THE DE LESSEPS MONUMENT.

WE reproduce herewith, from L'Illustration, two engravings, the first of which gives a general view of the De Lesseps monument designed by the great sculptor Fremiet, and inaugurated at Port Said on November 17. The monument, stands on a projection in the great jetty, at about 300 yards from the shore.

The second engraving, reproduced from a photograph taken during the mounting, gives all the details of the head, and permits of obtaining an idea of the dimensions of the effigy of the great man. The height of the head is 3.28 feet, and the nostrils measure about five inches.

ARTIFICIAL SILK.*

By JOSEPH CASH.

IT is a trite saying that all inventions are creatures of evolution. I shall give a short description, therefore, of a few attempts to produce the appearance of silk before the perfected artificial article of to-day became an established fact. Some were partially successful in effect and others have been a pronounced commercial success, adding greatly to the variety of the cheaper textile fabrics.

SPUN GLASS.

Spun glass is probably the earliest production which resembles natural silk. The thread is perfectly flexible, possessing great brilliancy, and is produced in a variety of colors. The feel to the touch is soft and smooth; it can be woven into many textiles, and is specially useful in millinery articles where warmth is not a necessary adjunct.

POLISHED OR DIAMOND COTTON.

Polished or diamond cotton is a lustrous looking article, and in the fine sizes, or counts as it is called in the trade, is silky in appearance and soft to the touch. An enormous trade is done in this article for dress goods, as it is often used in combination with silk. The process of producing it is very simple, waxy and starchy substances being put on the thread in a liquid emulsion; the yarn is then transferred to a polishing machine with rapid revolving brushes, which completes the process.

MERCERIZED COTTON.

A process for giving a silky appearance to cotton has lately been brought to the notice of manufacturers with very satisfactory results. The process is practised by most cotton dyers, there being no valid patent. The name is derived from the inventor, John Mercer, who discovered the process in 1844. The cotton yarn is passed through strong solutions of caustic lye. The yarn must be at full tension during the whole operation, even until it is quite dry. Mercer's theory of the action of caustic soda is that received to-day, viz., that the mercerized yarn is a hydrate of cellulose, the first action being the formation of a compound of sodium oxide and cellulose. The subsequent washing replaces the sodium oxide by water, which is held by the cellulose like the other metallic oxide. Such a theory as this gives us very little light on the matter, and does not explain the difference between the hydrate formed and the original hydrate. It can be dyed any color without materially affecting the brilliancy which has been imparted to it by the mercerizing process.

VANDURA SILK.

Vandura silk is a gelatine thread, therefore animal in its composition, and more nearly allied to natural silk than any of the imitations already described. Adam Millar, the inventor and patentee, quite recently died, unfortunately before he attained the perfection at which he was aiming. The manufacture of the silk is conducted by pressing an aqueous solution of gelatine through a very fine glass capillary tube. On issuing therefrom the thread is laid on an endless band which carries it some distance to allow it to dry; from the end of this band or table it is wound on to bobbins ready to put into skeins for the manufacturer. I am of the opinion that this article will not meet with a very great commercial success, as the gelatine being soluble in water, it cannot be dyed after the thread is made. Therefore the solution of gelatine must be colored to the required shade before being spun. The impracticability of this is manifest when I tell you there are at least fifty colors with fifty shades in each color, and at least four sizes of thread; the stock would be at least 990 pounds, if only one pound of each size and color was made.

Mr. Millar described his process as follows:

"I take 4 pounds weight of the best gelatine I can get, break it up into granular pieces such as will pass through a riddle of four meshes to an inch, sixteen meshes per square inch. I place the broken gelatine in a melting vessel, and add 2 pounds of cold water, and stir it well, put on a cover or lid and let it stand for one hour. The vessel is next placed in a can of hot water and kept heated to 120° F. for another hour, stirring it once or twice. By the end of the second hour I have a solution of gelatine of uniform consistency, containing 66 per cent. of gelatine and only 33 per cent. of water, a very thick solution.

"The group of filaments are next twisted together and spread out in a thin layer on an open metal reel, about a foot in diameter. A number of these reels of plain gelatine yarn are now placed in a chamber in which a very small quantity of formaldehyde has been poured, and is therefore filled with formalin vapor—about 80 minims of formalin to a space of 10 cubic feet. An exposure to this vapor at ordinary temperature completely changes the gelatine. It is no longer soluble, even in boiling water, nor in any solvent that I have tried, and has a splendid luster.

"The reels are hung up to allow all smell of the formalin to disappear, and the artificial silk is finished, needing only to be wound on to bobbins for the convenience of handling before it gets into the hands of the textile manufacturer.

"You will have noticed that this process for producing an artificial silk, which I have described, is a chemical process, but it is also a mechanical process. The successful substitute for the product of the silk-worm must be a yarn made up of very fine filaments,

* Paper read before the Society of Arts and published in the Journal of the Society.

so as to be smooth to the touch, and so pliable as to feel soft to the handling. The material of real silk, when obtained in somewhat thick threads, is neither smooth nor pliable, but is very harsh to the touch, and very stiff in handling. Indeed, to one not acquainted with the fact, it is very difficult to understand how the softest of velvets are produced from this harsh, stiff material—so stiff that it can hardly be tied into a knot. It is this extreme fineness of filament required in any artificial process which makes the mechanical part of the process such a dominating factor in the commercial aspect of the case.

"The nipples of my machine have a bore of one-hundredth of an inch, but the filaments drawn from these nipples may be only one-thousandth of an inch in diameter. The flow of the liquid through the nipples is regulated by air pressure. An India rubber pipe leads from a receiver of compressed air, and has its other end attached to a small pipe fixed to the airtight cover of the cylinder which contains the gelatin solution. The endless traveling band, on which the threads fall, and by which they are drawn away rapidly, moves at a uniform rate—say 60 yards per second; but if the speed be increased to 120 yards, the filament would be twice the fineness; the same result is obtained by reducing the pressure in the air receiver or reservoir."

COLLODION SILK.

Several persons have given their attention to the perfecting of the manufacture of collodion silk, among whom are Count Hilaire de Chardonnet, Dr. Lehner, and Nobel of cordite fame. The different systems vary only in detail, so I shall describe the most successful one, known as the Chardonnet silk. I first saw this artificial silk at the Paris Exhibition of 1889, where it obtained a "Grand Prix." Previous exhibits were made of artificial silk in 1878, but no commercial success was attained for many years.

A public company for the manufacture of artificial silk by the Chardonnet process has been formed in England. The factory, extending over two acres, is at Wolston, on the river Avon, near Coventry, and will be capable when filled with machinery of producing 7,000 pounds of silk per week.

The first stage of manufacture is the nitration of cotton or wood pulp, producing pyroxyline, discovered by Pelouze in 1838. The greatest care must be employed in conducting this operation, as it is the most important one in the whole process; mistakes sometimes even occur at the long established factory at Besançon in France. The process of nitration of cellulose is the displacement of a few molecules of hydrogen by nitric peroxide. There are several varieties of pyroxyline which are obtained by using different mixtures of acid. The highest nitro-cotton product, gun cotton, or trinitrocellulose, is useless for the manufacture of artificial silk, as it is insoluble in a mixture of alcohol and ether. To obtain the pyroxyline or binitrocellulose suitable for the production of collodion for our purpose, a mixture of 15 volumes of sulphuric (H₂SO₄) and 12 volumes of nitric acid (HNO₃) is made; two pounds of bleached raw cotton is then taken and put into an earthenware jar with about three gallons of mixed acid; this is left standing for four to five hours, when the nitration is complete. The chemical reaction may be expressed by the following formulæ:

The object of the sulphuric acid (H₂SO₄) is to take up hygroscopically the excess of water produced, leaving the nitric acid (HNO₃), of which there is always an excess. The only known way of testing the quality of the pyroxyline is the use of the microscope in conjunction with the polariscope. A small piece of pyroxyline is taken from one of the jars, thoroughly washed in water and dried; it is then moistened with alcohol, when the colors exhibited should be in exact proportion which practice has proved to give the best results.

The pyroxyline is now taken out of the pots and subjected to pressure to extract all the acid possible. This extracted acid is not wasted, but is renovated with a mixture of new acid and used again for more cotton. From the press the pyroxyline is taken to the washing room and at once put into the washing machine, called a Hollander, and similar to those used in paper making for washing pulp.

This washing continues for from 12 to 15 hours until the acid is thoroughly eliminated; from thence the material is removed to a centrifugal machine to extract the moisture, which must not exceed 28 per cent.; if too much water is present, the collodion will not be tenacious and therefore will not spin. The pyroxyline is now ready for dissolving in a mixture of alcohol and ether. The pyroxyline is placed in a cylinder, with a mixture of 40 parts alcohol and 60 parts ether; the cylinder is then hermetically sealed and made to revolve slowly for 12 hours, when, if the pyroxyline is good, all should be dissolved; the resulting mixture is collodion. The next process is the filtration. Upon this depends the amount of production from the spinning machinery, supposing the collodion be good. The filtering is to eliminate every particle of suspended matter which may exist in the collodion before it arrives at the spinning machines, as grit and seeds from the cotton, or suspended matter in the washing water, or even trinitro-cellulose, which is insoluble in alcohol and ether, but this latter should never occur in good silk collodion. Each filter contains a sheet of cotton wool between calico. A pressure of 15 atmospheres is required to force the collodion through the filters; it is therefore first passed into an hydraulic press, by the aid of which it is forced through the filters and into the collodion reservoir, where it should remain as long as possible to allow any bubbles to rise to the top, for should they pass into the glass silk-worms, the continuity of the thread would be broken.

A pressure of 40 to 45 atmospheres is required to force the collodion from these reservoirs to the spinning machines, which are constructed with pipes running on each side. Into these pipes are screwed a number of taps with a glass capillary tube fixed on the end, called a silk worm, through which the collodion is forced by the pressure before mentioned; immediately it comes into contact with the air it solidifies, enabling the operative to take hold of the thread or silk, as it can now be called, and convey it to the bobbin. From twelve to twenty-four of these threads are run together on to

one bobbin, according to the size of silk required, as is the case with natural silk. The silk would soon dry by the evaporation of the alcohol and ether if left exposed to the air; it is therefore kept moist by damp cloths to facilitate the next process of throwing and twisting. This is accompanied by putting on the silk the required number of turns or twists per inch. The reeling or skeining of the silk into a given number of yards in each skein is the next operation. One thousand or two thousand yards is the usual quantity, and according to the weight of skein so is the size designated. The Chardonnet silk is about 30 per cent. heavier in S.G. than natural silk, so the comparison of sizes is easily arrived at. The silk is still damp, and should now have the remaining alcohol and ether dried out of it. The inventor claims this to be one of the most important points to give the silk good dyeing properties.

The silk at this point of manufacture is very inflammable and quite unfit for use in textile goods, therefore a process called denitration is next carried out which reconverts our product into cellulose, now very different in appearance from the raw cotton we commenced with, but practically the same in chemical composition.

One of the substances used for this purpose is sulphhydrate of calcium, and the chemical reaction may be expressed by the following formulæ:

The silk, now it is finished, requires no precautions in manufacturing more than cotton, in fact less, as there should be no loose fiber which can detach itself from the thread.

The bleaching is carried out in the usual way for vegetable fibers with chloride of lime and acid.

Up to the present time artificial silk has always been used in conjunction with other fibers in textile goods; the friction of weaving has a tendency to split the threads if used in warps, but this objection will no doubt be overcome.

Mantles for the incandescent gas light are manufactured of artificial silk, it being found that the salts of the rare metals can be mixed with the collodion with greater economy than with any other thread.

For braids and such classes of trimmings it is much more brilliant; for covering electric wires and all electric work it is better. Large works are in operation at Besançon, in France, producing 7,000 pounds per week; but the demand is so great that they are making extensions to their works to enable them next January to produce 2,000 pounds per day. The production at Spriettenbach is 600 pounds daily. Other factories are about to be established in Belgium and Germany.

Collodion silk can never replace natural silk in articles where warmth is required, its composition being vegetable, and that of silk analogous to horn and hair or wool. The artificial product is to be preferred, being more durable than the natural when the latter is weighted in the dyeing up to 100 per cent. in colors, and as high as 300 per cent. in black. If this system of weighting natural silk for manufacturing dress goods continues, I am of opinion ladies will be asking for dresses of the new product in preference to the old, unless a guarantee is given that the article is pure natural silk.

THE HISTORY AND PRESENT DEVELOPMENT OF WIRELESS TELEGRAPHY.*

By GREENLEAF W. PICKARD, Boston, Mass.

I MUST in the start limit the meaning of the phrase "Wireless Telegraphy." It is evident that, strictly speaking, communication with flags and numberless other methods would properly come under this head. I intend to take the phrase in its popular significance and consider only the purely electrical methods of signaling through space.

Wireless telegraphy has a history—a history that runs much further back than most people imagine. The idea of magnetically communicating through space between distant points is over two centuries old, and electrical means of accomplishing the same end were thought of before the beginning of the present century. The first successful attempt at space telegraphy was made sixty-eight years ago by a Scotchman. In 1831, James Bowman Lindsay, of Dundee, Scotland, conceived the idea of conveying electrical signals across water without the use of wires, and actually so did convey them across the Tay River. He even went so far as to express the opinion that signals might be transmitted across the Atlantic, and in the printed proceedings of the British Association for 1859 his method is briefly described. More recently Prof. Silvanus Thompson has suggested the same method, and there is no doubt in the minds of electricians but that it would work across the Atlantic Ocean. (A diagram was shown illustrating Lindsay's system.) On one side of the pond two metal plates dip into the water as far apart as possible. In circuit with these plates are a battery and key. When the key is pressed, a current flows in the circuit, passing through the water between the plates, and seeking the path of least resistance. In so doing, the current spreads out, a very small portion of it going to the other side of the pond, where it is picked up by two other metal plates there and passed through a sensitive telephone receiver, manifesting its presence by a click.

Electrical phenomena often have very apt hydraulic analogies. If instead of having a current of electricity lead into the pond at one plate and out at the other, we had a current of water, it is evident that the stream would spread out and flow sluggishly through the entire pond, and that a delicately poised water-wheel would show this current even in a distant portion of the pond. Only one such transmission of signals could be operated at a time, because a system powerful enough to send messages from England to America would interfere with the working of every similar system in Europe, in addition to rendering all of the transatlantic cables worthless, by its powerful current scattered broadcast in the water.

A system of space telegraphy based on electromagnetic induction has been tried both in this country and abroad with success over short distances. Preece, the chief electrician of the British postal service, has de-

* Paper read at the thirty-fifth stated meeting of the Maine Academy of Medicine and Science, November 13, 1899, and published in Journal of Medicine and Science.

voted much time to experiment with this system and sent messages several miles by its aid. It was in practical operation in England a few years ago between a lighthouse and the shore, where strong tides and a shifting bottom would not permit of the maintenance of a submarine cable. This lighthouse was on a small island over a mile from shore, and a wire was strung from one end to the other parallel to the mainland. At a point on the shore opposite the lighthouse, a long wire was placed parallel with the first and connected with a key and a small dynamo, so that powerful currents could be passed for signaling. The induced current in the lighthouse wire, although not strong enough to operate a telegraph instrument, could be plainly heard in a telephone receiver, and the dots and dashes of the Morse alphabet easily read. (This system was illustrated by diagram.) When the key is pressed, a current flows in the sending circuit, inducing a momentary one in the reverse direction in the receiving circuit, and the telephone that is connected there will respond. Experiments made with this system show that for clearness of the signals in the receiver, the lengths of the parallel wires must be equal to the distance signaled over, that is to say, the distance between the nearest sides of the rectangles in the diagram. This requirement is of course a great drawback to its employment over any considerable distance. Every one who has used a telephone has noticed what is called "cross talk," which is nothing more or less than induction from neighboring lines, and is a good example of the practical operation of the electromagnetic induction system of wireless telegraphy in an undesirable manner. Perhaps in this case a better name for it would be that of "wireless telephone."

In 1882, Prof. Dolbear, of Tufts College, well known in connection with the invention of the telephone, experimented with a system very much like the present one of Marconi's, using long vertical wires at both stations, and an induction coil for sending the signals, connected as in the last method, one terminal to the wire and the other to the ground. Instead of receiving them by a device known as a coherer, as Marconi does, Dolbear used a static telephone receiver to detect the signals. Using kites coated with tinfoil, at an altitude of several hundred feet, he was able to detect the signals at a distance of over a mile. A patent for this method of communication was asked for in the same year, but was then refused by the Patent Office, as being "contrary to science;" and it was only after the apparatus had been packed up and sent to Washington, and the fact demonstrated that it would work, whether "contrary to science" or not, that the patent was granted in 1886. An important feature of this patent is, that although a telephone receiver was employed to detect the waves, a paragraph of the patent states explicitly that "any other receiving device may be used," which of course covers Marconi's apparatus, or that of any other system employing a vertical wire and a ground.

A very practical system of wireless telegraphy from moving trains was patented by Phelps in 1886, in which the signals were transmitted from a wire strung on the poles alongside the track, one of the ordinary telegraph wires, in fact. They were received by the tin roof of the car, to which one terminal of a telephone receiver was connected, the other terminal being grounded on the wheels below, which of course made contact with the rails. The sending station was in any convenient way station of the railroad, and for the transmission of the signals a powerful induction coil was used, one of the secondary terminals being grounded while the other was connected to the wire. By making and breaking the primary circuit of the coil, the dots and dashes of the Morse code could be sent into the wire, a dot consisting of a single spark and a dash of a series of sparks following one another at very short intervals. The telephone on the car would receive these as short and long buzzing sounds, that an experienced operator could easily read. There was also an induction coil on the car, so that the reply could be sent to a messenger. This system was in successful operation on several railroads, among them being the New York, New Haven and Hartford, but it was finally abandoned, as there was not enough business to pay the expenses of an operator on the train.

I have drawn an analogy between the first mentioned system and a flowing stream of water. Now the systems of electromagnetic and electrostatic induction do not depend upon an actual flow of electricity between the stations, but rather upon a wave or impulse in the ether. The best analogy here would not be an hydraulic one, but with sound waves. Sound is not transmitted by an actual bodily movement of the air, but by an impulse transmitted from particle to particle, each particle simply oscillating to and fro. Ether waves travel in a similar manner, but very nearly a million times as fast as sound is propagated.

In 1888, Hertz, a German physicist, demonstrated for the first time the existence of electrical waves in the ether, waves that possessed all the properties of visible light as regards reflection, refraction, and diffraction, but that on account of their great wave length as compared to that of visible light, could penetrate wooden walls with ease. The longest ether wave that is perceptible to the eye has a length of three hundred-thousandths of an inch, while the shortest Hertzian wave yet produced has a wave length of over three-tenths of an inch. (A diagram was shown of the apparatus used by Hertz for exciting and for receiving these electrical waves.) The oscillator is composed of two metal plates connected to a spark gap between polished brass spheres and to an induction coil. The induction coil, fed by a battery, charges the metal plates oppositely until the electrical tension between the spheres of the spark gap becomes so great that the air between them breaks down and a spark passes. This spark, although to the eye a single one, in reality consists of a number of extremely rapid surges of the electrical charge on the plates, first in one way and then in the other. There may be a score of such oscillations before the charges have neutralized each other and equilibrium is established, all taking place within less than a hundred thousandth part of a second. The oscillation is like that of a pendulum, set swinging by the hand, that goes past its lowest point, the point of equilibrium, again and again before it comes to rest in this position.

The oscillation of the electric charge on the plates sets up a disturbance in the ether, a disturbance that

propagates itself as a series of waves, traveling with the speed of light in all directions from the oscillator. Like light the intensity at a point distant from the oscillator is inversely proportional to the square of the distance. The detector devised by Hertz to show the presence of these waves consists of a circle of stout wire, with a very minute spark gap inserted. When the oscillations strike the wire, their energy is transformed into an electrical current, that manifests itself as an almost microscopic spark at the gap. A detector such as this is not a sensitive one, and Hertz at the best could trace the waves but two hundred feet from the oscillator. It remained for Lodge, an English physicist, to discover an extremely sensitive detector of electrical waves, an instrument called by him the "radio-conductor." This consists of a glass tube, partly filled with metal filings, and with electrodes inserted at each end. The electrical resistance of such a tube is normally very high, so high that it presents an almost insurmountable obstacle to the passage of an electrical current, but when the electrical waves strike it the resistance falls, the metal filings begin to conduct—to "cohere," as it is called—and the current thus established will allow a telegraph relay to operate over it. Such a tube of filings is called a coherer.

Marconi, the young Italian experimenter with the new telegraphy, commenced his experiments in 1895, adopting the oscillator of Hertz, and the coherer of Lodge. He very soon found that the addition of a long vertical wire to a terminal of both the oscillator and the coherer tube, the other terminals being grounded, very greatly increased the efficiency of the system, and that the distance that could be signaled over was increased in a more than arithmetical ratio to the length of this vertical wire.

I have set up a sending and a receiving station in this room. Both the receiver and transmitter are connected to short vertical wires, and for a ground I have used the wooden floor. A pressure on the key at the sending station sends a current from the storage battery through the coil, from whose terminals it emerges greatly increased in tension, and charges the vertical wire, which discharges itself across the gap to earth, setting up a powerful impulse in the ether that radiates in all directions from the wire, an almost infinitesimal portion of it reaching the distant wire and the coherer tube. Here the filings in the tube instantly cohere in response to the wave, and become a conducting path for the current of the local battery operating the relay. A point to which I would call special attention, is the extreme sensitiveness of the coherer. The most delicate of the measuring instruments known to science would not respond to a million times the energy that this device detects and instantly responds to by a lowering of its electrical resistance. One way of illustrating this sensitiveness would be to consider the case of signaling across the English Channel, a distance of about thirty-four miles. We may consider the energy from the sending station as radiating outward in the form of an ever widening sphere. When the wave had reached the distant station, this imaginary sphere would have a radius of thirty-four miles, or about one hundred and eighty thousand feet. The entire surface of this sphere would be over 400,000,000,000 square feet; and if the vertical wire at the receiving station presented an area of one square foot to the radiation, it would intercept only the infinitesimally small portion of one 400,000,000,000th of the energy, assuming that there had been no absorption in transmission. When we consider that the wire at the sending station probably emits less than a hundredth of a horse power in electrical waves, the smallness of the fraction that reaches the other end is apparent. Even the bolometer of Langley, an instrument that will detect the radiant heat of a candle at two miles, is clumsy in comparison with this simple tube of filings.

Early in the past summer the Smithsonian Institution, hearing of Marconi's successful experiments with long distance wireless telegraphy, desired that experiments be tried at the Blue Hill Observatory, near Boston, with kites to elevate the wires, hoping that as an altitude of over two miles could be attained in this way, correspondingly great distances could be signaled over. A grant was made from the Hodgkins fund for the work, and Mr. Rotch, director of the observatory, asked me to assist in the experiments. We commenced our work in June, at the Blue Hill Observatory, situated in Milton, about ten miles from Boston. Our first trial of a somewhat crude apparatus between the observatory at the summit and Mr. Rotch's house at the base of the hill gave us such encouraging results that this distance, a little over a mile, was increased to three, the summit of Mount Chickatawbut, one of the neighboring hills, being taken as the other station. In our first trials, between the summit and the base, kites were not used, as the flagpole on the observatory and a small tower near the house at the base gave us a support of sufficient height for our wires. We tried the kites for the first time between Blue Hill and Chickatawbut, sending up a light copper wire, about five hundred feet in length at the receiving station, and a shorter though heavier one at the sending station on Blue Hill.

Our troubles really commenced when we moved to Chickatawbut. Day after day we would make the long journey to the summit, and find on reaching the top that there was no wind to raise our kite. Or else, as frequently happened, there would be just enough wind to support the kite, and not the additional weight of the copper wire and flying cord, and an entire forenoon would be spent in the vain endeavor to raise the apparatus, usually ending in the fall of the kite, cord and wire in the bushes on the side of the hill, the wire always becoming most completely tangled up with the bushes, kite and cord. During the entire period that we were at Chickatawbut, over a month in all, there were but four days that favored us in this respect. Unfortunately for our experiments, we had taken a time of year when there was very little wind, less than usual for that time of year even. The first day that we succeeded in raising our kites at both stations signals were sent and received, but a not altogether unexpected difficulty arose—that of the interference of the atmospheric electricity with signaling. Our long wire collected enough electricity to give frequent signals—frequent enough to greatly complicate those sent from Blue Hill. These interruptions showed clearly that the limiting height of the conductor was under five hundred feet, and that the wires of a mile

or more in length that the Smithsonian had thought of would gather so much electricity as to completely disorganize the delicate receiving apparatus.

I must here explain something of the nature of this atmospheric electricity. As far back as the days of Franklin it was known that the atmosphere was in an electrified condition, and that a sufficiently long upright conductor would show marked signs of electrification, and even sparks between it and ground, on clear as well as cloudy days. Later and more accurate measurement showed that this electrification increased in proportion to the altitude, and that it was always present, although in varying amount, and that it bore certain relations to meteorological conditions. Some of our experiments have shown that in addition to this change from day to day, there is a momentary variation in the current down a long upright conductor, a variation from second to second, precisely as if the upper end of the wire were being struck by a series of lightning strokes in miniature. It can readily be imagined how troublesome such interruptions must be, and what a disturbing effect they have upon the even tenor of a telegraphic message. We soon found that the best results, as far as freedom from such disturbances was concerned, were obtained when the wires did not exceed two hundred feet in length. Even with comparatively short lengths of wire, from thirty to forty feet, a delicate adjustment of the coherer and relay would show the presence of atmospheric electricity by occasional clicks. One of my experiments seemed to show a definite relation between the wind velocity and the frequency of these clicks.

After a satisfactory conclusion of the experiments at Chickatawbut, a greater distance was tried—that from Blue Hill to Memorial Hall, Cambridge, about twelve miles. Instead of using kites at both stations this time, the tower of Memorial Hall was used as a support for the wire, and a kite flown at Blue Hill when we wished to signal. Again we had to wait for a favorable wind, and after an interval of nearly a week were enabled to make our first trial. This trial was partially successful, as most, if not all, of the signals sent were received, although not all identified. But a new difficulty arose, that of interference from neighboring electrical apparatus, particularly the electric cars, which run quite near the hall. Every time that an electric car approached within a hundred yards of the apparatus, it was heralded by a series of dots and dashes—an incoherent message sent by the changing current in the motors of the approaching cars. It was apparent that we had all the essentials for a very perfect form of car indicator, but a car indicator was not at all desirable; for we wished to receive the signals from Blue Hill intact, and not overlaid with a bewildering tangle of electric car messages.

I am at present engaged in a series of experiments in wireless telegraphy for the newly organized company—the Wireless Telephone and Telegraph Company—at Providence, R. I., between two experimental stations there, which are placed among the worst possible conditions for such work. Although the distance there is small—under two miles—the is an intervening hill, numberless wires in the immediate neighborhood of both stations, and electric cars galore, some half dozen lines between our stations. We have had little trouble with this plant, as it has worked perfectly from the start, and by a few changes of detail we have been enabled to transmit messages at the same speed as that of an ordinary telegraph line, that is to say, about thirty to forty words to the minute.

As yet the commercial future of wireless telegraphy is not well defined. There is, of course, a wide field at once open to it as a means of communication between ships, between lighthouses, lightships, and the shore, and especially as a danger signal in stormy weather and in fogs. Its service to the navigation of the future will be of the greatest importance. The service that it can render in this direction is apparent when one looks over a list of the vessels and lives that are lost for lack of such certain communication. One of the strongest points of this system is its cheapness and great compactness. Probably the cost of Marconi's installation for signaling across the Channel was not in excess of a thousand dollars. This will enable it to economically replace short submarine cables, where the traffic is insufficient to carry the expense of a submarine cable. Submarine cables are expensive things, costing about as much a mile as a complete installation for wireless telegraphy. As an aid to naval operations it has already been of service abroad, its compactness and ready installation on board of any vessel being points in its favor.

For certain purposes it may be used between disconnected points on land, particularly in military operations, where immediate communication is desired between forces miles apart, and there is no time to erect a military telegraph line. It is also apparent that such a "line" of communication cannot be cut by the enemy, although if they were equipped with the proper receiving apparatus they could receive the messages, and profit by them. Sending in a cipher code would of course render such messages valueless to the enemy, or better still some system of electrically tuning the instruments that I shall speak of presently.

But before this system can come into successful commercial use, there are difficulties that must be overcome, and very serious difficulties many of them are.

As I have before stated, the waves are not in any way directed, and a receiver placed anywhere within the range of the transmitter would pick up the message. Leaving out of consideration the rapid diminution of energy with increased distance, this is both an advantage and a disadvantage of the system. It is an advantage if a lighthouse is signaling a ship in the fog, whose position is unknown. It is a disadvantage inasmuch as anyone with a receiving instrument can pick up the message anywhere within the range of the transmitter. In addition to this the present system is not an electrically tuned one, that is to say, that any receiver will respond to any transmitter, and there can be but one transmission going on at a time within the radius of the influence of the sending station.

The possibility of electrically tuning a receiver to a distant transmitter, so that it will respond to this and to no other, is an interesting one, and I think that a little explanation will not be amiss. I have before spoken of the varying lengths of the waves, these lengths being chiefly dependent on the linear dimensions of the transmitter. It is well known that if two

tuning forks are of the same pitch, if one be set vibrating, the other will respond even though it is at a distance from the first, and (excluding from the discussion the effect of a fork an exact octave above or below, or even of an interval of a fifth) it will not respond to a fork of a different pitch. It is evident that if we had a series of tuning forks, of varying pitches, at one end of a room, and an exactly similar series at the other end, we could send a number of signals simultaneously, and without interference, each fork responding to its mate and no other. In a like manner we can imagine a number of wireless telegraph systems working side by side without interference. Unfortunately, there are at present no receivers sensitive enough for long distance work that will respond only to one wave length. The combination of coherer tube and vertical wire will respond equally well over a vast range of wave lengths, from the short ones set up by a small oscillator to the long ones that are caused by changing currents in the electric car motor. What the future will bring forth in the way of electrically tuned receivers is impossible to predict, and one can only say that this line of investigation is a most promising one.

I have mentioned the fact that electrical waves are capable of reflection, as are those of light. An oscillator placed at the focus of a parabolic mirror will send forth a parallel beam of Hertzian waves, that can be as accurately directed as the rays from a searchlight, and unless a receiver is in direct line with this beam it will not respond.

At present, there is no way of producing sufficiently

paint all over the rest of the sky. Every bit must be covered, or it will print patchy. The sky must look perfectly opaque when viewed by transmitted light. The only disadvantage to this method is that the paint takes several days drying. The other method is to do an untuned print of the negative, place on a glass film, side up, and with a sharp penknife carefully cut away the view, leaving the sky intact. Then smear some thin paste all over it, and place on the sky of negative, to register exactly. If carefully done, the sky will print perfectly white.—“O. T.” in Photographic News.

THE HOMEMADE WINDMILLS OF NEBRASKA.

By ERWIN HINCKLEY BARBOUR.*

WHILE engaged upon the preparation of a paper treating of the relations of the homemade windmills of Nebraska to its agriculture, the writer finds such great and increasing demand for some short and immediate report on the subject that he is led at the request of correspondents to publish the following brief preliminary paper, awaiting the time when a systematic and formal report may be possible.

It is not the writer's object or intention to offer our citizens advice—for he is the one who is under instruction—but rather to bring together views of a number of mills and to compile facts about their uses, construction, cost, and durability, which may be of possible use to prospective builders, and by which they may be enabled to select the design which seems to

more expensive than the poorer, and their efficiency considerably greater. It is advantageous to have good models to copy, and the next best thing to the actual model is a good simple drawing. This is the first object of this paper on our homemade windmills; it aims to supply cuts illustrating all sorts of windmills as found in Nebraska. These in a certain way will serve as models and may guide citizens to this extent, that they may benefit by the experiences of others without necessarily compromising their own individuality and personality. They can build the mill which they have conceived of, and do it in their own way, and yet they may benefit somewhat by what others have done before in the same line.

Those who have had little chance to observe for themselves can scarcely be brought to realize the great number of homemade mills and the wide territory which they cover. But to the writer's knowledge they extend in almost unbroken succession from Omaha to Denver, and from South Dakota through Nebraska, Kansas, and Oklahoma, our own State being plainly the center of the movement. The writer has gone by rail over the various roads; has driven by team; has employed—at his own expense—students to drive several times across the State in various directions. In this way, as will be very plainly seen, a large number of places have been visited and a very fair survey of the windmill has been made, and from the knowledge obtained it may be said that the Platte valley from Omaha to Denver seems to be the very backbone of the homemade mill, its ribs extending

FIG. 1.—The Baby Jumbo, designed and built by W. W. Her, Havelock, Nebraska. It has four fans each 3 feet long, with arms $2\frac{1}{2}$ feet long attached to an iron axis. It is attached by a 16-inch crank directly to the pump handle. It is mounted on a 16-foot tower. This little mill, which cost but \$3.70, pumps water for the stock and for a boarding house with thirty guests, lifting the water from a 60-foot well.

FIG. 3.—A six-fan Jumbo windmill on the farm of W. W. Goodrich, Bet any, Nebraska, used in watering a 4-acre patch of egg plants for the Lincoln market. The fans are each 9 feet long, with arms $5\frac{1}{2}$ feet long. Jumbo box $9 \times 11 \times 6$ feet high, with door below for the escape of dead air. Extra well built. Axis of Damascus steel. Total cost, \$8.

FIG. 2.—A remarkable little Jumbo, designed and built by Mr. J. L. Brown, proprietor of the Midway Nurseries, at Kearney, Nebraska. It cost but \$1.50, yet it pumped sufficient water to irrigate and save the garden truck, the strawberry patch, and the small fruit during the most trying season of drought ever recorded in the State. Box 3 feet wide, 9 feet long, 6 feet high. Eight fans 3 feet wide by $4\frac{1}{2}$ feet long, supported on a gas pipe axis.

FIG. 4.—Mill No. 1 of the Travis brothers, market gardeners, Lincoln, Nebraska, showing edge of reservoir, 150 feet long, 4 feet wide, $2\frac{1}{2}$ feet deep. The sails are made of old coffee sacks. The “cut-offs,” or wind guards, may be seen on either side. These are raised and lowered by pulley and rope. Dimensions, 9 feet wide, 13 feet long, 13 feet high. Cost, \$8. Successfully irrigates a 5-acre garden.

intense Hertzian waves from a small radiant point. Unless the waves proceed from a very small surface, one that is practically a point, the mirror cannot send them out in a parallel beam. However, such a system, using parabolic mirrors at both stations, has been tried over a distance of two miles with success, the rays being so nearly parallel that at this distance from the mirror, the width of the beam was found to be only fifty feet, the receiver working vigorously in this space and not at all outside of it.

BLOCKING OUT SKIES.

MANY negatives have what are known as “dirty skies”—that is, the sky of the negative is thin in parts, thus making a muddy or tinted sky in the print. If clouds are required on the print, the sky, of course, must be perfectly white, otherwise they would print in flatly. There are two methods of blocking the skies out on the negatives—painting out and pasting out. The former is the one usually resorted to, and is done as follows: Obtain a tube of ivory black oil paint, a small sable, and a hog's hair brush, also some turpentine. Squeeze a little of the paint out, and carefully paint round the edge of the sky against the horizon. Care must be taken that the color does not overlap any part of the view. Next use the hog's hair brush, and

them least faulty or best suited to their individual wants.

In the judgment of the writer, whose seven years of residence has enabled him to visit nearly every corner of Nebraska, this is an important agricultural movement, and is worthy of much fuller treatment than is possible within the scope of this paper.

The importance of this movement, inaugurated by the inventive farmers of Nebraska, is made manifest in that many acres of garden truck, fruit land, and even farm land are irrigated; that stock is supplied with water; that ranchmen and sheep herders are benefited; that dairy products are increased and improved; and that the comfort of the village and the rural home is often enhanced.

The merit of homemade mills has enjoyed such prompt recognition that they are going up daily. Not to the detriment, we are happy to say, of those important adjuncts to the farm, the shopmade mills, but in addition to them.

In a given community, the man who puts up the first mill generally furnishes the model for the rest of the community. Hence it seems the more desirable that good models should be at hand. The better models are often of quite as easy construction and no

out on all sides along the lesser river courses of the State. They are found in valleys rather than on table lands, for the reason, perhaps, that there the water is shallower and more easily raised by mills of low efficiency.

As said before, the first mill sets the style in mills for a community. Accordingly, in certain German settlements we find the old fashioned Holland mills, more or less modified, until they little resemble the original or mother mill.

As to the usefulness, cheapness, and durability of such home-made productions, it may be said that a good basis for a fair judgment in this matter is found in the fact that the designers and projectors speak in high praise of their mills. This would be otherwise if the mills were not satisfactory in each of the above respects. Some are so hearty in their praise of the home-made mill that the author by contact comes naturally to speak with equal confidence of these mills as important agricultural aids. Some have looked upon them with distrust, believing that any citizens too poor to put up the regular shopmade mill were on the face of it shiftless, unreliable, and undesirable citizens. As a fact it turns out that just the reverse of this holds true.

The builders of homemade mills in Nebraska are generally the wealthier and more progressive among the older and better established farmers; or else

* Condensed from the Bulletin No. 59 of the United States Agricultural Experiment Station of Nebraska, Lincoln, Neb., to which we are indebted for kindly lending the engravings.