THE GREAT ELECTRICAL POWER PLANT AT RHEINFELDEN ON THE RHINE.

Prominent among the rivers which present conditions favorable to the erection of electrical power plants is the Rhine, and particularly that part of it which extends from Reichenau to Basle, a distance of 154 miles, in which there is a total fall of 1,120 feet. At Schaffhausen, where there is a fall of 90 feet, the Neuhausen Aluminum Works are already established, and are using all the water that can be diverted from the falls without destroying their picturesque beauty. Below the confluence of the Aar and the Rhine there is a constant flow of 77,000 gallons per second, and this circumstance, coupled with the fact that the topography of the surrounding country is favorable to the location of factories, and that in a stretch of the river 1½ miles long, just above Rheinfelden, there are three rapids, with a mean fall of 23½ feet, determined the location of the great power plant which forms the subject of the present article.

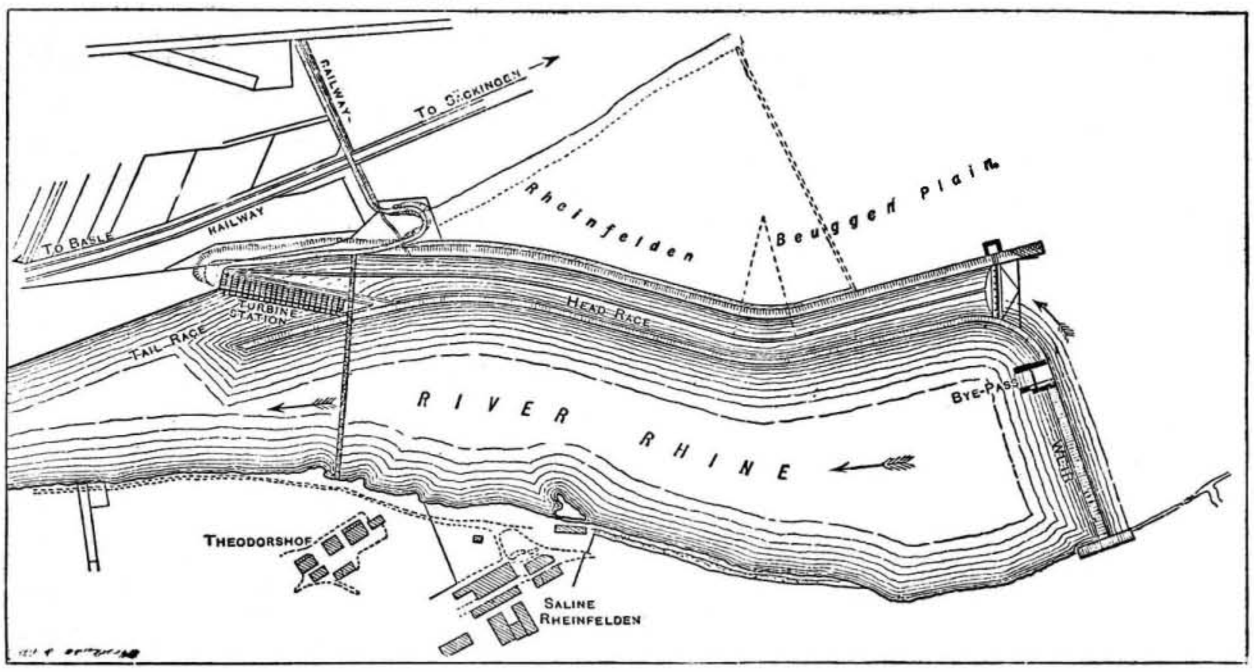


Fig. 1.—PLAN SHOWING LOCATION OF THE POWER STATION, THE DAM AND THE HEAD RACE.

It was originally proposed to utilize the whole low water head of 25 feet, and the first plans estimated that 11,000 horse power could be realized for an expenditure of $2,500,000. The plans were finally modified by Prof. Intze, of Aix-la-Chapelle, and it was decided to use a head of only 16 feet, thereby confining the construction to about 1,100 yards of the river. It was estimated that, to secure 15,000 horse power, the cost of turbines and buildings alone, exclusive of the electrical equipment, would be $1,115,000. The contract was let to Escher, Wyss & Company, of Zurich, and Zschokke & Company, of Aarau, Prof. C. Zschokke taking charge of the work under the superintendence of Prof. Intze. The electrical plant was built by the Allgemeine Elektricitäts Gesellschaft and the Oerlikon Works, to the former of which we are indebted for our illustrations and particulars.

The plan of the works, Fig. 1, shows the location of the dam, which is built clear across the river and contains a sluiceway 65 feet in width, the head race which leads the water to the turbines and the power house. The crown of the dam is 6½ feet broad, and while the back of it has a steep angle, the face slopes gently to the bed of the river. The head race is 170 feet wide, the wall on the river side being 23 feet high, 5 feet broad at the top and 13 feet at the base. The entrance to the head race is protected by screens to keep out rocks, bowlders and rubbish. Here also are located the gates which regulate the flow of water. The sides of the head race are lined with brick and cement. A sluiceway, 20 feet wide, is provided on the right hand side of the turbines for letting out the ice from the front of the screens in winter time.

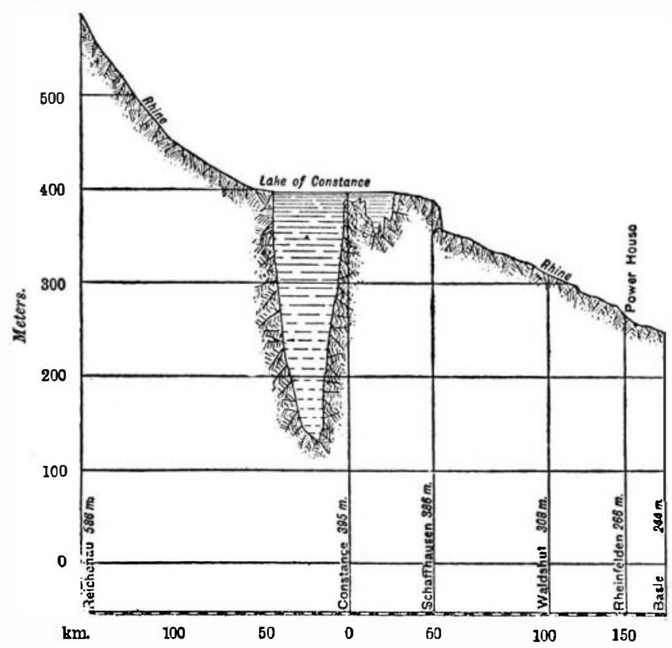
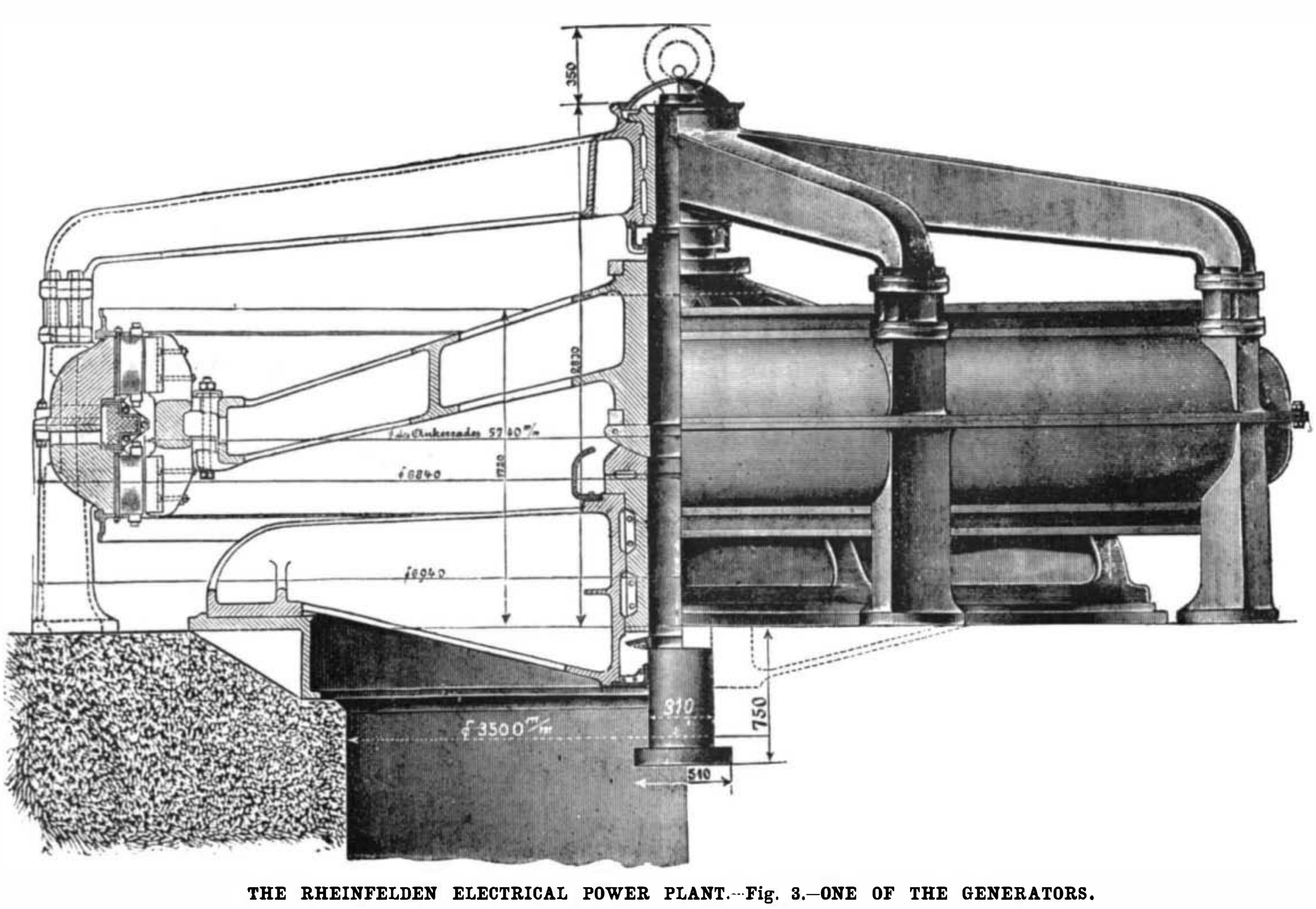


Fig. 2.—PROFILE OF THE RHINE FROM REICHENAU TO BASLE.

The power house has twenty chambers, though only ten of the 840 horse power turbines are at present installed. The chambers measure 18 feet by 33 feet by 49 feet high. The partition walls are 4 feet in thickness. Each chamber is supplied with a balance gate 9 feet wide by 16 feet high for shutting off the water. These gates are moved by a handwheel in the dynamo room, which is situated above the turbine chambers. The gates were built to withstand a pressure of 70 tons. When repairs are necessary, bulkheads will be put in above and below the turbines and the water will be drawn off by electrically driven pumps.

As a result of the large quantity of water, 3,740 to 5,500 gallons per second, which passes through each turbine, they all had to be built with a large diameter and to operate at a slow speed of revolution. It was decided to run the turbines at 55 revolutions per minute, and the design adopted was the Francis reaction turbine, with two turbine wheels superimposed. The wheels, Fig. 6, which are 7 feet 8½ inches in diameter and 4 feet 1 inch high, have each 32 vanes, and the guide frames have each 36 blades, the distance between centers of the wheels being 11 feet.

The lowest guide frame, which rests on a bearing ring cast into concrete, conducts the outflow of the lower half of the turbine to the tail race. A wrought iron receiver rests upon this guide frame and receives the outflow of the upper half of the lower turbine and the lower half of the upper turbine and conducts it into the tail race. Another wrought iron receiver on the upper guide frame leads away the outflow from the upper guide frame. Both wheels are carried on a 12 inch shaft, which is held by three 24 inch bearings of lignum vitæ, which is particularly suitable, on account of its hardness and the large percentage of resin which it contains, for bearings of this kind. The turbines are direct connected to the dynamos by means of a vertical shaft, which is a continuation of the turbine shaft. This works in a metal bearing carried on a cross framework. Regulation is effected by cylinder gates in the lower turbine by means of a four-part gate and in the upper turbine by two independent double gates. When there is a high head of water, the lower turbine is sufficient to supply the necessary power and the upper turbine is entirely cut off. As the water of the river rises, decreasing the head, the lower pair of valve chambers is opened first and then the upper pair



THE RHEINFELDEN ELECTRICAL POWER PLANT.—Fig. 3.—ONE OF THE GENERATORS.

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 semi-circular 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.

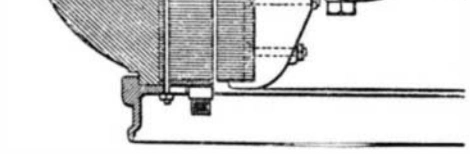


Fig. 5.—DETAILS OF THE GENERATOR.

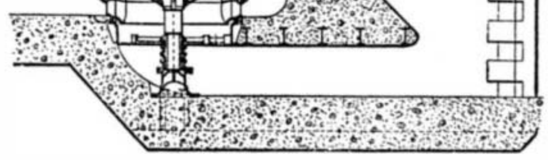


Fig. 6.—THE ARRANGEMENT OF THE TURBINES.

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

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

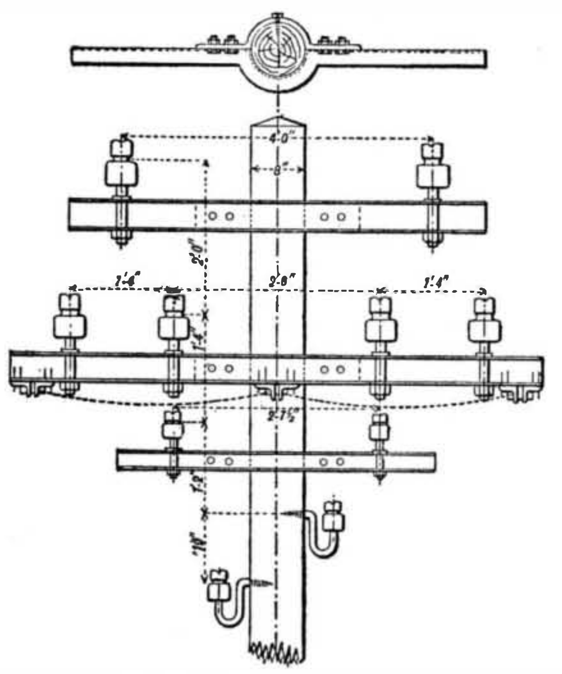


Fig. 4.—POLES FOR THE ELECTRIC TRANSMISSION.

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.

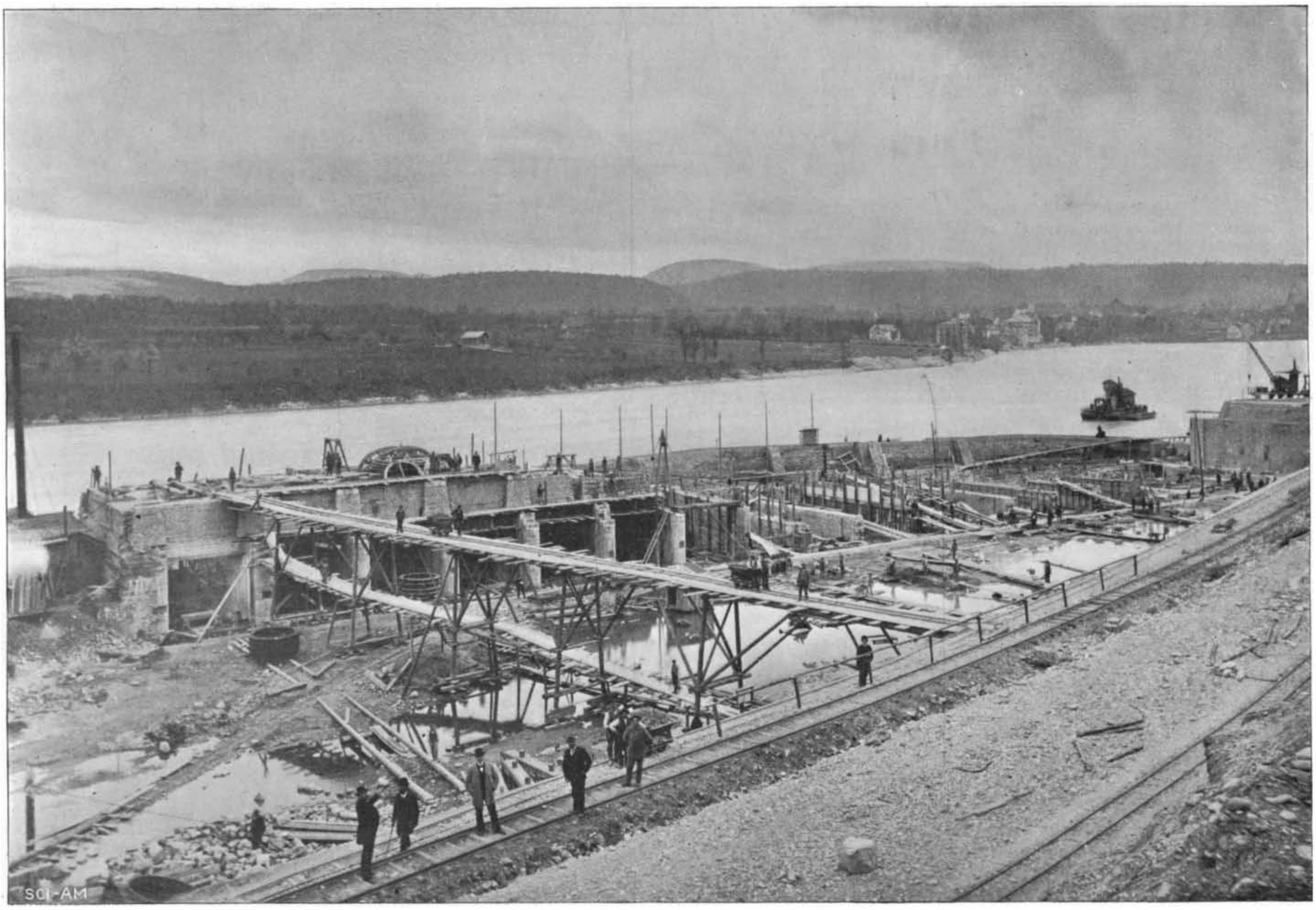
In view of the military expedition which the British government is conducting in the Upper Nile country, the illustration which is herewith presented of one of the new gunboats which have been built for river service above the cataracts will possess special interest. These vessels, which have been constructed 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.

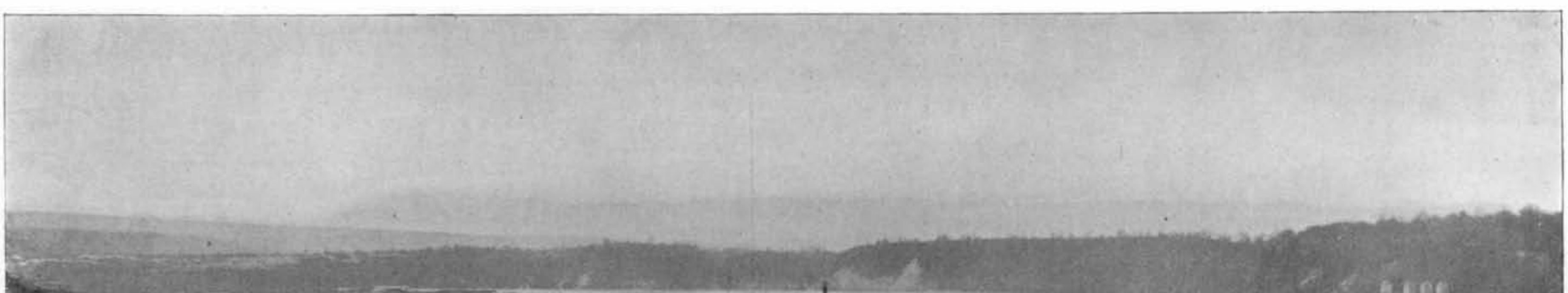
The boats used in the former expedition were stern wheelers, but it has been determined by the advisers of the Egyptian government that vessels capable of carrying guns of greater power at a higher level would be desirable. It was decided, therefore, that stern wheelers were not desirable if any other 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



THE RHEINFELDEN ELECTRICAL POWER PLANT—THE CONSTRUCTION OF THE TURBINE CHAMBERS.



THE CONSTRUCTION OF THE POWER HOUSE OF THE RHEINFELDEN ELECTRICAL POWER PLANT—VIEW LOOKING UP THE HEAD RACE.