A DESTRUCTIVE THUNDERBOLT.

A rather curious thunderstorm visited the neighborhood of Whitby the other week. There were only two loud thunderclaps, accompanied by two flashes of lightning. The first stroke caused the destruction of a large oak tree in the park of Mulgrave Castle and the second damaged rather seriously a farmhouse in the village of West Barnby, about two miles distant. In the case of the oak tree the electric current seems to have run upward. The ground for several yards was torn up, and the large root of the tree was ripped in

EFFECT OF LIGHTNING ON OAK TREE.

pieces. For a circle of a diameter of 160 yards the ground is littered with heavy pieces of bark and wood, in some cases split into ribbons. We are indebted for our engraving to Black and White.

PETROLEUM WELLS IN THE SUBURBS OF LOS ANGELES, CALIFORNIA.

The discovery of petroleum within the city limits of Los Angeles, California, has so transformed one of the suburbs of that city that as a remarkable spectacle there is nothing to compare with it in any city in the world. The accompanying illustration is reproduced from a photograph taken in one of the outlying suburbs, in which, some three or four years ago, a profitable oil-bearing stratum was discovered. The fact that the oil underlay a thickly settled territory, where most of the land was divided into fifty foot lots, naturally made each landholder anxious to secure the oil before it should be drawn up by his next door neighbor. The consequence was that wells were driven with all possible speed, and a picturesque residential district was very quickly covered by the huge, unsightly derricks and tanks which are to be seen in the engraving. Every consideration gave way to that of securing the valuable oil, and, as a consequence, the pretty cottages with their surrounding lawns and shrubbery were soon incongruously intermingled with all the unsightly paraphernalia of hundreds of modern drive-wells. In his hurry to secure the oil the owner of a little 50 by 150 foot lot in some cases erected as many as five derricks within that area. Naturally this haste to grow rich defeated its purpose, and after a year or two the wells began to decrease in yield. Some of them, it is true, began to yield again later to a limited extent, while other wells have been abandoned altogether Of course the work of recovering the oil might have been done more economically if the property owners of half a dozen lots had combined to sink one well between them, instead of sinking two or three wells to each lot, as they have actually done. In some cases, after the first exhaustion, the wells were sunk to a greater depth, with the result that a further flow was encountered.

Petroleum has been produced in California for many years, and the oil fields seem to extend throughout the whole length of the State, as indicated by the frequent oil croppings. It is only in the southern counties, however, that there has been any development of the industry, and this has been confined mainly to the counties of Ventura, Santa Barbara and Los Angeles. The discovery of oil in Los Angeles has naturally created quite a boom in the industry, and prospectors are busy in other sections of the State.

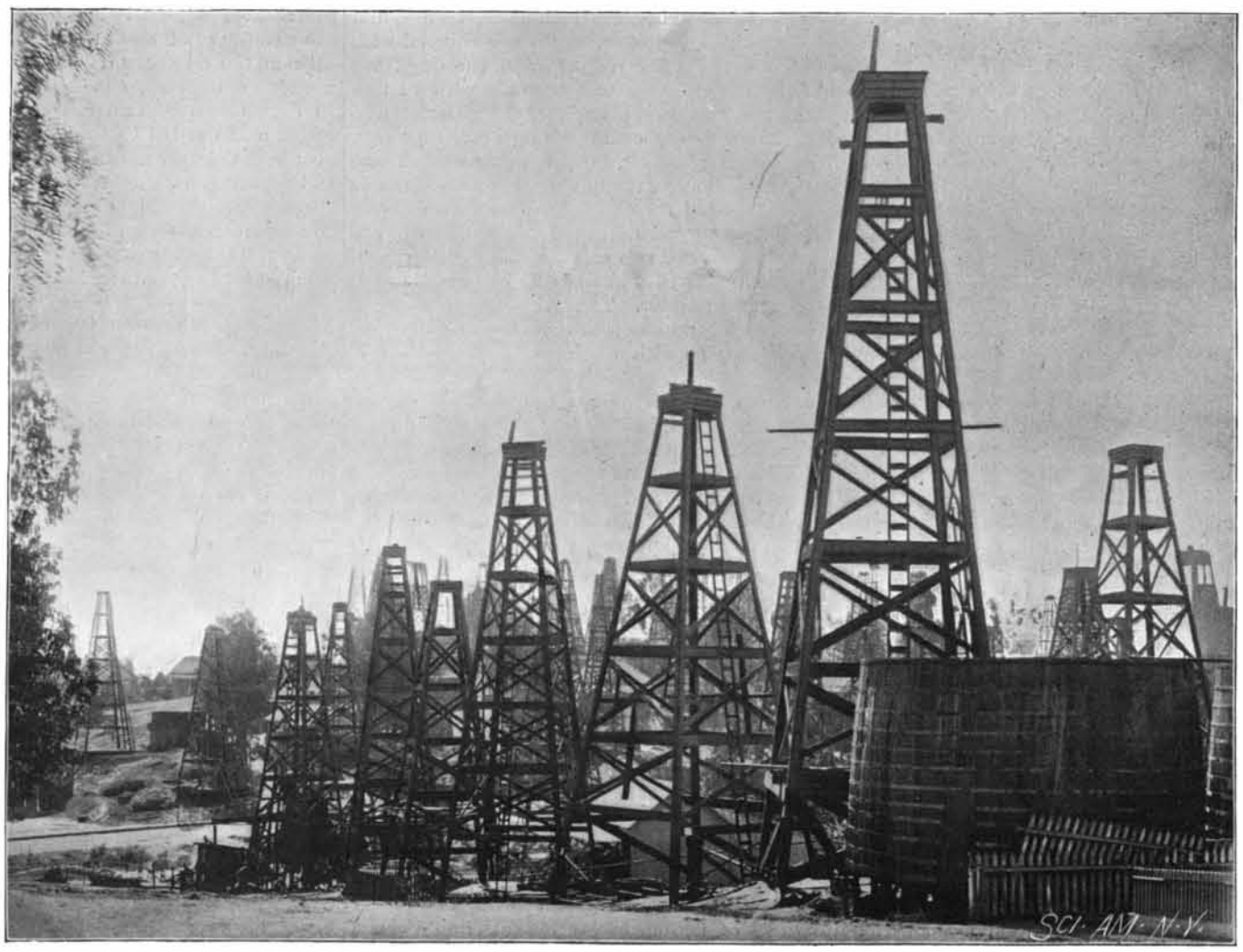
The early Mexican residents of Los Angeles were aware of the fact that there was petroleum in the formation underlying the city, and they used the asphaltum residue of the oil which they gathered at the outcropping for roofing their adobe houses. In those early days the commercial value of the oil was unknown, and the Mexicans made no attempt to utilize it. The first boring for oil was made about four years ago at a point about one mile west of the business center of the city, and since then over five hundred wells have been sunk within the city limits and within an area which extends over a mile east and west and about 600 feet north and south. During the past nine months new wells have also been sunk with a fair measure of success about half a mile beyond the eastern limit of the producing field above mentioned.

The Los Angeles oil differs from that of Pennsylvania in that it has an asphaltum instead of a kerosene base, and is not suitable for illumination. It is thick, and black in color, with a low specific gravity, and it is said to be the best fuel oil that has ever been discovered. It is used for the manufacture of lubricants, paints, printing ink and various other commercial products. The cost of sinking a well varies considerably, but $1,200 to $1,500 may be taken as the approximate cost for a well 800 feet deep.

As was to be expected in a new industry such as this, there has been a considerable fluctuation in the price of the oil in Los Angeles. It was first sold for about $2 per barrel of 42 gallons. The price began to fall rapidly, until it reached as low a figure as 35 cents per barrel. A Co-operative Oil Exchange was then formed, and this, together with the increasing use of the oil in factories and by some of the railroads, brought the price up to $1 a barrel, delivered at the well. At this figure it remained until the spring of this year, when the increased demand caused the price to rise to $1.50 at the well, at which figure it now stands. At this rate it is considered to be a cheap fuel in comparison with coal. A ton of soft coal is reckoned to be equal as fuel to three barrels and a half of oil, which would make the equivalent cost of coal in Los Angeles about $5.50 per ton, at the factory. At this price it is considered that Los Angeles manufacturers should be able to compete with those in the East. The daily yield of oil is from 4 barrels a day in the older wells to 40 barrels a day in those which have been recently bored at the western edge of the field. At the present price, this represents a total output valued at $1,250,000 per year.

It was natural that the development of these fields within the city limits should meet with considerable opposition from citizens who object to see the suburban section of Los Angeles rendered hideous by such a forest of grimy derricks as are shown in the accompanying illustration, and the opposition has been particularly strong since wells have been driven in the direction of the handsome residence section surrounding Westlake Park.

The city council has very wisely passed an ordinance forbidding the boring of wells within 1,600 feet of this park, and it is likely that the disfigurement of the city will be confined to the strip of land to which reference is made above.



AN OIL FIELD IN THE SUBURBS OF LOS ANGELES, CALIFORNIA.

The Borghese Treasures.

Ever since the bankruptcy of the Borghese family in 1892, art lovers have been afraid that this collection, which is one of the most remarkable in the world, would be dispersed, but it is now announced that the Italian government is to pay 6,000,000 francs, about $1,200,000, for the pictures and statues in the museum, while the city of Rome will pay about $600,000 for the great villa and the park which the museum occupies. Now not only will the collection be kept intact, but the villa, which is perhaps the finest of the old Roman villas built by the popes, will also be preserved. The building speculation which ran riot in Rome a few years ago has already destroyed too many of the lovely palatial villas, and it is a satisfaction to have one of them kept from despoilment. The park, which consists of a large tract of rolling meadow and woodland, exhibits in perfection the unsurpassed beauty of Italian landscape art. It has little of the formal gardening of the Villa Medici, and more nearly resembles a great English estate wherein nature is left much to herself. But added to this perfectly free and easy treatment will be found the beautiful ilex trees and stone pines, with here and there an avenue of cypresses. In the villa is preserved the great collection which the government has just bought. The Borghese collection was first formed by Marco Antonio Borghese before 1800. His son, Prince Camillo Borghese, married Pauline Bonaparte, the sister of the Emperor Napoleon, and in 1806 sold to his brother-in-law the most valuable of his treasures, which now adorn the Louvre. Afterward he gathered the new collection which the Italian government has just prevented his descendants from getting rid of. None of the antique marbles are of very great importance, but in modern statuary and pictures the gallery is exceedingly rich. Indeed, it is generally believed to be the most valuable private gallery in the world; it is certainly the most valuable private collection of Italian masters in the world. Perhaps the most famous of the pictures is Titian's "Sacred and Profane Love," and Correggio's "Danae," after its long wanderings, here finds a home. Raphael is represented by the "Entombment," which has a very interesting history. There are other pictures by Sodoma, Fra Bartolomeo, Andrea del Sarto, Francesco Francia, and many others. The decadent masters of the High Renaissance are probably better represented here than elsewhere.

The Japanese Nation—A Typical Product of Environment.

Mr. Gardner G. Hubbard, in a lecture in the assembly hall of the United States National Museum, Washington, D. C., recently gave some very interesting particulars regarding the Japanese nation. In brief, he said of all countries of the earth, none have made such wonderful and rapid progress in the form of government and in the development of industries and commerce and such changes in its conditions of environment as Japan. This country, which, twenty-five years ago, was almost unknown, has come forward to take its place not only as the foremost of Oriental powers, but in the sisterhood of nations. A glance at her geographic position, her internal and industrial resources, a brief study of her past history and the character, manners, and customs of her people, will help us to understand her present, and perhaps foretell something of her future. Both the old and the recent development show Japan to be a typical product of environment.

In the geographic position of Japan and Great Britain there is a striking resemblance, both consisting of a group of islands with an extensive sea coast indented by excellent harbors, their insular position protecting them from invasion by land and offering every opportunity for commercial intercourse. Almost within sight of each lies a continent densely populated, affording a market for productions and manufactures; both are rich in mines, coal and iron ore. The mines of Japan are developing her manufactures and her commerce, and she must become the first commercial power of the Orient. The empire of Japan is composed of four large and three thousand small islands, forming an arc of a large circle extending from the northeast within a few miles of Kamchatka, southwest about two thousand miles, and with Formosa, nearly three thousand miles, from an Arctic climate to one of perpetual spring and everlasting summer. A long range of high mountains follows the general trend of the islands, culminating in Fuji-yama. The rapids, streams, and inland seas contribute to make Japan a nation of sailors. The oldest existing race in Japan is the Ainos, who now occupy the northeastern islands. They originally occupied the greater part of Japan, but were gradually dispossessed of their land and were driven far north or enslaved and so gradually intermingled with the subsequent immigrants who came from the islands of the Pacific, China, Corea, and Mongolia. The southern portion of Japan became inhabited by people of the Malay and Polynesian type. Into the center came the Coreans and Chinese, while into the north came men of the Mongolian type. The habitable portions of Japan are on or near the shore. This gives easy communication by water to all parts of Japan, and has led to the mingling of its races and the formation of the Japanese nation.

In former times the Mikado, as the earthly representative of the Deity, ruled with absolute power, but by degrees the Mikado and his court became weak and the real power passed from the court and civil rulers to the army. The military officers gradually withdrew from court to fortified camps and subsequently built castles where they lived, surrounded by retainers. They embodied in their customs and mode of life most of the features of the feudal system of Europe. Japan is greatly indebted to this for subsequent development, for each castle became a center of civilization and of independent growth.

The merchants of Europe had commercial relations with Japan for seventy-five years between 1550 and 1625. With the traders came the Jesuits. This contact with European civilization wrought important changes in Japan, though not perceptible to us. During the last part of the sixteenth century persecution began, until the Christians had all either renounced their faith or been put to death. This attempt to establish commercial relations with Europe, and to introduce Christianity, resulted in the sealing of Japan against all communication with the outside world for two hundred years. Finally a few Japanese became desirous of seeing more of the foreigners, and about the middle of this century the Mikado, a man of greater ability than his predecessors, determined to recover the power formerly wrested from his ancestors. It was about this time, 1853, that Matthew C. Perry, commander of the naval expedition of the United States, visited Japan and demanded the opening of certain ports to American commerce. Next year he returned and renewed his demands. England and other European powers immediately followed and compelled Japan to make treaties with them. The ports were opened in 1859 and 1860, but it was only by slow degrees that western civilization was brought to Japan and the barriers to intercourse and progress removed. The Mikado now slowly recovered his old powers, and the old Japan passed away. A commission of the highest nobles was sent to the United States, Germany, England, and France to study their systems of education, finance, justice, religion, and the organization of their armies and navies. Japanese youths were sent abroad for education, and men of high reputation were brought from other countries as professors and teachers. Their financial and educational systems were modeled on those of the United States, Germany, and England. Their judicial system was borrowed from the code of half the nations of Europe. Their navy was patterned upon the English, their army upon the German system.

In 1871 the Mikado overthrew the feudal system, and freedom was given to the serfs; in 1872 education was made compulsory; in 1876 Sunday was adopted as an official holiday and all acts against Christians were repealed, and in 1877 an edict was issued forbidding the Samauri to wear the long and short sword, which resulted in the passing away of the order.

In 1889 the Emperor gave a written constitution to the people, limiting his own powers and establishing a parliament with a representative form of government. The reorganization of the government and the compensation to the nobles resulted in a large debt, which has been considerably reduced. The paper money, formerly at a heavy discount, is now redeemed at par. Taxes, formerly unknown to the people, were imposed and increased from time to time by the government, but by the breaking out of the war with China all opposition to the government was changed to patriotic feeling, and all classes joined in support of the Emperor.

Another cause which contributed greatly to the making of Japan into a nation is its good roads, which have been for a long time better than in most other countries. The first railroad was constructed in 1870; now between two thousand and three thousand miles are in operation. These are largely patronized, the travel increasing every year; other roads are in process of construction. A few years ago many Japanese substituted the European dress for the Oriental, as an evidence of civilization; they soon realized that it was unsuited for Japanese life and that its adoption would lead to the introduction of western domestic customs and the abandonment of their ancestral habits. A reaction followed and they generally decided to retain their own dress. In the army, navy, police, and in business houses fashioned on foreign models, the European dress has been adopted as most convenient. Although required in court circles, some officials who are compelled to wear the European dress take it off as soon as they return home. One very wealthy nobleman occupies a double house—one half his Japanese home, the other furnished in the French style, where he receives foreign visitors and officers of the court. The Japanese houses usually receive light and air, not from the street, but from small courts or gardens in the rear. The entire side of the house on the garden is movable, so that the interior can be thrown open to the day and sunlight. Houses are usually small and low, and are from six to eight feet in height. The partitions are wooden panels three feet wide and sliding in grooves in the floor and ceiling and covered with paper. Neither paint nor varnish nor finish is used about the house. Instead of windows they have screens covered with thin white paper, protected on the outside by sliding shutters. As the people sit upon the floor, they have no need of furniture. For seats they have mats all of the same size, and upon these mats the people eat, sleep, and die. They are bed, chair, lounge, and table combined. The mats at night are covered with wadded quilts, which are put away in the day time, and on these they sleep. The houses are without fireplaces, chimney, or smoke, being heated by braziers and charcoal. Every house contains one or more vases, and often hanging baskets, filled with flowers. These typical Japanese houses, though quite unsuited to our life, are better fitted for earthquake shake in Japan than buildings of wood and stone. Public baths are universal; for a cent or two one may have a hot bath, while for the house they have bath tubs made with ovens for heating water. That the Japanese are a most cleanly race is apparent in their houses and workshops and in the care with which they look after everything in their charge.

The Japanese language is a combination of the tongue of the ancient inhabitants of the islands, and is, therefore, unlike other languages. Literature was introduced into Japan from China with the religion of Buddha, but the words and pronunciation have been so softened to fit the melodious Japanese tongue that the Japanese cannot understand the Chinese, nor the Chinese the Japanese. As a large proportion of the Chinese characters are used, it is not difficult for the Chinese and Japanese to communicate by writing. The difficulty of learning to write the Japanese language is very great, as, in addition to the Japanese alphabet, some fifteen thousand to twenty thousand Chinese characters must be memorized, and the eye and hand trained to distinguish and delineate them. An American started the first newspaper, in 1871, with twelve hundred characters, but was compelled to increase them, and now uses twelve thousand. In the printing office each compositor sits at the desk, with the letters of the Japanese alphabet within his reach, while boys bring the Chinese characters from their numerous places for him to set up. The Japanese literature is rich in works of fiction, fables, legends, and poetry, and as they are generally written in Japanese, they are largely read by the common people.

The mythology of Japan abounds with beautiful, romantic, and weird stories, the foundation of much of its art and poetry. As the intellectual progress of the people, their art and literature, were developed, the need of a religion higher and more spiritual than Shintoism—as their old religion was called—was felt. This was found in Buddhism, which came from China in the sixth century. The influence of this religion was not confined to the daily life, but acted upon the literature and art. For a time it seemed as if Buddhism would supplant Shintoism and become the religion of Japan, but instead of that it elevated and spiritualized Shintoism, so that it regained much of its hold upon the people.

The art of the Japanese differs from the Aryan or Indo-European, for it is not, as with them, the grafting of one style upon another, but the accumulated knowledge of many centuries, unaffected by foreign influences. Within its confined scope it was in advance of the art of other nations when the country was opened to foreigners. After the introduction of art, its development was greatly promoted by the influence of the feudal system. Pictorial art has never attained any great importance, but the decorative and industrial art of Japan is original and excites the admiration of the world. They know little of either sculpture or music in their highest development, and their delineations of the human form, though showing skill, are only bizarre and grotesque; but they have the closest and most sympathetic appreciation of nature in a most delicate and beautiful aspect, and their exquisite representations of the varied forms of animal, insect, and plant life make their work the wonder and envy of our western artists. In porcelain, pottery, and lacquered ware, and in metals and bronzes, the Japanese have never been surpassed; but in the increase of the demand the individual workman is giving place to men and women crowded together in factories, using machinery, where the personality of the workman disappears.

The Japanese have always been a warlike people, and in January, 1893, before the Japan-China war broke out, Japan had an army which, though small, would not have done discredit to any of the nations of Europe in organization, discipline, and equipment. In actual fighting strength it had between sixty and seventy thousand men, with power to call a much larger reserve force into the field.

The position of Japan, with its inland seas, good harbors, early led them to become good sailors. As a result of this, the fleets of China either lie at the bottom of the ocean or fly the flag of Japan, enrolled in its navy. The campaign was all as well planned and carried out by Japan as the campaign of Germany against France, in 1870. The war was the contest of civilization against barbarism, of intelligence with ignorance. Japan is not only the foremost nation of the East, but her civilization compares, in every way, favorably with that of Europe. They are the French of the East, and Japan as a nation possesses an individuality stronger than our own.

Japan is indeed a typical product of environment. A warm climate, where the land and water not only contribute food, but induce continued intercourse and the welding of different races into one nation.

From the contact of man with man, from city life, not from country, comes the highest civilization. In Japan this contact has been maintained for centuries, and has led to the steady development of her people. Volcanoes, earthquakes, mountain torrents, and typhoons have affected not only the land but the character, religion, and art of its inhabitants, while its development has been hastened by the opening of the ports, the introduction of western civilization, and the demand for her products in every market of the world.

The Exhibitions of 1896.

It will be remembered that in 1896 exhibitions were very much overdone. It was easy to count a dozen exhibitions, some say sixteen, and by reckoning every show, this number might, no doubt, have been considerably exceeded, says the Trade Journals Review. On the whole, the exhibitions did not do well. A few statistics which a German journal compiles or reproduces forcibly bring out some of the reasons. The great traveling public cannot be everywhere: thus a town which indulges in the big advertisement of an exhibition must to a certain extent rely upon its own citizens as safe visitors. The maximum daily attendance was 130,000 at Berlin, 67,000 at Budapest, 50,000 at Nuremberg, 35,000 at Geneva, 45,000 at Dresden (art and industry), 15,000 at Stuttgart, 27,790 at Nijni-Novgorod, and 14,540 at Kiel (fisheries). The comparative figures are: Vienna (1873) 139,070, Paris (1889) 402,000, Chicago 71,888 daily visitors. If the attendance of the above exhibitions had been made up of the respective citizens alone, the citizens would have to put in appearance a good many times. We give the numbers and add the percentage of the population which actually passed the gates daily: Berlin, 3·5 times, 2·8 per cent; Budapest, 5·6, 3·36; Dresden, 4·4, 4·4; Nuremberg, 13·5, 8·76; Novgorod, 6·6, 5·2; Stuttgart, 7·4, 6·02; Geneva, 28, 16·4; Kiel, 12·8, 9·4. How these figures were ascertained we cannot say. And yet 1897 will be quite as much an exhibition year.

Science Notes.

A bill to legalize the use of weights and measures of the metric system is now before the House of Commons.

Rhinometers are devices to measure the amount of air a man breathes through his nose, in order that his doctor may compare it to the amount he should take in that way.

Dr. Charcot's statue, by the sculptor Falguière, is nearly finished, and will soon be erected in the Salpetriere Hospital, where Charcot made his experiments on hysteria and hypnotism.

Newfoundland has issued a series of Cabot postage stamps to celebrate the four hundredth anniversary of his discovery. One of the designs used are portraits of Cabot and Henry VII and scenes of Newfoundland life.

Konakry, on the west coast of Africa, has been reached by a French expedition in three weeks from the Niger, for the second time. This establishes the advantage of the route by way of Fula-Djalon, and surveys for the road are being hastened.

A dispatch from Danes Island, dated June 28, announces that the filling of Prof. Andree's balloon was completed on June 22, and everything was ready to start in his attempt to cross the Arctic regions on July 1. The winds have been hitherto chiefly northerly.

Neapolitans have a bad reputation for ill treatment of animals, and the Naples S. P. C. A. seems to have plenty to do. During last year its agents stopped 44,321 carts for carrying too heavy loads, and in nearly one-half the cases had the load reduced; they confiscated 41,011 sticks used for beating animals and 887 spikes used on curb chains; 2,282 convictions for cruelty were obtained.

In connection with the "Diamond Jubilee," Mr. William Crookes and Dr. Gowers received knighthoods. The Order of the Bath was conferred on Mr. Wolfe Barry, President of the Institution of Civil Engineers, Dr. Frankland, Dr. Huggins, Mr. Norman Lockyer, Dr. Thorne Thorne and Admiral Wharton. Minor honors were conferred on a number of scientific men of the kingdom. The selection of Mr. Crookes for knighthood was very appropriate.

Mr. Frank M. Chapman, of the Museum of Natural History, compiled a list of the birds which he saw on the hats of women recently in New York City, during two afternoons. Forty species were represented. In all he saw 173 wild birds, or parts of them, on hats. Of these birds, at least thirty-two varieties are protected by law during all or a major portion of the year. A Boston court has just decided that it is unlawful to wear feathers of a bird that is protected by law, and a similar law exists in New York State.

In a recent number of the Gardeners' Chronicle, Mr. G. J. Burch contributes an interesting article, accompanied with figures, upon the use of the X rays for photographing flower and fruit buds. Mr. Burch and his assistants began by exposing plates of glass of different colors to the action of the rays. The violet glass showed itself much more opaque than that of other colors. It contained alumina and cobalt in addition to the ordinary elements. An experiment was afterward made with a violet-colored hyacinth, and, as had been anticipated, the flower gave different results from those given by the glass. It was much more transparent. The sensitized plate, after development, showed that the contour of the petals, the veins, and the internal form of the ovary were well represented. For taking such radiographs Mr. Burch advises the use of tubes that give very little light, and that, for example, would scarcely give the contour of the hard parts of the hand. The aeriferous tissues are very transparent to the X rays. The more water the tissues contain, the more opaque they are. Dry fruits and flower buds give excellent radiographs. The seeds are very distinctly seen, as are also the different parts of the flower.

In north latitude 70° 40′ 11·3″, where the most northerly town in the world, namely, Hammerfest, is situated, there is a monument which was visited by most of those who went to Norway to obtain a view of the total solar eclipse. This monument consists of a fine granite pedestal and pillar supporting a large terrestrial globe made of copper, and was placed there to commemorate the completion of a grand piece of surveying work. The primary object of this survey was, as Mr. Fowler writes in an interesting article in Knowledge (June), the measurement of the earth, and to provide a permanent mark in order that the measurements may be repeated at any future time if considered desirable. Without entering into the details of a trigonometrical survey, and how a triangulation is accomplished, we will limit ourselves to the inscription, written in Latin and Norwegian, on the pillar, referring the reader to the article in question for details: "The northern termination of the arc of meridian of 25° 20′ from the Arctic Ocean to the river Danube, through Norway, Sweden and Russia, which, according to the orders of His Majesty King Oscar I, and the Emperors Alexander I and Nicholas I, and by uninterrupted labors from 1816 to 1852, was measured by the geometers of the three nations."

THE DENUDATION AND RECOVERY OF FARM LANDS.

One of the most useful of the Farmers' Bulletins issued under the administration of the present Secretary of the United States Department of Agriculture is that entitled "Washed Soils: How to Prevent and Reclaim Them." We reproduce in this impression three illustrations which accompany the paper, showing the effects of erosion and how to remedy them. The denudation or washing of lands in the higher levels of the earth's surface has been one of the most important factors in the geological changes which have so modified the surface of the earth. As a rule, this denudation is exceedingly slow, and the general level of large tracts of country is not lowered more than an inch or two in a hundred years; but when it is excessive, and more rapid than the natural decay of the subsoil material which is exposed, it may work serious injury to agricultural lands.

The excessive erosion or washing of lands may be prevented, the fields already cut up with gullies and watercourses may be recovered, and steep slopes may be held and prevented from washing by chemical means; by cultivation and under-drainage; by reforestation; and by grass and similar vegetation.

I.—CHEMICAL RELATIONS OF THE SOIL TO SURFACE WASHING.

Surface erosion can be largely prevented by such a system of cultivation and cropping as will introduce as large a quantity of organic matter into the soil as possible. A very old method of recovering washed and gullied lands is to place straw in the furrows while plowing, the straw not only acting mechanically to hold the soil in place and prevent surface erosion, but also in a very efficient way to increase the quantity of humus, thus making the soil hold large quantities of water which otherwise would have passed off over the surface.

As soon as a sufficient supply of humus has been accumulated and the lands are brought up to an adequate condition of fertility, clover or grass should be seeded, if the land is at all suited to these crops, or rye, oats, or field pease should be sown to help hold the surface.

A soil containing a fair supply of lime is much less liable to wash than one similarly situated and exposed which is deficient in lime. Clays which are heavily impregnated with lime salts are in a flocculated state, the fine grains of clay being held together and in contact with the larger grains of sand. This flocculated mass quickly settles and is originally not so easily disturbed and carried off by moving water. A stiff clay soil is practically impervious to the penetration of surface water when it is delivered in such torrents as we are liable to have in our summer storms. A well limed soil, on the contrary, although it may contain as much clay but in which the particles are flocculated or drawn together, is much more pervious to water, and the amount of water which the soil will carry down through under-drainage is increased, and the excess which has to flow off over the surface is diminished.

II.—WASHING OF LANDS MAY BE PREVENTED BY METHODS OF CULTIVATION AND UNDER-DRAINAGE.

A field in a condition of fine tilth and plowed to a depth of 10 inches will hold 2 inches of rainfall and absorb it very readily, and a soil in such a condition will suffer no surface washing from any ordinary rainfall. This will not only save the surface from being washed and gullied, but it will also increase the store of moisture held by the soil, which is of very great value in the time of drought.

It is important also for this, as for other reasons, that the soil be covered with vegetation as much as possible throughout the year, as the roots and organic matter serve to bind the grains of the soil together.

Another very effective method, when properly carried out, to prevent the washing of lands is to underdrain the soil with tile or other drains. These drains carry off quite rapidly an excess of moisture, so that much more of the rainfall is absorbed by the soil and carried off through the drains and less washes over the surface of the land.

In cases where these methods may not be sufficient it will be necessary to provide for a more uniform distribution of the flow over the surface, and to prevent any accumulation of water which would have the effect of a torrential stream. This is secured in a great measure in cultivating the soil by laying off the rows according to the contour of the surface, so that each row will have a very slight incline of not more than from 1 to 6 inches in 100 feet, in which the flow of water would be so slow that there would be little or no erosion.

To prevent an accumulation of water from breaking down the rows larger and more substantial ditches may be provided, following very nearly the contour of the field, so that there shall be a fall of from 1 to 6 inches in 100 feet. The distance apart of the ditches will depend upon the slope of the field; with a very steep slope they should be close together, often not over 6 to 10 feet apart; with a gentle slope they should be at intervals of 15 or 20 feet, or even farther apart, depending upon the texture of the soil and the contour of the surface.

These sidehill ditches are very easily constructed, being made almost entirely with the plow. It is well to get the bank forming the lower side of the ditch sodded with grass to help hold it and to lessen the danger of its giving way during a heavy rainfall. Unless these ditches are thoroughly constructed they are worse than useless; for if they break they concentrate a volume of water upon one point in the field which would otherwise have been distributed over the surface, and this often forms a torrent which does great damage. They should always be run with a level, of which there are several forms on the market suitable for this work.

A more efficient, but at the same time much more expensive, method of preventing the washing of lands where there is a considerable slope is to terrace the fields so that there shall be level steps upon which the water can rest for awhile and be absorbed.

III.—RECOVERING GULLIED HILLSIDES BY REFORESTATION.

Forest ground is not subject to this erosive action of the rainfall, because in a forest a large part of the rainfall never reaches the soil, as 20 or 30 per cent is intercepted by the foliage and evaporated before it reaches the ground. The rainfall which reaches the surface is rapidly absorbed, as the soil is kept granular and loose and much more of the water is carried off by under-drainage rather than by surface drainage.

Just as deforestation of hillsides and hilltops is the first cause for inducing erosive action, so is reforestation the most effective means in curing the evil. This has been demonstrated in France, where the government and the farmers together have spent, during the last thirty years, over $40,000,000 and expect to expend three or four times that amount to reforest 1,000,000 acres of denuded mountainsides, the soil and debris from which has been carried by the torrents of water into the plain, covering over 8,000,000 acres of fertile ground and making it useless for agriculture. Sodding for pasture has been found mostly less effective and on the steeper slopes entirely ineffective.

Wherever the ground in the hill country is not fit for agricultural use it should be set and kept in forest, not only to make it produce a timber crop, but also to prevent the erosion which finally becomes dangerous to the lower valley lands. The forest should occupy all hilltops which, as a rule, have too thin a soil to allow profitable agricultural use; it should be kept growing on the steeper slopes where the water acquires the greatest momentum and the loosening of the soil by the plow furnishes a most favorable condition for erosive action; it should be placed on all rocky, uneven, agriculturally useless spots, because it will produce useful material even on such unfavorable situations, and, finally, forest belts should be maintained on long slopes alternately with fields and pastures, running along the brow of the slope of widths and at distances proportionate to the character of the land and the angle of the slope—on the steeper slopes closer together, on the gentler slopes further apart. In the deeply gullied hill lands, where plowing is impracticable, it is necessary to break the force of the water by constructing brush dams across the gullies, as shown in the second illustration, and roughly fill in the latter with stone, gravel, earth, etc., in front and rear if they are shallow, and at least in the rear if they are deeper. Where the ravines are especially deep and wide it may become necessary to supplement and strengthen the rough dam with a loose rubble embankment or a dry wall of stone. A simple and efficient method has been practiced in France, which consists in filling up the ravine with brush placed lengthwise and keeping this down by poles laid across and fastened in the sides of the ravine. The waters are thus allowed to drain off, while the soil carried by them is retained in and over the brush, and in a short time the gulley will fill up of its own accord. Then alders and willows are planted along the edge and soon finish the work of securing the ravine against washing. The means for thus breaking the force of the water in the gullies and changing it from a rushing torrent into a series of gentle falls, and in part from surface drainage into subterranean drainage, and of filling up the gullies themselves will have to be devised in every special case as circumstances permit and the ingenuity of the operator suggests. The brush dam is preferably made of willow, poplar, alder, or other readily sprouting material, which becomes alive and, by striking root, adds to the firmness of the dam.

PLANTING.

To cover the soil as quickly as possible with a dense and permanent arborescent cover is the object to be attained. Where the soil has not been so far eroded that plowing could be done, it might be best for the first season to sow oats, field pease, or other crops that will readily grow and make a cover. The cheapest and most readily germinating tree seed should be looked for and the quantity used per acre should be lavish, to secure a dense stand from the first. The most readily available kinds are the silver or red maple, box elder, elms, ash, and black locust; and since for various reasons variety or mixed woods are preferable, it is advisable to use as many kinds as can be readily obtained.

Where the ground is too much cut up and too uneven