that it embodies a thoughtful and well matured scheme It will be within the recollection of our readers that Messrs. Yarrow & Company, about ten years ago, built a number of shallow draught stern wheel gunboats for the Nile expedition under the command of Lord Wolseley. These vessels proved very successful at the time and still more so during last year, when they took a leading part in the advance toward Khartoum.

The boats used in the former expedition were stern wheelers, but it has been determined by the advisers of the Egyptian government that vessels capable of carrying guns of greater power at a higher level would be desirable. It was decided, therefore, that stern wheelers were not desirable if any other means of propulsion equally efficient could be devised, because in the case of stern wheel machinery the engine room and stokehold staff, as well as the boiler and engines, are necessarily much exposed. It was also essential that the vessels should be capable of being shipped to Egypt and transported by rail to the Upper Nile; and moreover, to avoid the delay and difficulties incidental to riveting up and launching, it was determined to have the sections floatable, as the risk of passing the cataracts if the vessels went out whole would be altogether prohibitory. This system of construction in floatable sections was first introduced by Messrs. Yarrow in a stern wheeler built by them for the King of the Belgians for the navigation of the Congo.

In order to get the desired result as regards propulsion, it was evident that ordinary screws would not be advisable, and Messrs. Yarrow & Company had recourse to a device which they have adopted for some years with great success. In the bottom of the boat, near the stern, two tunnels are raised, and in each of these one of the twin screw propellers revolves. These propellers are of very special design. The upper part of the tunnel is as much as 2 feet 6 inches above the waterline. The working of the screws drives any air that may be present out of the tunnels and its place is immediately taken by water. As the space within the tunnels above the waterline is wholly shut off from the surrounding atmosphere, the water itself, as it were, seals this airtight compartment, and the tunnel remains full of water, just in the same way that a siphon, when once filled, does not empty itself. The screws, therefore, are wholly immersed. On trial the speed was found to be a trifle over 13 miles an hour and the draught of water 1 foot 11½ inches.

One important point in this system of propulsion is

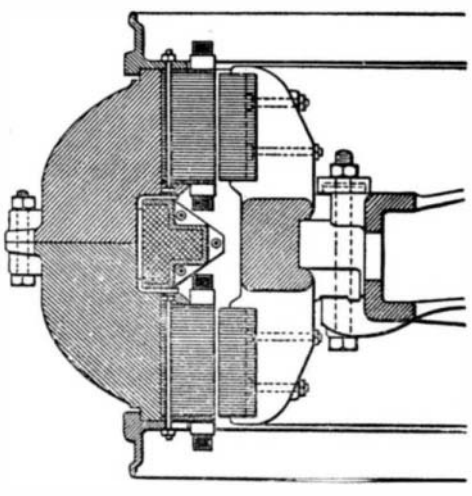


Fig. 5.—DETAILS OF THE GENERATOR.

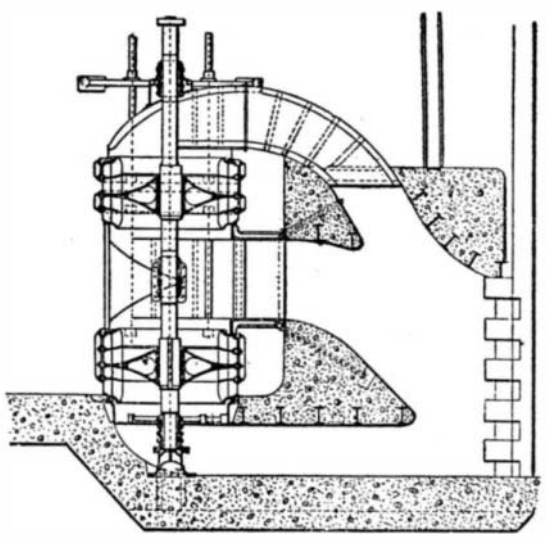


Fig. 6.—THE ARRANGEMENT OF THE TURBINES.

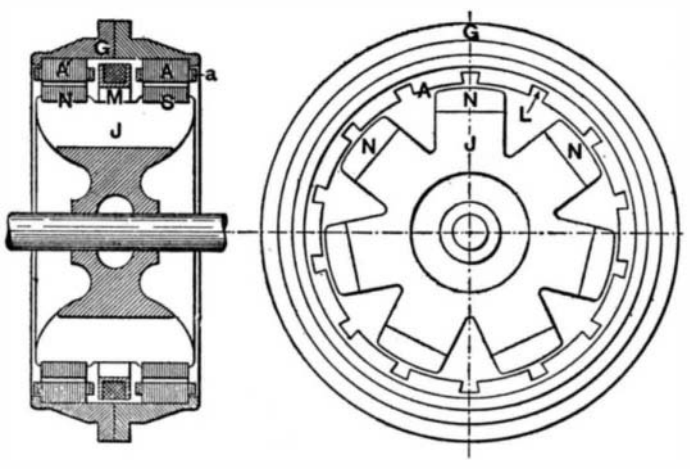
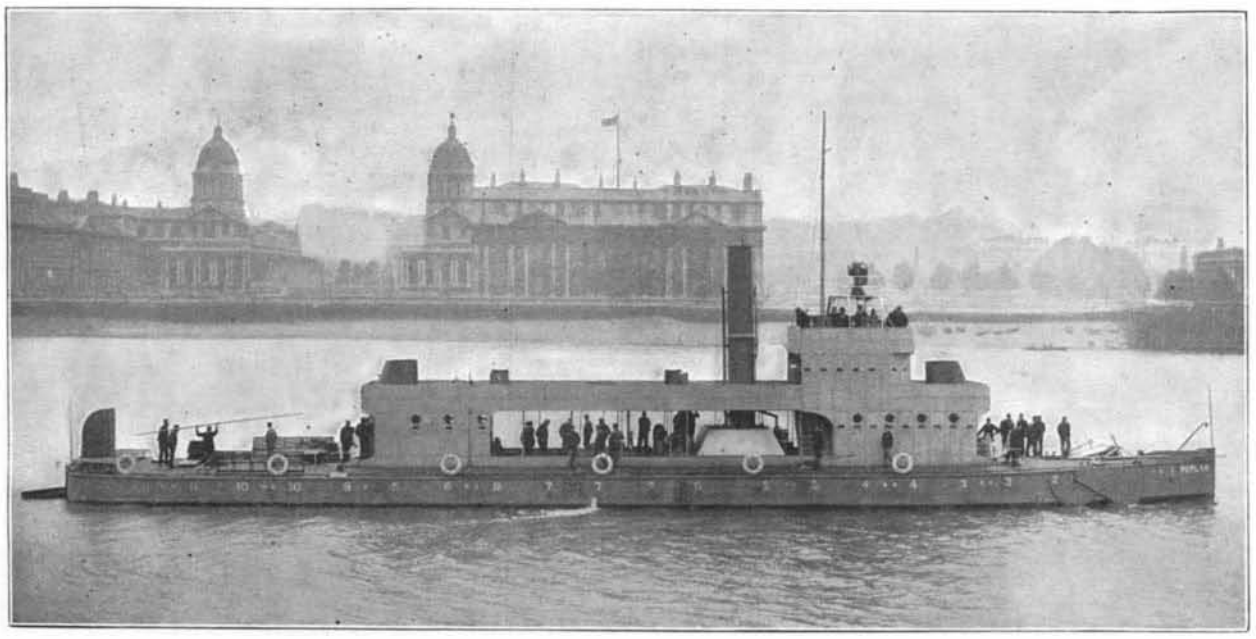


Fig. 7.—DIAGRAM OF THREE-PHASE GENERATOR.

that it offers exceptional advantages for going astern, or what is the same thing, stopping headway; in fact, on the trial it was found that from full speed ahead to a state of rest the vessel would only travel about two lengths. This power of going astern is of the utmost value when navigating rivers which are shallow, the beds of which are continually changing, because on going down stream it is clearly necessary, on approaching a shallow, to stop the progress of the vessel as quickly as possible.

The superstructure, which forms the fighting and inhabited part, is well shown in the illustration. A distinctive feature about these boats is the fitting of leeboards in the fore part, the object of which is to take the place of "deadwood," which is necessarily absent in a flat-bottomed craft drawing only two feet of water. These leeboards perform exactly the same function as leeboards do in a Thames barge by offering lateral resistance, which prevents the vessel blowing off to leeward. Light high-sided vessels are extremely difficult to handle when there is a side wind; and it is to render them easily handled and maneuvered when a side wind is blowing that these leeboards are required. It may be added, however, that the steering when going ahead is so rapid that leeboards under these conditions need not be used; it is only when going astern that they are required. The steering is arranged by means of three rudders worked by steam steering gear.



LIGHT DRAUGHT GUNBOAT FOR THE NILE MILITARY EXPEDITION.

The superstructure consists of two deck houses as shown. These are connected by a flying bridge, 38 feet long by 13 feet wide, while above this is a bridge deck, 14 feet long by 13 feet wide, and above this again is a platform on which is fixed a search light. The deck houses and the central portion of the vessel are made of chrome steel, and the parts surrounding the boiler and engine are of such a thickness as to be proof against the Lee-Metford bullets at 20 yards point blank. The bulwarks of the flying deck also are of the same material, and it will be seen that the cabin sides are loopholed for rifle fire.

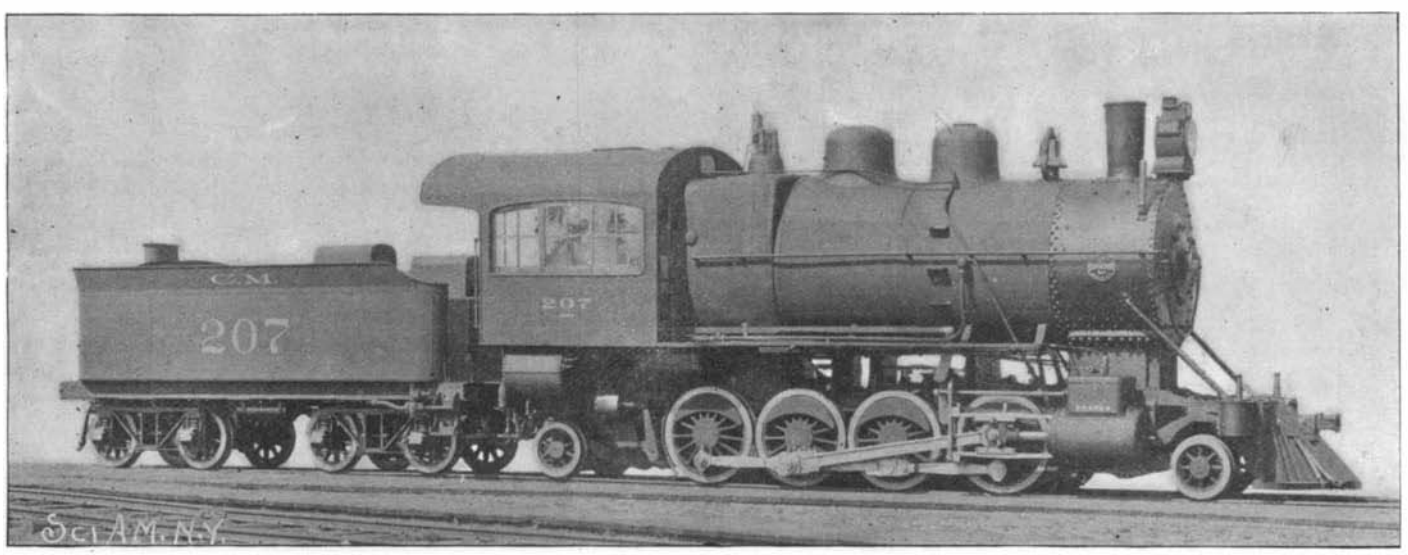
The armament consists of two 12 pounder quick firing guns, placed at each end of the flying deck, the bulwarks being hinged so as to fold down at the ends to form an extension of the platform when the guns are brought into use. On the flying deck also are four automatic Maxim guns, two on each side. Four similar guns are placed in the upper battery or bridge deck, and these are 21 feet above waterline, at which level it is anticipated that these guns will have perfect range over the banks on each side of the Nile.

It is worthy of remark that the arrangement of propellers adopted by Messrs. Yarrow & Company offers a considerable advantage in the fact that the screws can be taken off and replaced while the vessel is afloat. This is effected by means of a movable cover, which is placed on the top of the tunnel, immediately over the propeller itself. By opening this the water in the tunnel at once falls to the general water level surrounding the vessel, and the screw is, consequently, more than half out of the water. The propellers are not likely to get damaged, because they do not work below the bottom of the boat, and are surrounded on all sides by the hull itself. At the same time, it is an immense advantage, if they do get damaged or fouled by any means, that they can be at once got at. As a matter of fact, on a trial made specially to test the time occupied in removing the propeller and replacing it by another, it was found that it could be readily done in eight minutes.

The name of the vessel is now the "Sultan," but she was originally known as the "Poplar." She has already been sent out to the Nile and is probably by this time half-way between Cairo and Abu Hammed, where she is to be put together. A second vessel of the same type is on the point of being dispatched from England, and her erection, it is contemplated, will follow immediately after that of the "Sultan." It may be added that these vessels are calculated to be able to carry, on an emergency, 1,000 troops. There is little doubt that before long we shall hear of the part that these vessels will play in the operations on the Upper Nile in the expedition against the Madhi.

MOUNTAIN FREIGHT LOCOMOTIVE FOR THE MEXICAN CENTRAL RAILWAY.

The accompanying engraving represents the latest and in some respects the largest of those enormous freight locomotives which are being turned out in increasing numbers by American locomotive builders. The tendency in all branches of industry toward concentration, not merely in the vast manufacturing establishments, but in the objects of manufacture themselves, is very marked. In the great field of transportation we see it exemplified in such enormous ships as the Pennsylvania, the Kaiser Wilhelm, and the Oceanic, shortly to be launched, and on land the same tendency is seen in such powerful machines as the mountain locomotives of the Northern Pacific, recently illustrated in this journal, and in the locomotive which forms the subject of this article. The economy of these engines, whose hauling power is fully double that of the locomotives of fifteen or twenty years ago, lies in the fact that they will haul double the amount of freight with the same train crew, besides encumbering the too often overtaxed freight lines less than would two separate trains. Moreover, now that roadbed, rails, and bridges have been brought up to such a high state of efficiency, there is no more wear and tear of the road than there was in the days of lighter rolling stock.



POWERFUL MOUNTAIN FREIGHT LOCOMOTIVE FOR THE MEXICAN CENTRAL RAILROAD.

Cylinders, 21 in. diameter by 26 in. stroke; heating surface, 2,803 sq. ft.; steam pressure, 180 pounds; weight, 193,450 pounds.

The engine was designed by Mr. F. W. Johnstone, superintendent of motive power on the Mexican Central Railroad, and has just been completed by the Brooks Locomotive Works, of Dunkirk, N. Y. It is of course exceeded in power and size by the great Johnstone double bogie compounds built in 1892 for the same road, but as these were practically two locomotives combined in one, they constitute a class by themselves. The total weight of the engine in working order is 193,450 pounds. Of this, 145,200 pounds is on the drivers, 23,450 pounds on the front truck and 24,800 pounds on the rear truck. The engine measures 36 feet 6¾ inches over all, and the total length of tender and engine over all is 61 feet 4¼ inches. The boiler is of the Belpaire type and carries a steam pressure of 180 pounds to the square inch. The firebox, which is carried above the frames, is of steel; it measures 3 feet 2½ inches in width by 10 feet 1 inch in length, and the grate area is 31·45 square feet. In diameter the boiler is probably the largest ever carried by a locomotive, the first course measuring 78 inches and the smokebox 81 inches. It contains 412 two inch tubes whose aggregate heating surface is 2,585 square feet. This added to the 218 square feet of surface in the firebox gives a total of 2,803 square feet for the boiler.

The cab and the running boards are of steel, the former being of an exceptionally neat design, with large side windows. Special attention has been given to the internal fittings of the cab, with a view to placing them conveniently within reach of the engineer and fireman.

The cylinder cock lever is just in front of the engineer, near the floor, while the brake valve and air signal whistle are attached to the right side of the cab. The reversing lever is to the left, and just above it, on the boiler, are the levers which operate the sand box, whistle and throttle valve. A whistle lever is also mounted on the fireman's side of the cab. The steam and air gages face the engineer, while the fireman's steam gage is at the center of the boiler head.

The cylinders are 21 inches diameter by 26 inches stroke, and the driving wheels are 49 inches in diameter. The rigid wheel base is 13 feet and the engine wheel base 28 feet. The shortness of the rigid base was necessary to enable the engine to travel round the many sharp curves of the mountain roads, several of which are as high as 18°. It is expected that it will haul a train of 210 tons weight up a 3 per cent grade 30 miles in length, and it is on this grade that the 18° curves occur. When we bear in mind that the total weight of train and engine will be 355 tons, it will be realized that this will be a great performance.

A NEW PACIFIC STEAMSHIP COMPANY.—The States Steamship Company was chartered under the laws of the State of New Jersey, November 11, with $7,000,000 capital and Charles H. Cramp as president. The company acquires from the International Navigation Company five steamers—Pennsylvania, Ohio, Indiana, Illinois and Conemaugh. They will place them in service between Seattle and Alaskan ports. The Ohio will sail from Philadelphia for Pacific ports. The steamers are due at Seattle by March 1.

BEAUTIFUL black chalk is obtained by mixing ordinary chalk with a suitable quantity of a decoction of logwood to which either green vitriol solution or chromate of potassium is added. By means of either of these substances logwood extract becomes black. The chalk is intimately incorporated with this black solution and from the doughy mass pencils are formed, which are ready for use after drying.