pounds to the square inch and the steam is expanded in three high-pressure cylinders, two being outside the frames and one between the frames on the center line of the engine. Each cylinder is 18½ inches in diameter by 24 inches stroke. To avoid having to incline the middle cylinder, a divided connecting rod is used, the leading axle passing through the connecting rod and being slightly bent to enable it to clear. The ten driving wheels, all coupled, are 4 feet 6 inches in diameter, and the rigid wheel-base, which is equally divided, measures 19 feet 8 inches. The length of the engine over all is 37 feet 9 inches, and its total weight is 87½ tons.

This new departure in locomotive practice will be watched with great interest by engineers on both sides of the water. Mr. Holden claims that the fight between steam and electricity as the motive power for suburban traction is not by any means decided, as yet, in favor of electricity. Although we do not agree with him in this, we have no doubt that this engine will show marked power and economy as compared with the lighter engines hauling smaller trains, which it is intended to displace.

ORE FINDING BY ELECTRICITY.

BY HERBERT C. FYFE, LONDON.

The writer has recently been afforded an opportunity of witnessing the new Draft-Williams method of electrical ore finding in operation on actual mineral lodes at the Telacre Mine, Prestatyn, North Wales.

The inventors, Mr. Leo Draft and Mr. Alfred Williams, claim to be able to detect the presence of certain mineral ores invisible to the eye, and during the course of the last few months to have located, traced, and mapped out metalliferous deposits of various natures which were quite invisible to the prospector and undiscoverable by mining engineering.

In many cases mine prospectors have made borings and opened up lodes solely on the strength of the inventors' predictions, and have discovered new and unsuspected sources of mineral ores, which are now being worked at a profit.

It is claimed that by the Draft-Williams method not only can deposits be located, but that the extent and depth of the lode can be determined with an accuracy that is quite impossible with any existing system of prospecting.

Before giving an account of what the system has already accomplished, mention must be made of the instruments employed.

There are two stations, the transmitting and the receiving. At the former there is a battery of 12 volts, giving 4 amperes and 50 watts; a special form of break works in methylated spirits, and is driven by a motor, which is supplied with current by a special local battery and a primary condenser. The current is next led through the primary by an inductor, a special form of induction coil having a large core and very heavy winding on the secondary circuit. The current now passes through a secondary condenser to adjustable series and parallel spark gaps. The electric waves generated by this arrangement are taken to earth by means of two iron spikes driven two to three inches into the ground. At the Telacre Mine there were two circuits, one vertical, the other horizontal. In the former case the wire was taken down the mine shaft close at hand and along the tunnel as far as the fore-breast, a distance of 200 yards; and in the other it was placed some yards away in a line with the tent in which the transmitting set was placed. In both cases one spike was driven into the ground close by the transmitter.

The receiving set comprises two similar iron spikes, driven into the ground to a depth of an inch or two, and connected up to a tripod on which are placed a series parallel and with a transformer and two delicate receivers or resonators. The interrupter breaks contact 700 tines a minute.

By adjusting his earth connections the operator can focus the waves on any field that he may wish to explore; the lines of force travel outward and onward until they reach the iron spikes in the receiving set. When this occurs, the observer can by means of the resonators detect their presence by hearing the noise of the break, or by the sparking across the gaps.

Now, in a normal condition, i. e., if the ground be of a homogeneous character, the prospector should hear the noises loudest when exactly opposite the center of the base line of the transmitting station.

The existence, however, of a vein or reef containing metal has the tendency of throwing the waves out of normal course, by reason of the fact that it has a different conductivity from the material by which it is surrounded. The prospector must therefore make his earth connections in different places, and shift his position until he can detect the presence of the waves. When directly over the lode, the noise in the resonators will be loudest.

Condenser-discharges from lodes manifest themselves as overtones in the receivers, and at certain spots or nodal points the noise will cease altogether, owing to the influence of the waves.

The condenser discharges can be heard over some lodes when the distance from the inductor is so great that the noise of the break or of the spark gap cannot be heard; thus they form a great assistance to prospecting, helping to determine, not only the position and depth of a mineral deposit, but also, to a great extent, its nature and characteristics.

The area to be energized by the electric waves may be as small as 300 square feet and as large as 30 square miles, and the terminals may be placed hundreds of yards apart.

It is interesting to note that so far back as the year 1830 Fox made some experiments with a galvanometer with a view of attempting to determine the continuation of ore bodies. This method has since been tried on many occasions, but in nearly every case unsuccessfully. Recent variations of this consisted in connecting a current to earth and to watch the swinging of the galvanometer's needle or some equivalent. The idea was that the presence of a mineral lode would decrease the local resistance of the earth, thereby allowing more current to flow through the galvanometer, which would thus indicate the presence of the lode.

Mr. Alfred Williams informed the writer that he had measured over a hundred lodes in Alaska, British Columbia, the United States, Wales, and Cumberland, and had been unable to detect the slightest variation in resistance on the surface.

More delicate instruments than the old galvanometer have been employed in the measurement of earth resistance, and mining engineers and prospectors know only too well the numerous instruments and processes that have been brought before their notice.

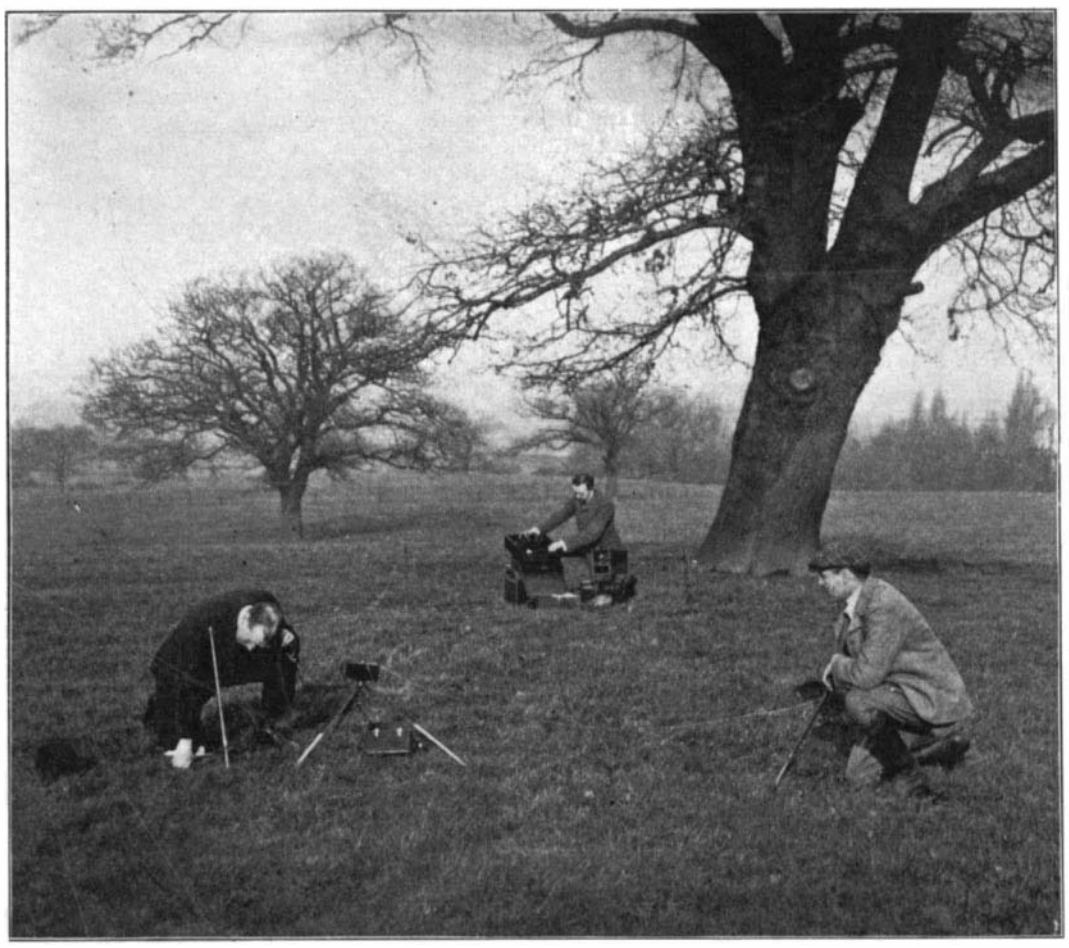
With the exception of the dip needle, which is used in prospecting for magnetic ores, no instruments are used by the modern prospector, who trusts to his geological knowledge, his past experience, his maps, and his knowledge of the country.

Prospecting is, of course, a very inexact science, and the mining world, it need hardly be stated, would welcome with open arms a system of ore finding which could be depended upon and which would do something toward lessening the yearly loss entailed in making borings which prove unsuccessful, and in opening up lodes which turn out to be not sufficiently promising to encourage the mine proprietors to continue their working.

In 1899 the inventors commenced experimenting with electrical methods of ore finding, and in 1899 Mr. Williams, in place of a galvanometer or potentiometer, used his body by passing quickly pulsated induced currents from a dry cell and a small coil in series with the earth. By this method the slightest increased intensity in the current flowing by virtue of the decreased resistance of the earth was instantly noticed.

He, however, soon abandoned this method as useless, for reasons characteristic of all earth measurements.

Messrs. Draft and Williams made their first practical experiment with their present system in Seattle, Wash., and San Francisco, Cal. These met with success, and the next trials were made in the southeastern Alaskan archipelago. Coming to England, they have achieved considerable success in prospecting for



ORE PROSPECTING BY MEANS OF ELECTRICITY.

DETECTING THE EARTH CURRENTS SENT OUT BY THE TRANSMITTER.

lead and zinc ores in Wales and for nemalite in Cumberland. The following is an instance of successful prospecting with this method.

The lead and zinc mines at Cwmstwth, Devil's Bridge, Cardiganshire, Wales, owned by Mr. H. Gamman, have been worked for the past 1,700 years, and a good-paying lode was found to cease suddenly in one direction. After costly and numerous attempts to discover this lode beyond this fault, the attempt was abandoned.

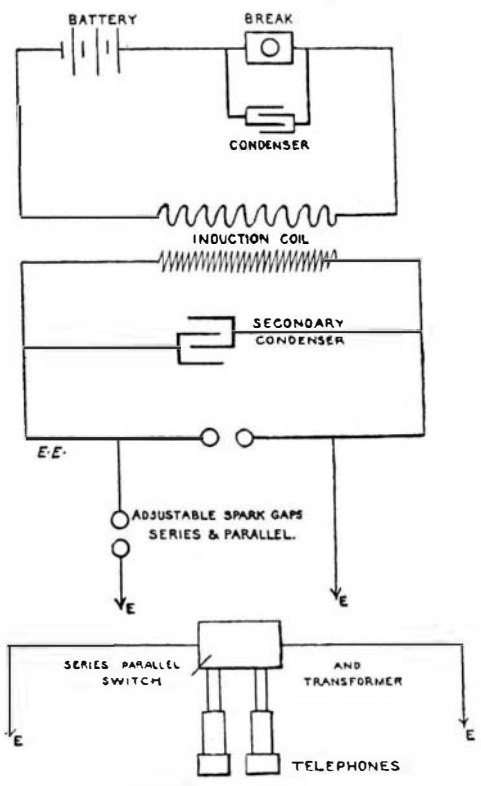
Mr. Williams, being called in, placed the two electrodes at a considerable distance from the broken lode on unmined ground, and in such a position that a perpendicular through the center of the line joining the two electrodes would coincide with the run of the lode as worked out.

The current streams from the one electrode to the other would thus, under normal conditions of homogeneity, pass at right angles through the extension of the lode if it existed beyond the fault.

Exploring with the resonators, Mr. Williams found on the hillside that the line of normal current flow was in several places rotated through a very considerable angle. After careful mapping out of the results obtained, the direction of the lode was finally predicted.

A tunnel was at once commenced by Mr. Gamman's instructions, with the result that a good lode of lead and blend was discovered after a drivage of less than three fathoms. Mr. Gamman told Mr. Williams that in proof of his belief in his *modus operandi*, he had ordered a third drivage to be started, to reach the rich ore detected by the instruments at a lower level.

Transmitting Apparatus.



Receiving Apparatus.

DIAGRAM OF THE DRAFT-WILLIAMS SYSTEM OF ORE PROSPECTING.

"Had your instruments," writes Mr. Gamman, "been discovered years ago, it is my opinion that tens of thousands of pounds would have been saved in these mines alone."

It will, of course, be necessary to train mining engineers and prospectors in the use of the instruments and in the detection of the presence of the waves. The whole outfit is, however, simple and easy to work with. Its development during the next few years will be watched with interest by all interested in mining operations.

[While this method of finding ore enables the prospector to detect and locate a body which is a good conductor of electricity, it, on the other hand, offers him no guarantee that this conductor is valuable ore; for any metal substance, such as iron piping or a piece of wire, or better still a stratum of moist earth or a subterranean stream, would affect the detecting instrument and indicate a vein of ore. Nevertheless, though this be so, the Draft-Williams system should be of valuable assistance to the prospector, because it reduces greatly his chances of failure by assuring him of the location of some good conducting medium, which can be further investigated by boring or some other test.—Ed.]

It is announced in Berlin that Count Zeppelin's airship shed on Lake Constance, together with his apparatus, will be sold at auction. The count is a poor man. He sank over one million marks in the enterprise.

In Sweden books are placed in third-class railway cars for the free use of passengers. A similar plan is about to be adopted in Denmark.

ALEXANDER GRAHAM BELL.

BY MARCUS BENJAMIN, PH.D

The World's Fair held in Philadelphia in 1876 had for its principal object the celebration of the one hundredth anniversary of our national independence, but of greater importance was the demonstration of the wonderful mechanical genius of our people, that has since given to the United States the industrial supremacy of the world. An event of that exhibition that is now historical is characteristic. Men of science had come from various countries to examine and study the numerous inventions that were to be seen. A demonstration of the transmission of sound by electricity was announced, and a special wire connecting widely separated parts of the grounds was installed. There were those who were incredulous of the possibility of sending the human voice over so great a distance, and they did not hesitate to express that opinion, but the youthful physicist with a boldness begotten of knowledge insisted that the instrument would do what he claimed for it, and it did. Distinct and clear came the tones of the voice at the other end of the line, forcing conviction upon those who were doubtful, and a new invention—the telephone—was given to humanity.

A few words will suffice to give an outline of the inventor's career. Alexander Graham Bell was born in Edinburgh, Scotland, in 1847, and in 1872 settled in Boston, where he was called to the chair of Vocal Physiology in Boston University, and there introduced the system of visible speech invented by his father, the venerable Alexander Melville Bell. The success of the telephone brought him fame and ample means, and having married the daughter of the late Gardiner G. Hubbard, he settled in Washington, residing there during the winter months, and spending the summers at his country place at Cape Breton.

While he is a man of leisure, as the phrase goes, Mr. Bell finds much to occupy his attention, and he has but little spare time. During the season that he spends in Washington, which is frequently interrupted, however, by trips to Florida or California, and to Europe, as is shown by the many interesting objects that he has gathered from various parts of the world, with which his house on Connecticut Avenue is filled, he nevertheless finds much to do with several institutions in which he is interested, for he makes the pursuit of knowledge his principal pleasure.

It will be remembered that for his invention of the telephone, the French Academy bestowed upon him its valuable Volta Prize of 50,000 francs, and with this sum, together with important additions, he founded in 1883 the Volta Bureau. A building was erected in Georgetown in which a library is installed and facilities are afforded for the study of problems by the solution of which the condition of deaf mutes may be improved. He frequently visits this Bureau, and exercises toward it almost a paternal interest.

Another institution in which Mr. Bell takes great interest is the Smithsonian Institution. He has followed most closely the experiments made by Secretary Langley in aerodynamics, and in 1891 presented him with the sum of $5,000 for the further prosecution of his investigations. Mr. Bell was an eye-witness of the successful ascensions of Dr. Langley's aerodrome in 1896, and communicated a description of those flights to the French Academy of Sciences. Mr. Bell was appointed in 1898 to the vacancy on the Board of Regents caused by the death of Mr. Gardiner G. Hubbard, and he also succeeded to Mr. Hubbard's place on the Executive Committee. He has recently advocated with much earnestness the bringing of Smithson's remains from Genoa to Washington, offering most generously to defray the expenses, provided the Regents will care for them on their arrival in this country.

Mr. Bell devotes considerable attention to the National Geographic Society, of which he is president, and the erection of the new building, a memorial to the late Mr. Hubbard, its former president, now rapidly approaching completion, is carefully watched by him. Whenever questions concerning the policy of the Society come up for consideration, or indeed other important matters pertaining to the development of geographic science, he gathers the Board of Managers around him at his home, and the subject is then thoroughly discussed. Two topics of more than common importance are now receiving much careful consideration. The first of these has to do with the Geographic Congress which is to assemble in Washington a year hence, and for which plans are now being matured; and the other is the selection of a suitable representative to accompany the Ziegler Expedition to the North Pole.

As a host Mr. Bell is most delightful. For several years his Wednesday evenings have been noteworthy, for to his home are invited men who know things, and who have something to say that is worth listening to. Distinguished visitors to the capital are invited to meet the men of science whose regular duties make them part of the official life of Washington; and Simon Newcomb, most eminent of American astronomers, S. P. Langley, the distinguished Secretary of the Smithsonian Institution, Carroll D. Wright, first among political economists and statisticians, Harvey W. Wiley, the genial chief of the chemical division of the Department of Agriculture, Willis L. Moore, the able head of the Weather Bureau, O. H. Tittman, of the Coast Survey, and the many younger men whose names need not be mentioned here, for they fill the pages of the most recent scientific journals, announce their latest discoveries, which are pleasantly discussed and commented on. It should be mentioned that as president of the National Geographic Society he frequently entertains distinguished explorers and travelers. The splendid reception that was tendered to Nansen a few years since was an event that will be long remembered, and this winter De Windt was made the guest of honor at a reception given by Mr. Bell after his recent lecture "From New York to London by Rail via Bering Strait." It is by such means that he finds his greatest enjoyment.

At his summer home in Cape Breton Mr. Bell finds it possible to devote even more time than ever to his hobbies, and these, as I have tried to show, form his chief enjoyment. His kite experiments, concerning which so much has been written without authority, have occupied much of his time; and it may be said that at one of his Wednesday evenings during the past winter he was prevailed upon to describe these experiments, the results of which will shortly be prepared for publication; it may be now said that after many trials with various forms of kites it became apparent that certain forms possessed greater force than others, and showed a power quite capable of carrying several hundred pounds. Another interesting investigation which he has carried on at his summer home has been the improving of the breed of sheep on his farm. He found curiously enough that the amount of food given to the animals seemed to have a direct relation to the sex of their young. His results of this investigation were presented before the National Academy of Sciences at the spring meeting in 1901, and referred to in the Scientific American for April 27 of that year.

Naturally Mr. Bell has received many honors. The French government, ever quick to recognize science, has conferred upon him the decoration of the Legion of Honor in one of the higher classes. The Society of Arts in London in 1902 gave him its Albert medal, which is awarded only to those who by their writings, researches, inventions, or investigations have done something that will forever be of lasting benefit to humanity. Eads and Edison are the only Americans who have previously received this medal. In 1883 he was chosen a member of the National Academy of Sciences in our country.

Universities at home and abroad have conferred honorary doctorates upon him. The National Deaf Mute College of Washington and the University of Würzburg, Bavaria, have given him the degree of Ph. D. The exceedingly ingenious electrical device, by means of which the exact location of the bullet in President Garfield's body was detected, was invented by him and gained for him the honorary conferment of the degree of M. D. from the University of Heidelberg at the time of the celebration of its fifth centenary. Amherst (1901), Harvard (1896), and St. Andrews (1902) have conferred upon him the degree of LL. D., and that from Harvard was in special recognition of his method of improving the condition of deaf mutes.

PROF. BELL'S KITE EXPERIMENTS.

The final paper read before the last meeting of the Academy of Sciences was "On the Tetrahedral Principle in Kite Structure," by Alexander Graham Bell. At the outset he said that in the old Hargrave box kite, and all subsequent kites and flying machines of the same order, there were two important defects, which he described as follows: The box kite is braced in a horizontal and vertical direction, but not otherwise, so that cross supports have to be introduced in the frame, which increase the weight without adding to the flying power, and at the same time operate as an obstacle to the wind. The chief defect of the box kite, of which Dr. Langley's aerodrome is an elaboration, is that the weight increases with the cube as rapidly as the lifting power does with the square, so that the larger the kite, the less it will lift in proportion. In view of these facts, he had been led, he said, to construct a kite, the frame of which would present the form of a triangle no matter from what side one viewed it. In other words, the frame was a perfect tetrahedron; and in experimenting with the same, he found, as he had expected, that it was self-braced in every direction, and moreover, that the lifting power increased at a greater ratio than the increase in weight. He was, furthermore, surprised at the facility with which such a kite could be managed. By combining a great number of these kite tetrahedrons he had recently built up an immense kite, with which he successfully lifted not only a man, but a weight of 200 pounds, showing the vast improvement of this over all previous machines of the same order.