of 650 millimeters, which weighs 0.022 gramme, so that 1 kilo. of tantalum metal will make 45,000 lamps. To bring such a length into curved form, as in carbon filament incandescent lamps, is practically impossible. The osmium lamp, which was only used with comparatively low voltage, had the same defect if the curved form were preserved. The beginning of the tantalum lamp consists, therefore, in the application of a frame on which the necessary length of wire is wound. The patents of Siemens & Halske and Scholvien—German patent 159,096—relating to this may include all possibilities in the application of long metal wires for incandescent electric lamps. A process has also been protected by Siemens & Halske to manufacture fused tantalum from the amorphous variety, as well as the application of drawn tantalum wire, and wire from other difficultly-fusible metals, such as zirconium, thorium, yttrium, and erbium—German patents 165,057, applied for October 14, 1904, granted November 24, 1905; 169,565 of May 3, 1903, granted April 5, 1906—for incandescent electric lamps. In order to prevent any possibility of the formation of carbides which would bring about the rapid destruction of the lamp, the pulverized amorphous metal is pressed without the aid of any organic binding material into disks or pads, and then fused in the electric arc in the absence of air or in the presence of some inert gas.

A piece of tantalum heated to redness is transformed under the steam hammer into a thin metal plate, which by heating to incandescence and hammering acquires a hardness like hardened steel, although still flexible.

Siemens & Halske intend to manufacture tools and other articles out of tantalum alloys, and the German patent No. 167,217 granted to this firm means, perhaps, the end of an extensive, and since the twentieth year of the last century, vigorous industry. The tantalum pen is said to have a great resistance against chemicals, to be much harder and more elastic than the steel pen, and on account of this hardness and elasticity, to be indestructible. It exceeds in elasticity the well-known gold nib of the fountain pen, and so these two kinds of writing pens will soon be supplanted, if they succeed in manufacturing tantalum metal at an acceptable price.

In the last annual report of Siemens & Halske it is stated that a large laboratory for the chemical and metallurgical part of tantalum production will be set to work in the early future. Since the obtaining of tantalum mineral now gives no great difficulty, and almost any quantity can be bought cheaply daily, it is to be hoped that the most modern branch of industrial chemistry will soon occupy itself in the valuable production of tantalum metal.

(To be continued.)

CHEMISTRY AND AGRICULTURE.

It has well been said that an experiment is a question put to Nature, and that Nature always answers every question truthfully, but the question that Nature answers and that the experimenter asks is not always the question that he thinks he asks.

In order to determine with certainty the definite cause of a given effect, we must first eliminate other causes or influences which might contribute to that effect. This applies not only to simple qualitative analysis, but also to the application of chemistry to the development of agricultural science and the control of agricultural practice. Chemistry already controls in large measure many industries. Iron and aluminium, zinc and copper, silver and gold, and other metals are extracted and refined by methods largely developed and controlled by chemistry, the preparation and mixing of materials being based upon chemical analysis. Soap, starch, sugar, paper, gunpowder, and fertilizers are only examples of products now manufactured under chemical control.

Progress in agriculture demands that to the greatest possible extent practice shall be controlled by science, not by chemistry alone but by every science that deals with principles fundamental to agriculture. Every science that can contribute to agricultural development is a necessary, and should be a loyal, servant to agriculture, the industry upon whose success rests all industries and all civilizations.

It is only the ignorant who say agriculture is simple. To analyze an unknown substance, to operate a mine or a factory, to manage a bank or a bank failure, to drive a railway locomotive, to erect a cathedral, or to bridge Niagara—these are simple compared with raising on an acre of land the largest crop of corn possible with maximum profit.

Who has sufficient knowledge to select the best seed? What should have been its breeding? What kind of land shall be chosen? How and when shall it be fertilized? What crop rotation should have preceded? Who knows how best to prepare the seedbed? At what time shall the corn be planted? What should be the temperature and the moisture content of the soil? What distance between and how many kernels in the hills? No man to-day can answer any one of these questions with certainty or with satisfaction, and the seed is not yet germinated in the soil, where the bacteria, the fungi, and the insect enemies await the young plant.

The factors and influences are many, but every effect has its cause. Many can contribute to the science of agriculture by gathering facts, but few can interpret the meaning of the facts gathered.

While it is easy to accumulate exact chemical facts, it is easier still to promulgate erroneous agricultural conclusions; and not only the science but the practice of agriculture has suffered, and is suffering to-day, from an insufficient accumulation of facts and data and from an over-production of theories and conclusions.

About three hundred years ago Van Helmont, a Flemish alchemist, planted a five-pound willow tree in 200 pounds of dry soil. He watered it with rain water for five years, and then found that the tree had gained 164 pounds and that the soil had lost only two ounces in weight. Therefore, he concluded, water is the source of plant food. While it seemed to him that his evidence was strong and positive, we all know that his conclusion was wrong, and that the air, the water, and the soil are all essential sources of plant food.

In 1822 William Corbett, in his compilation of the writings of Jethro Tull, made the following statements:

"Mr. Tull's main principle is this, that tillage will supply the place of manure; and his own experience shows that a good crop of wheat, for any number of years, may be grown every year upon the same land without any manure from first to last.

"Mr. Tull continued his wheat crops to the harvesting of the twelfth upon the same land without manure; and when he concluded his work, . . . he had the thirteenth crop coming on, likely to be very good."

It is now known that the conclusion drawn by Tull and Corbett was wrong, although a theory recently promulgated by the United States Bureau of Soils, "that practically all soils contain sufficient plant food for good crop yields," and "that this supply will be indefinitely maintained," is in accord with the teaching of Jethro Tull. Indeed Tull's data are perhaps as trustworthy and conclusive as any thus far reported in favor of this theory.—Cyril G. Hopkins in a bulletin issued by the University of Illinois.

THE SLEEPING SICKNESS.

By A. Acloque.

Public attention has recently been strongly directed toward the terrible sleeping sickness, which at first aroused little interest because it was supposed to be a merely sporadic and comparatively mild disease. On the contrary, it is easily transmissible, epidemic in character, and threatens, if not checked, to depopulate equatorial Africa.

Without repeating oft-published details, it is sufficient to recall that the immediate agent of the disease is a blood parasite, *Trypanosoma zambaise*, one of the flagellate protozoa. The sleeping sickness, therefore, belongs to the class of trypanosome diseases, which are caused by protozoa introduced into the body by blood-sucking insects. (Greek *trypanon*, a boring tool, and *soma*, the body.)

The tsetse fly, *Glossina palpalis*, and its congener *G. fusca* are the insect carriers of the sleeping sickness. The tsetse swarms on the mangrove-covered banks of West African streams, and is very annoying in the hot season. Attempts made in Gambia to transmit the sleeping sickness to animals by the intermediation of this insect gave no decisive results. The conjecture that the tsetse is the carrier of the disease was published, independently, by Sambon and Brumpt in 1903, and the proof was furnished by Bruce and his collaborators, who succeeded in inoculating monkeys with the sleeping sickness by exposing them to the repeated attacks of tsetse flies which had sucked the blood of negroes smitten with the disease.

Bruce, Nabarro, and Greig have made maps of the Uganda showing the geographical distribution of the sleeping sickness and of the tsetse. The two maps correspond closely.

Although these facts might appear to fix the cause of the malady, several points are still obscure, and the solution of the problem, eminently desirable for economic as well as humanitarian reasons, has not yet been reached. A French commission, appointed to investigate the subject, started for Brazzaville last October.

All of the powers which have African colonies have been compelled to give attention to the sleeping sickness. Portugal took the initiative in investigation. Afterward England established permanent experiment stations under the direction of Major Ross, and Prof. Koch received a subsidy of 100,000 marks ($25,000) from the German Emperor and was sent to Uganda, where he is now. The King of the Belgians recently set aside a research fund of 200,000 francs ($40,000) and founded an international prize of 300,000 francs ($60,000).

The French commission was organized by the Geographical Society of Paris, which raised a fund of 200,000 francs ($40,000). Technical instructions and the programme of researches were furnished by a committee of specialists selected by the International Scientific Association. The members of the commission are Dr. Martin, of the French colonial troops, already distinguished by his studies of typanosome diseases in Guinea; Dr. Lebœuf, of the colonial troops, and MM. Weiss, Rambaud, and Muny. The commission is placed under the authority of the minister of the colonies and the commissary-general of the French Congo. All physicians in the French Congo have been invited to communicate their personal observations to Dr. Martin, who will thus be enabled to extend his investigation over an immense territory extending from 15 degrees north to 5 degrees south of the equator.

The following are the chief problems which the commission must solve in order to plan an effective campaign against the disease:

In the first place, it will be necessary to ascertain whether the relation between the geographical distribution of the disease and that of the Glossina is maintained throughout. For this purpose it will be necessary to make, for the whole of the vast region, maps similar to Bruce's maps of the Uganda, showing, on one hand, the infested and, particularly, the exempt localities and, on the other hand, the geographical limits of the *Glossina*, the localities infested by the different species, singly and collectively, and the localities in which no species of the insect has yet been found.

It is evident that the entire value of the apparent connection between the tsetse and the sleeping sickness depends on the elimination of swamp fever, ankylosis, filariosis, and other diseases which might be mistaken for the sleeping sickness. For this purpose early diagnosis by microscopic examination of the blood is necessary.

As there is reason to believe that certain vertebrates in the wild state, including fishes possibly, may serve as hosts of the *Trypanosoma* and therefore as sources of the virus carried by the tsetse flies, the commission will study all trypanosome diseases of animals that may be found to exist in the French Congo.

The researches of Laveran and Mesnil have shown that some Cercopitheci (green monkeys) and all macaques, as well as ouistitis, dogs, cats, and hedgehogs, are very sensitive to trypanosome diseases. Chimpanzees, rodents (especially rats and mice), goats, sheep, horses, and asses are less sensitive, and in them the disease is curable. Hogs, baboons, and some of the green monkeys are entirely immune. According to Bruce, the Bovidæ are also immune, but other experimenters claim to have infected cattle with the disease. These experiments must be repeated, verified, and extended with especial reference to the sleeping sickness.

A very important point in the life history of the trypanosome is still uncertain. Is the tsetse fly merely a passive vehicle for the protozoan, or does the latter complete one stage of its development in the body of the fly? This question is not of theoretical and biological interest alone, it is also of great practical importance. If the fly is only a vehicle, it is evident that the danger of its bite decreases in proportion to the length of time that has elapsed since the same fly sucked the blood of an infected animal. If, on the contrary, the tsetse is a necessary alternative host of the trypanosome, time is required for the change which the parasite undergoes in the body of the fly, which will, therefore, not be able to transmit the disease until the expiration of a definite interval of time after its own inoculation.

The biology of the fly must also be studied, and it must be determined whether the disease can be carried by other species of *Glossina*, in addition to *G. palpalis*, the tsetse, or by insects of other genera. Insects open to suspicion include *Stomoxys*, *Haematobia*, gadflies, mosquitoes, and perhaps bedbugs.

The points in the biology of the arch enemy, the tsetse or *Glossina palpalis*, which especially need elucidation are the following:

The habits of the insect and the places in which it lurks before and after it attacks; the seasons of its greatest abundance; the wild animals which it attacks, regularly or occasionally; and, above all, its mode of reproduction.

From the knowledge of these four points a rational method of destruction may be devised. The last point is of especial importance, for if the mode of reproduction were known, it might be possible to find a substance that would destroy the larvæ, and to wage against the tsetse a war similar to that which has been carried on so successfully against the mosquitoes that serve as carriers of malaria and yellow fever.

The commission will also have to study methods of treatment and protection and, in particular, to test thoroughly those remedies that have already been found useful (atoxyl, arsenious acid, and trypanroth) and to elaborate a plan of protective sanitation, consisting chiefly of the destruction of the tsetse and the isolation of patients in hospitals established in districts not infested by this dangerous insect.—Translated for the Scientific American Supplement from Cosmos.

An important pioneer survey for the construction of a railroad has just been completed in the southern part of British North Borneo by the Government Survey Department. Previously the penetration of this country has been rendered impossible, owing to the ferocity of the Dyaks or head hunters, who massacred all the members of a previous expedition for this purpose with the exception of three natives accompanying the party and who succeeded in effecting their escape. The successful accomplishment of this expedition marks the first occasion in which the interior of the country has been traversed by Europeans. The party comprised four European officials escorted by fifty military police and assisted by one hundred native carriers, but the party were not molested at any time during the journey. The object of this mission was to complete the surveys of the country, about which nothing has hitherto been known, for the continuance of the transcontinental railroad, a section of which is already in operation. This railroad starts from Jesselton on the west coast and runs to Tenom, 95 miles inland and which at present constitutes the terminus of the line. The expedition set out from the last-mentioned point and struck across the country toward Cowie Harbor on the east coast. The distance as the crow flies is 150 miles, but owing to the difficult nature of the country to be traversed, six months were occupied by the party to effect the crossing. The route lay through a vast primeval forest, through which there did not exist even the barest trail, so that the party had to cut their way through the dense growth. It is stated that the extension of the railroad will not prove difficult from an engineering point of view, since the configuration of the country is not very broken, and probably the work of construction upon the remaining section will shortly be commenced. On arrival at Cowie Harbor the party at once set out upon a second expedition for the survey of a railroad from Sandakan northward to Murudu Bay, which will be approximately 300 miles in length, but owing to the fact that the country through which this line will extend is fairly well known, the survey will be enabled to carry out its work with greater facility and expedition.

THE NEW WIRELESS TELEGRAPH STATION AT NAUEN, GERMANY.*

By L. RAMAKERS.

ONE of the most serious inconveniences that have hitherto attended the operation of important stations for wireless telegraphy is due to the employment of wooden towers and masts, to which it is impossible to give strength and stiffness sufficient for all emergencies.

A great advance has been made by the Gesellschaft für Drahtlose Telegraphie of Berlin, which has devised a steel tower of such construction that no loss of current can result from vibrations of the support of the antenna. This novel arrangement, which includes also an antenna of improved construction, has been adopted for the central station for wireless telegraphy which was recently established by the German government at Nauen, about 25 miles from Berlin.

The installation comprises three principal parts: the tower, the antenna, and the operating rooms and apparatus. The tower is a steel skeleton of triangular section, measuring 100 meters (328 feet) in height and 4 meters (13 feet) in the length of each side of the triangle. It consists essentially of three vertical beams connected by diagonal tie-rods. Each beam is itself of skeleton construction, consisting of two plates connected by short diagonal braces, and is made in lengths of 8 meters (26 feet) which are bolted together. This construction continues from the top of the tower down to a level about 6 meters (20 feet) above the ground. Here the beams converge to a ball of cast steel which rests on a plate carefully insulated from the concrete foundation and supports the entire

FIG. 2.—DIAGRAM OF TOWER AND ANTENNA.

weight of the tower. At a height of 96 meters (315 feet) above the ground there is a platform from which it is easy to operate the three pairs of pulleys at the top of the tower by which the antenna is raised and lowered. At a height of 75 meters (246 feet) three anchor cables are attached to the tower to prevent its being overthrown or broken by the wind and to maintain it in a nearly vertical position—not exactly vertical, for the object of pivoting the tower on a steel ball is to allow it to yield to the wind by inclining 20 degrees or less from the vertical and thus lessen the danger of being overthrown. These cables are composed of round eye-bars connected by stout pins and run to three anchorages, each of which is 200 meters (656 feet) from the foot of the tower. The cables are insulated throughout their entire length. In consequence of the high electrical tension—sometimes corresponding to a sparking distance of 1 meter (39

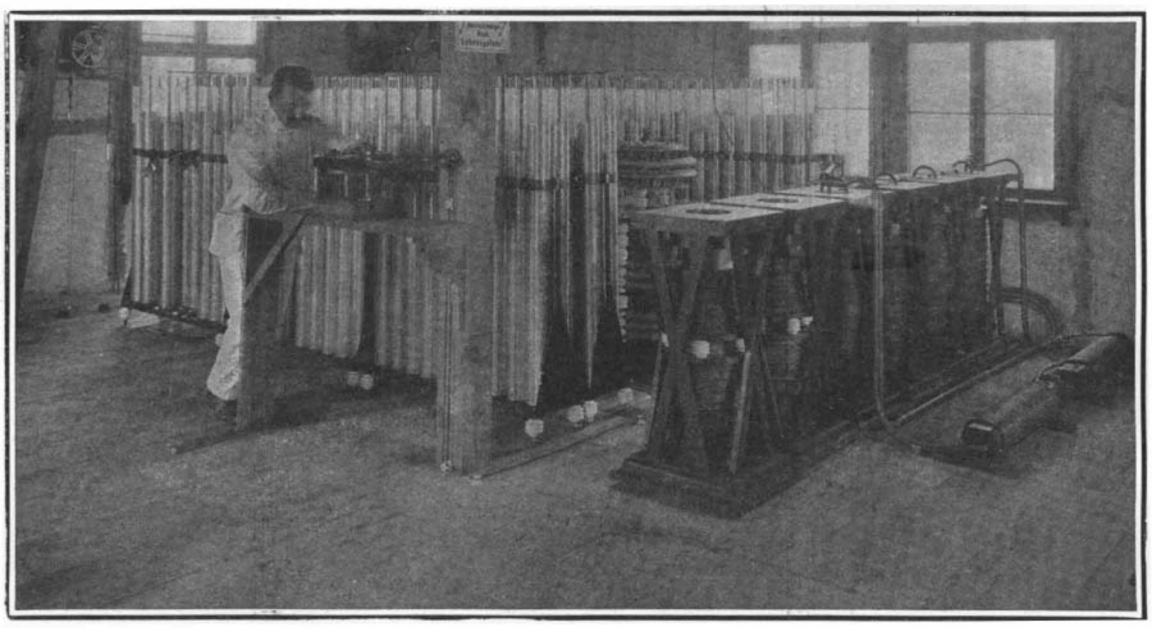

FIG. 3.—APPARATUS FOR THE TRANSMISSION OF MESSAGES.

The attendant is adjusting the annular spark-gap. The tall Leyden jars are seen at the left hand, the transformers and inductance coils at the right of the picture.

inches)—which exists at their points of attachment to the tower it was necessary to employ a mode of insulation by which the cables are constantly bathed in oil. This method appears to have given excellent results. The anchorages are heavy masses of solid

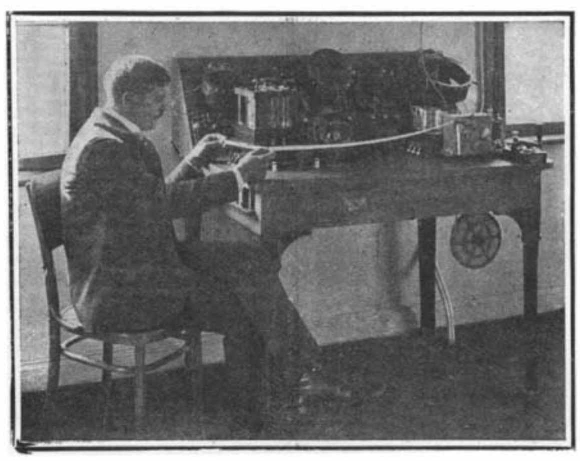

FIG. 4.—APPARATUS FOR THE RECEPTION OF MESSAGES.

brickwork carried to a height of several yards above the ground.

The antenna is shaped like an umbrella, the tower representing the rod. It is divided into six sections, which are so balanced in pairs over the pulleys mentioned above that the horizontal stresses are reduced to a minimum, and the resultant pressure is very nearly vertical. This arrangement, by the way, is patented. Each sector, however, can be detached and lowered separately.

The upper part of the antenna consists of 54 wire cables, nine in each of the six sectors, but at a point one-fourth its length from the ground each cable divides into three so that there are 162 cables at the bottom. To the bottom of each sector are attached two hempen ropes, which are insulated from the wires and are fastened to the ground by pegs at their lower ends. The aggregate surface of the antenna is about 60,000 square meters (646,000 square feet, or nearly 15 acres).

From the top of the tower the nine cables which compose each sector are continued in a parallel bundle to the bottom and thence to the operating room. These fifty-four cables are not insulated from the metallic frame of the tower, which is consequently a part of the antenna.

The ground contact is made through a system of 108 wires buried in the earth. These wires like those of the antenna divide as they diverge so that at the outer part of the system, which extends over 126,000 square meters (1,356,000 square feet, or about 31 acres) there are 324 wires. At the center the converging 108 wires are connected with the apparatus. The site of the station was determined by the unfailing abundance of subsoil water which assured a good "earth."

The operating rooms occupy a brick building which covers an area of 100 square meters (1,076 square feet), to which is annexed a garage for a locomobile. The ground floor contains the dynamo room, the transmitting office, and a workshop that may be used as a dormitory in emergencies. All the high tension apparatus is placed in the second story where it is better protected from dampness and hence more perfectly insulated. Another advantage of this arrangement is that the operator is less disturbed by the noise of the sparks. The building is heated by waste steam from the locomobile and lighted with incandescent alcohol lamps. The interior equipment comprises the source of power, and the apparatus for transmission and reception of messages. The power is furnished by a locomobile of 35 horse-power. The flywheel of the locomobile is connected by a belt with a monophase alternator coupled to an exciter on the same shaft.

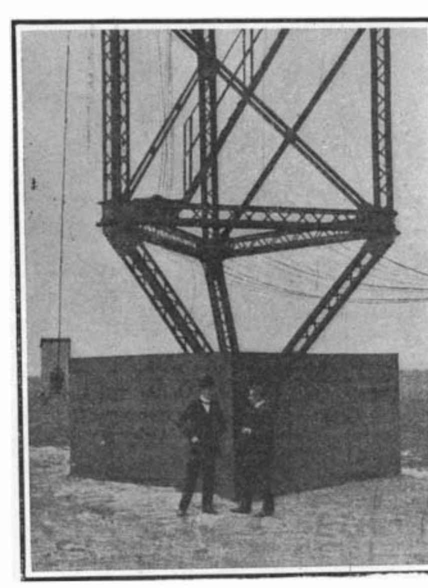

FIG. 5.—THE BASE OF THE TOWER.

The function of the board fence is to hide the secret of the method of insulation.

This generator, driven at the rate of 750 revolutions per minute, furnishes 25 kilowatts of electrical power in the form of a monophase current of 50 cycles per second. It contains a device which prevents the generation of a current of very high frequency.

Two cables connect the dynamo with the switchboard to which are attached a bipolar interrupter with

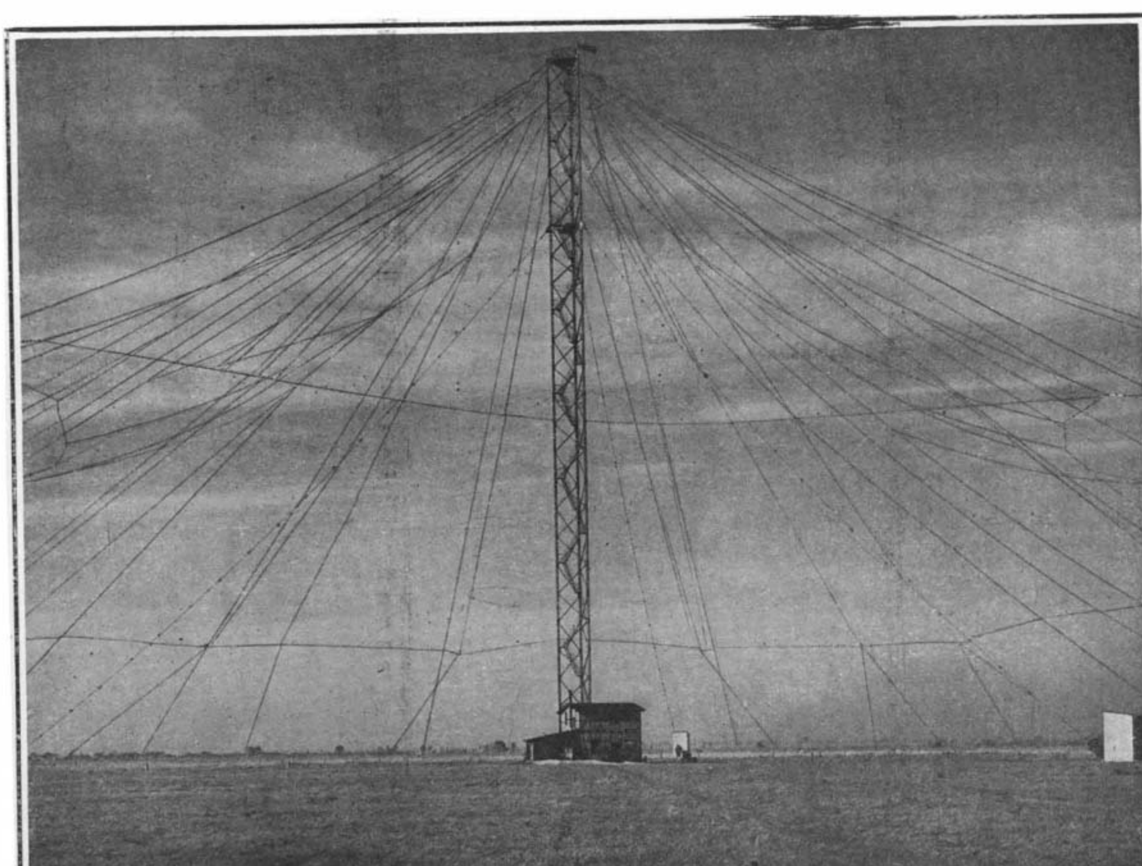

FIG. 1.—GENERAL VIEW OF THE WIRELESS TELEGRAPH STATION AT NAUEN.

The dotted lines are the eye-bar staying cables. In the photograph the cables forming the antenna have been retouched. In reality they are almost invisible.

*Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.