Observations on Hardening.

Too many of the so-called steel articles sold in the market are either made from steel incapable of being hardened, or are not hardened at all. Good cast steel can be hardened and tempered so as to receive and retain an edge. This is not required of table cutlery generally—only of the carving knife—but it is required of the hand saw and the buck saw, of the spade and the manure fork, of the scissors and the pocket knife. Saw blades (so far as the writer has tried them) are not hardened; they will not retain "set" nor hold edge. They are gummed, as they come from the rolls and the slitting machine, with no pretense at hardening or tempering. But they are stamped "cast steel," and that probably satisfies the public; but there are mechanics who would pay something extra to get good hardened and tempered saw blades, even at a much higher cost than that of the soft plates, the teeth of which can be bent by thumb and finger, and the set of which is removed by sawing through an inch thick spruce board.

A spade is only an enlarged chisel; it should be capable of retaining an edge sufficient to cut through tough turf and dead grass. But most of the "cast steel" spades in the market can be sharpened as readily by drawing the edge cold under the hammer as by the grindstone. The edge never breaks, but batters and bends.

The trouble with almost all the cast steel tools put ready made on the market is, that they have never been hardened. Cast steel unhardened is as soft as wrought iron uncasehardened. A cast steel hammer became so indented on its face by driving nails during one season in jobbing that it had to be reground and polished. Yet the hammer was of steel capable of being hardened, as was proved by its being subsequently hardened and drawn to temper. It is quite possible that the reason why many of these articles prove to be soft is not that the material is not good, but that they have never been hardened. Brightened steel that has not received a hardening may respond in after-heating to several of the tempering colors, and this is probably one reason why common steel articles are not thoroughly hardened.

It is not uncommon to see a forger or temperer heat a piece of cast steel to a very low red—a red that shows only in the shadow—and then brighten and draw the temper to color, when the after-trial proved that the steel had never been hardened. Indeed, the dull red that some smiths use for hardening such tools as cold chisels and other low grade tools is that at which a red annealing may take place—the piece being heated to a dull red and plunged into water.

The first requisite in making a cast steel tool into a working tool is to harden it. After its hardness is proved, then it may be tempered to the condition required. There is no intermediate process of properly tempering between absolute hardening and subsequent drawing.

The Lead Bath.

Users of the lead bath for heating for hardening make frequent mistakes in allowing something besides lead to form a portion of the bath, and also in allowing the bath to be kept below its proper temperature. Only pure lead should be used to obtain the full heat for hardening good tool steel. A mixture of lead and tin—a melted mass composed of pewter, type metal, and soft solder—is not a lead bath. The melting and heat holding qualities of metals are not alike. With clean, pure lead, either pig or bar, good cast steel can be heated to its proper intensity to obtain a good hardening, and then be drawn to color in sand or blazed in oil. But the lead must be kept at a limpid fluid heat, hot enough to make its covering of charcoal powder glow, else the steel will not receive sufficient heat to harden.

Anti-Induction Telephone Circuit.

Recent and very satisfactory trials have, we understand, been made by the National Telephone Company on their trunk line between Greenock and Glasgow, of a telephone circuit devised by Mr. Smillie. The telephone instruments at each end are each connected in circuit with a flat circular coil of wire, without a core, and the earth. These coils are confronted by equal and parallel coils of wire, also without cores, and in circuit with the main line wire and a loop line, thus forming a continuous going and coming circuit. The message is induced into the line by these coils, which, not having soft iron cores, exercise little retarding influence on the currents.

MUSICAL WAGON.

Our illustration represents a musical wagon of novel construction recently patented by Mr. Hiram J. D. Miner, of Dunkirk, N. Y. Mounted in any suitable way upon an approved kind of wagon is the case of a musical instrument consisting of a pin barrel and comb, the former being provided with the usual toothed wheel and worm for turning it. But instead of being geared with the train of a driving spring, the worm is geared with the axle of the main wheels of the wagon by a pinion and wheel, so that, when the wagon

MINER'S MUSICAL WAGON.

is drawn along, the barrel will be revolved and music made the same as if the barrel were driven in the ordinary way. The driving wheel and pinion can be readily taken off, to substitute others of different proportions, for varying the time of motion to render the music in quick or slow time as may be desired.

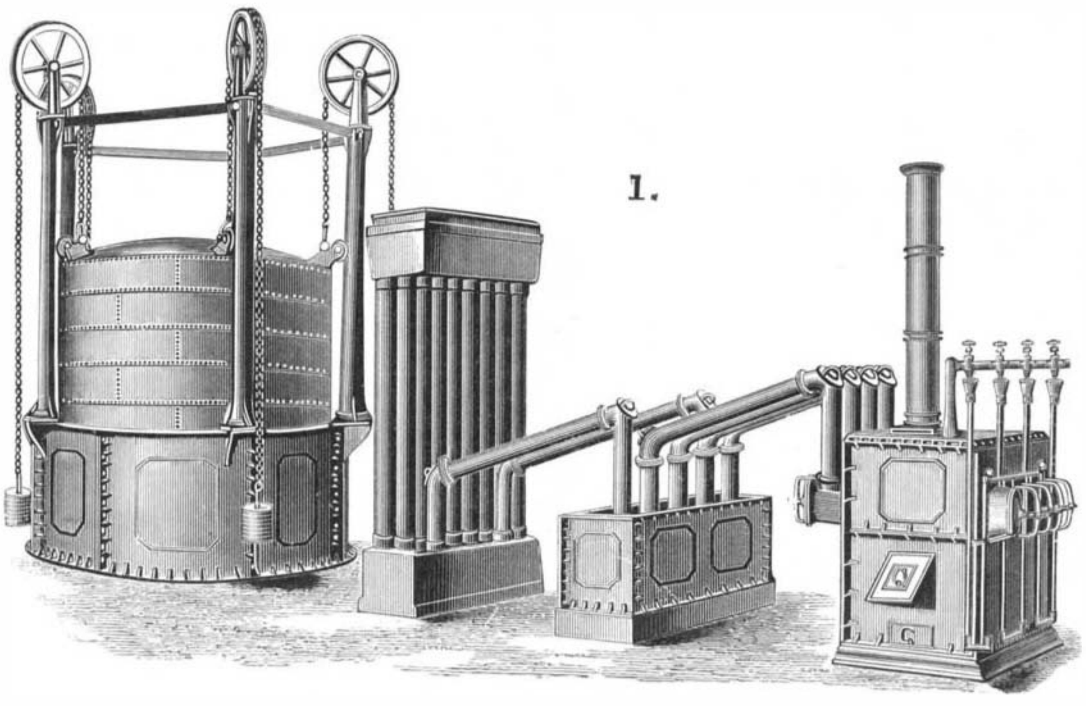
Wood Preserving Works at Las Vegas, N. M.

A Las Vegas exchange reports that the Atchison, Topeka & Santa Fe Company have executed a contract for the erection at Las Vegas of very extensive wood preserving works. They are to use the Line-Tonnier chemical process, which is owned and operated by the St. Louis Wood Preserving Company. This process was awarded the "gold medal" at the National Exposition of Railway Appliances, held at Chicago last June, as the best process for preserving wood, cross ties, and timber. This company has been using the New Mexican pine, but until treated, it is not particularly lasting. After being subjected to this chemical process, it is said to be very superior timber. This industry, when generally adopted throughout New Mexico, will prove one of importance.

OIL GAS PLANT FOR AILSA CRAIG LIGHTHOUSE.

A considerable time ago the Commissioners of Northern Lighthouses, on the recommendation of their engineers, Messrs. D. and T. Stephenson, decided to proceed with a scheme of erecting a new lighthouse on Ailsa Craig, an immense rock lying in the channel at the entrance to the Firth of Clyde; and as there was ample space on the islet for the fitting up of gasworks, they arranged to have the great lantern lit by gas. To provide against the obscurity of the light during the dense fogs which hang over the Firth during the winter season, the Commissioners determined also to fit up a large foghorn, to be operated by compressed air, the air being compressed by means of a number of gas engines. The works contemplated being of unusual magnitude, the Commissioners submitted the scheme to the most prominent oil gas engineers throughout the country, and asked for plans and estimates for carrying out the work. After a long delay, during which trials of various kinds of apparatus have been made, the Commissioners have at length definitely adopted the plans furnished by Mr. James Keith, gas engineer, of London, Edinburgh, and Arbroath, whose apparatus has already been used for similar purposes at Langness Point, in the Isle of Man, by the Northern Lighthouse Board. At Langness the oil gas plant was laid down merely to provide gas for a pair of Otto gas engines which operate the foghorn, but at Ailsa Craig the works are on a much larger scale, and provide for the supply of gas to the great lantern in the lighthouse tower, as well as to no less than 8 Otto gas engines of 8 horse power each. The works on Ailsa Craig will comprise a commodious gas house, in which will be erected three of Keith's patent oil gas producers and washers, with four retorts in each producer. There will thus be in all 12 retorts, capable of producing in the aggregate 2,000 cubic feet of gas per hour. The retorts are of simple construction, and are so arranged that the necessary heat can be raised within two to three hours, and the manufacture of gas be thereafter continuously carried on at the rate mentioned during the longest fogs. A short distance from the gashouse will be placed two gas holders, with cast iron water tanks, columns, and mountings of an exceptionally substantial character, to withstand the furious gales to which the rock is exposed. Each gas holder will contain 10,000 cubic feet, the two holders thus providing between them a store of 20,000 cubic feet of rich oil gas. The gas holders are connected to the producers in the gashouse through 12 of Keith's patent oil gas coolers placed outside, the gas produced from the oil being extremely pure; the scrubbing apparatus is of the simplest kind, and no purifiers are required. The material employed for the generation of the gas is a partially refined shale oil, technically known as blue paraffine oil, which has the advantage of being inexplosive, and of being obtainable in any quantity at a very cheap rate, ranging, according to quality, from sixpence to ninepence per gallon. The oil produces a rich 50 candle standard gas, which is reduced, according to a method adopted by Mr. Keith, before it is consumed, by admixture with about half its volume of air by means of a meter mixer, so that the total quantity of stored gas available—of a quality equal to good Scotch standard coal gas—is 30,000 cubic feet. The meter mixer automatically and accurately measures the proper quantity of air, which it thoroughly mixes with the gas, as the gas passes through the meter, and as it is being consumed. This reduction of the quality of the gas admits of the ordinary form of gas burners being used. The cost of the gas consumed on the rock will not exceed 5s. per 1,000 cubic feet, and the gas itself—though undergoing no purification by lime, etc.—will be much purer and brighter than the best Scotch coal gas.

The gasworks, says the *Mechanical World and Steam Users' Journal*, will be situated at a considerable distance from the new lighthouse and engine house, as well as the light keepers' dwelling houses. In the engine house, in connection with the fog signaling apparatus, will be placed the gas engines, so that they may be ready to start at a moment's notice at any time during the day or night, to sound the roaring fog horn, should a fog suddenly come on and obscure the light in the lighthouse tower overhead. The engines, as we have mentioned, are eight in number and are each of 8 horse power, the engines selected being of the Otto silent type. In ordinary circum-



OIL GAS PLANT FOR LIGHTHOUSE ON FIRTH OF CLYDE, SCOTLAND.

stances, during a fog, four of the gas engines will be kept running at a time, the other four being kept in reserve. The capacity of the gasworks is, however, ample to provide gas for all the engines and for the lighthouse as well; and when four engines are kept running, and the lights in the tower are kept burning, the gas stored in the gas holders would be sufficient to last thirty hours, even if no more gas were made during the interval. In practice, however, the gas holders will always be kept full, whether the engines are wanted or not, the gas produced in the retorts being led into one gas holder, while the other is used to maintain the necessary supply to the engines and to the lantern. It is expected that the works will be in operation this summer. The use of Keith's mineral gasworks at Langness during the past three years has proved the feasibility of employing rich 50 candle gas to drive gas engines, a point on which the gas engine makers expressed considerable doubt at the time Mr. Keith's plant was erected at Langness; but Mr. Keith successfully overcame all the objections, and the whole work has given satisfaction. The advantage gained by employing oil instead of coal for producing the gas is very great in such situations as Ailsa Craig, which is only accessible in fine weather for landing the necessary material. The oil yields three times the volume of gas, with at least twice the illuminating power, as compared with good cannel coal, taking oil and coal weight for weight—that is to say, only one-sixth of the gas producing material is required when oil is used instead of coal. It can also be conveniently landed in barrels and stored, while the process of making the gas is extremely simple, and does not require skilled labor.

Fig. 1 shows in perspective the arrangement of the gas producer, washer, coolers, and gas holders. Figs. 2 and 3 are respectively a transverse section and a longitudinal section of the producer furnace, showing the retorts. The retorts are fitted over a setting of brickwork, which protects them from the direct action of the fire in the furnace below, the flame being carried round the brickwork and over the retort to heat them equally all round. The oil from which the gas is produced is supplied to the retorts through pipes fitted in front, and formed with traps to prevent escape, the pipes being filled from a cistern. The retorts are slightly inclined downward from the front to the center, so that the oil entering by the supply pipes runs in a thin stream toward the middle of the retort, where the heat converts it into gas. The gas as it is generated passes to the other end of the retorts and rises through the ascension pipes, which are connected to the washer. The doors of the retorts are only provided to give access for cleaning purposes, the charge of oil being supplied through the pipes. The furnace is incased in metal plates, which are so arranged that each or all of the retorts can be withdrawn and replaced without taking down the brickwork. The gas produced is a fixed gas of great purity, and very little scrubbing is required. It is simply passed through water in the washer, and then led through a series of tubes which form the cooler, and thence into the holders. Mr. Keith's mineral oil gas apparatus has, we understand, been largely used for a number of years for supplying gas to country mansions.

Magnetism and Electricity.*

BY CHARLES F. CHANDLER, PH.D., PROFESSOR OF CHEMISTRY AND MEDICAL JURISPRUDENCE.

MAGNETISM.

I will say only a word about magnetism. A magnet is either natural or artificial. A natural magnet is a piece of magnetic iron ore or magnetic oxide of iron (Fe_3O_4), also called loadstone, and it occurs in nature. An artificial magnet is one produced by artificial means. Artificial magnets are of two kinds—permanent and temporary. A permanent magnet is a piece of steel that has been magnetized by bringing it in contact with another magnet or piece of loadstone, or by passing a strong current of electricity around it. A temporary magnet is a piece of soft iron which has been made temporarily magnetic by being brought near to a permanent magnet, or by passing a current of electricity through a coil of wire surrounding it. The properties of a magnet are: 1. The power of attracting certain metals—iron, nickel, cobalt, and, to a slight degree, chromium, and a few others. 2. The property of tending to assume a certain position as regards north and south. A magnetic bar or needle, if allowed to hang by its center on a string, or to float free on a piece of wood in water, will assume a position approximating north and south, but not exactly so. 3. The property of polarity—that is to say, a magnet exhibits its peculiar attracting powers chiefly at the extremities. There is a center of attracting power near each end, but not absolutely at the end, and at this point or center the magnetic power is strongest. These two magnetic centers are called the poles of the magnet; the end which points toward the north is called the north pole, and the one pointing toward the south, the south pole of the magnet. When two magnets are brought near each other, the north pole of one will attract the south pole of the other, and repel the north pole. So it has been found to be a law with magnets that "like poles repel, and unlike poles attract each other."

With regard to the direction the magnetic needle takes when allowed to move freely, it does not point directly north and south, but it assumes a position pointing a little to the east or to the west of north and south, depending upon the locality at which the observation is made. This is because the magnetic poles in different parts of the earth do not correspond exactly with the geographical poles, and the difference between them varies with the location at which the observation is made. This is why nautical almanacs are made to tell mariners the amount of variation from the true north and south made by the compass-needle in different parts of the world. This deviation of the compass-needle from the true north and south is called the "declination" of the needle. The term "declination" is very liable to be confounded with that of "inclination." When a bar of steel is hung by a thread at its center, it assumes an exactly horizontal position; but if this bar of steel is now magnetized, it will assume a direction pointing north and south, but it will no longer hang exactly horizontal except at the equator of the earth.

At all points north of the equator the north pole of the bar will dip downward, and the farther north you get the greater will be the dip, while at all points south of the equator the south pole of the bar will dip downward; and the degree to which the needle dips from the absolutely horizontal direction is called its "inclination." This is because the two magnetic poles of the earth do not correspond to the two geographical poles, but they appear to lie nearer the center of the earth. To overcome this tendency of the magnetic needle to dip at a varying angle according to the distance north or south of the equator, the needle of the mariner's compass is made by uniting two magnetic bars laid parallel, with the north pole of one adjacent to the south pole of the other, so that they lie with their opposite poles end to end. Such a needle is said to be "static." At a point on the surface of the earth corresponding with latitude 70° N. and longitude 96° 43′ W. the north magnetic pole seems to be located, and at this place the dipping needle assumes a vertical direction. The south magnetic pole is apparently located at latitude 75° 5′ S. and longitude 154° E.

The production of magnetism by induction is a curious phenomenon. If a permanent magnet is brought near a handful of iron nails it will attract them to it, and as soon as a nail becomes attached to the magnet it becomes a magnet itself and attracts another nail, which in turn becomes a magnet and attracts another, and so on, the magnetic power of each new nail attracted becoming constantly less than that of the preceding one. It is not even necessary that the nail should absolutely touch the magnet in order to assume this magnetic power, for it will be transmitted through short spaces from one to the other. This power which a body acquires by being brought near a magnet is called "magnetic induction." An important fact in this connection is that when a coil of iron wire is made to surround a permanent magnet it becomes magnetic itself by induction, and is capable of inducing magnetism in another bar of iron surrounded by it. This principle is made practical use of in the construction of the telephone and magnetic telegraph.

ELECTRICITY.

We now come to the subject of electricity. This is a peculiar agent, capable of producing certain astonishing results. There are different forms of electricity and different ways of generating it. The different forms are statical electricity, dynamical electricity, and magnetical electricity, or magnetism. It may be generated by means of friction, percussion, heat, chemical action, cleavage, and by magnets. The effects of electricity in its different forms are manifested as attraction, repulsion, light, heat, violent commotions, and chemical decomposition.

To excite electricity we must always do something, and the first way of producing it, discovered in the earlier ages, was by rubbing amber, and so the term electricity was derived from the Greek word ἤλεκτρον, signifying amber. It was afterward found that certain other substances when rubbed assumed electrical properties, and would attract or repel other materials. This electricity produced by rubbing or friction is called statical electricity. This is a form of electricity that can be held for a considerable length of time, and hence it has received the name of stationary or statical electricity. This is the only form of electricity that we can store up and keep for a time. What is known now as the storage battery does not really store up electricity, but only energy, which can be transformed into electricity at will. So much for statical electricity.

We have a totally different kind of electricity, called dynamical electricity, or electricity in motion. This is a form of electricity that circulates only in a conductor or along a wire, and it cannot be held. It was first discovered by Galvani in experimenting on frogs' legs, and hence it is often called galvanic electricity. It is now ordinarily produced by means of galvanic batteries and dynamo machines. The third form of electricity we have already referred to incidentally as that which is induced by means of magnets, and it is therefore called magnetic electricity, or magnetism.

According to the generally accepted theory, there are two so-called electrical fluids, and these two are commingled in equal proportions in all bodies; and hence all the processes for getting electricity must result in pulling these two electrical fluids apart, and in taking a portion of one away from a body. These two fluids are called one positive and the other negative electricity. It is found that when two bodies are electrified with the same kind of electricity, as both with positive, or both with negative, they repel each other; but when the two bodies are charged with opposite kinds of electricity, as one with positive and the other with negative, or when one body is charged with either kind while the other is left in its normal condition, then the two bodies attract each other. Hence we derive the law which states that "bodies charged with like forms of electricity repel, and those with unlike attract." The gold-leaf and pith-ball electroscopes are constructed on this principle.

When a piece of sealing wax is rubbed it manifests electrical properties for some time, but certain other substances, like metals, for instance, after being rubbed in the same manner, show no electrical properties, and this is because the electricity easily gets away from them. Thus we find that while certain substances remain electrified for some time others do not, and hence these bodies are named conductors and non-conductors. But these terms are not absolute, but only comparative. The metals, carbon, gypsum, and acids are called good conductors, while amber, glass, sulphur, and silk are poor conductors. If we want to insulate electricity and keep it from running off into surrounding objects, we surround the object containing it with a poor conductor. Thus, the glass insulators on telegraph poles prevent the electricity from leaving the wires and running off into the ground, and the non-conducting materials placed around the wires of the Atlantic cable so protect it that a small charge of electricity will carry a message from here to Europe.

Great difficulty is experienced in experimenting with statical electricity, because it so easily gets away. All substances are conductors to a greater or less degree, including the dust in the air and the moisture in the atmosphere. Perfect insolation and a warm, dry air are, therefore, favorable conditions for holding statical electricity. The reason it was not used earlier for practical purposes was because it was so difficult to manage. The electricity which is produced on glass by friction is called vitreous or positive, while that produced in the same manner on shellac or sealing wax is called resinous or negative electricity.

Franklin had a theory that there was but one electrical fluid, and that all substances in the natural state had an equal amount of it, but a body charged with an excess of this fluid was said to be in a positive state, and one in which there was a deficiency was said to be in the negative state.

But this theory has now given place to the two-fluid one, which maintains that all bodies are charged with an equal amount of the two electrical fluids called positive and negative, but when a body is electrified these two fluids are separated so that one remains in excess of the other. There is always a passage of the electrical fluid in two directions along a conductor, but, when the direction of the current is spoken of, it is the direction of the positive current that is always meant. Statical electricity can also be produced by pressure, as when certain crystals are firmly pressed together; by cleavage, as when two layers of mica are split apart; and by heat as well as by friction. It may also be produced by torsion. It is found that the charge of electricity, if collected in a spherical body, is on the outside, and not within the body; and if it is not a spherical body, the electricity collects chiefly at the part most nearly pointed. This kind of electricity is transferred in three different ways: 1. By conduction from one body to another in contact with it; 2, by convection, where gas or the air in contact with an electrical body takes away some of its electricity; 3, by discharge, where a highly electrified body suddenly loses a portion of its charge.

ELECTRICAL MACHINES.

Machines for producing statical electricity are usually based on the friction method. The old-fashioned machine consisted of a circular glass plate which was rotated between two cushions, and the electricity thus produced was taken off and carried to a metallic cylinder, called the prime conductor, by means of metal points. Silk and glass as insulators prevented the electricity from running off into neighboring objects. More recently machines have been constructed on the principle of induction, as illustrated in the electrophorus. These are known as the Holtz machines.

The condensation of electricity is illustrated in the Leyden jar. This is a sort of bottle, lined up to a short distance from its top, both inside and outside, by tin foil, and in the stopper is a brass knob which is connected with the tin foil on the inside of the jar by a chain. When the knob is charged with positive electricity from a machine, it collects on the tin foil inside the jar, while a corresponding amount of negative electricity collects on the outside of the jar. By this means a large amount of electricity may be collected and held by the jar until discharged, by making connection between the tin foil on the inside and that on the outside of the jar. The electricity is held, not on the tin foil, but on the surface of the glass. This is proved by means of a jar that can be taken to pieces after being charged—although the two pieces of metal which lined the inside and outside are now brought in contact, yet when the whole is put together again the charge is found to remain, and it is discharged by connecting the knob with the metal lining of the outside. All that these metal linings accomplish here is to make a large conducting surface over the whole of the glass upon which the electricity collects.

The discharge of electricity from such a jar, or a battery of several of them connected, produces a variety of results. The spark will pass through a thin plate of glass or a card and make a hole in them by disrupting them; or, in passing through points of metal, it heats them to a high temperature and vaporizes them, so that we get luminous effects from them. Electricity is estimated to travel at the rate of two hundred and eighty-eight thousand miles in a second.

* A review lecture delivered at the College of Physicians and Surgeons, New York.

Franklin first showed that lightning was simply a discharge of electricity from the clouds to the earth, and it occurred to him that, as points condense electricity and draw it away and discharge it quietly, lightning rods might be made on this principle that would prevent the disruptive effects of a discharge of lightning, and so be a protection to buildings on which they were placed. Such lightning rods are really a protection when properly made. A perfect one should be large enough to carry the charge of electricity, should have no break in it, should terminate at the top by numerous points, and connect at the bottom with the ground below the water line, and there be surrounded by fragments of iron buried in moist earth. It is well, also, to have it connected with the metallic water and gas pipes running through the house.

DYNAMICAL ELECTRICITY.

Now, a few words in regard to dynamical electricity. Galvani discovered, in experimenting on frogs, that when two pieces of metal, like copper and zinc, were placed in contact with the frog's leg and their ends connected, a movement of the leg would take place. This discovery gave rise to considerable discussion and experimentation, and, as a result, Volta developed the voltaic pile, which at first consisted of alternate layers of zinc, wet paper, and copper, piled one on top of the other in varying numbers. It was found that, when the top layer was connected with the bottom one by means of wires, a current of electricity was set up. It became understood then that the electricity was produced by the chemical action of the water in the paper on the zinc, and so more active solvent fluids came to be used instead of water, and cloth was substituted for the paper. It was found that the zinc was the positive element here and the copper the negative, and it is usual to find in all batteries that the metal acted upon is positive, and the one not acted upon is negative. There is now, practically, only one metal used for the positive element, and that is zinc, for it is the cheapest and the best.

THE GALVANIC BATTERY.

A galvanic battery is simply a combination by which we produce this chemical action, and zinc is the metal acted upon. The principle of the galvanic battery is this: If we immerse two pieces of metal, like copper and zinc, in a liquid like sulphuric acid contained in a glass vessel, and then connect the two metals by pieces of wire, a current of electricity is set up, because the liquid is decomposed by the zinc, and the H_2SO_4 is split up into SO_4 and H_2, and the H_2 is set free while the SO_4 unites with the zinc and forms Zn_2SO_4. The H set free tends to collect upon the surface of the negative element, and in this way the copper finally becomes "polarized" by the hydrogen. The positive element, the zinc, always drives the positive electricity through the fluid toward the negative element, the copper. The wires which conduct the currents from one element to the other are called electrodes, and the one coming from the zinc is the negative electrode, and the one from the copper is the positive electrode. While zinc is universally used for one element, the second element in the battery may be composed of different kinds of metals, according to convenience.

A difficulty in using zinc as the positive element was soon found in the fact that little local currents were set up between it and the impurities contained in it, and this caused an unnecessary waste of the zinc. So it became customary to amalgamate the zinc in order to prevent this local action of the fluid upon it. The next improvement made was to prevent the little bubbles of hydrogen from collecting on the surface of the copper, thus keeping the liquid from coming in contact with it in all parts—that is, to prevent the "polarization" of the copper. For this purpose certain substances came to be used to absorb the hydrogen. The first of these substances was the sulphate of copper as used in the Daniell's battery. This consisted of a copper vessel containing a porous cylinder in which was suspended a rod of zinc. Dilute sulphuric acid was contained in this cylinder, and in the copper vessel outside of the cylinder was placed a solution of the sulphate of copper. In this battery the hydrogen set free decomposes the sulphate of copper, forming with it sulphuric acid, and sets free copper which collects on the copper element.

Grove's battery consists of a glass vessel containing a porous cup surrounded on the outside by a coil of amalgamated zinc, and on the inside is suspended a rod of platinum instead of copper. The vessel outside of the porous cup is filled with dilute sulphuric acid, and inside with strong nitric acid. The nitric acid absorbs the hydrogen set free by the sulphuric acid and zinc. In the bichromate battery the bichromate of potash dissolved in sulphuric acid is used to absorb the hydrogen, and chromic acid is formed. So the three substances in use for absorbing the hydrogen in different kinds of batteries are sulphate of copper, nitric acid, and bichromate of potash. Bunsen suggested the use of gas carbon to take the place of the copper, or the negative element, because of its cheapness. So the Bunsen battery consists of a cylinder of carbon immersed in a vessel containing nitric acid, and within this cylinder is a porous cell containing sulphuric acid, in which a rod of zinc is suspended. To avoid using the porous cups, the force of gravity has been brought into play in the construction of the so-called "gravity battery." This consists of a glass vessel with plates of copper at its bottom, and upon this crystals of sulphate of copper are scattered, while over all is poured pure water, in the upper portion of which is suspended a plate of zinc. A very little sulphuric acid is added to start the battery, and then its action will keep up. Gravity here keeps the two liquids apart—the solution of sulphate of copper at the bottom, and the dilute solution of sulphuric acid at the top. This battery produces a constant current, and will run for a very long time. The Leclanche battery consists of a porous cup containing sal ammoniac in which is suspended a rod of zinc, and this cup is surrounded by the oxide of manganese as a depolarizer, immersed in which is the carbon. This battery is used when a current of electricity is desired for a very short time at once, as in striking burglar alarms, signal bells, etc. In the dipping battery a plate of zinc is suspended between two plates of carbon, and, when in use, these are let down into a solution of bichromate of potash dissolved in an excess of sulphuric acid. This fluid is called the electropoion. The galvanic battery is now being replaced for many purposes by dynamo-electric machines.

THE ELECTRIC LIGHT.

If a strong current of electricity is sent along a good conductor, it passes very easily; but, if passed along a poor conductor, it makes it hot. This is the principle upon which is based the incandescent electric light. A current sent over a fine thread of carbon heats it to a white heat, and thus produces a brilliant light. The same principle holds in the arc light, where the air acts as the poor conductor. Here two pointed sticks of carbon are placed in contact until a current is started through them, and then they are gradually separated for a short distance, when the resistance offered by the air to the passage of the electricity from one point to the other heats them to incandescence, and small particles of carbon in a state of combustion are broken off and carried through the air, thus causing an arc of light between the carbon points. The incandescent electric light and the arc light form two systems of electric lighting.

A current of electricity passed through certain substances will decompose them, and this process is called electrolysis. If it is desired to plate any object with a metal, that metal should be hung upon the positive pole of a battery, and the object upon the negative pole, and then, when an electrical current is passed through them, the metal on the positive pole will be decomposed, and a layer of it will be deposited over the surface of the object hanging on the negative pole. This process is known as galvanoplasty.

The most convenient method of measuring a current of electricity is by means of a rotating needle, around which the current is passed; and this is called a galvanometer.

THE ELECTRIC TELEGRAPH.

The electric telegraph is based upon the production of temporary magnets by passing a current of electricity through a coil of wire surrounding a bar of soft iron. All systems of electro-telegraphing involve a battery, a wire, a piece of soft iron surrounded by a coil of wire, a key or current breaker, and a sounder or indicator. Morse devised an alphabet, the letters of which were made up by various combinations of dots and dashes, which were scratched upon a strip of paper by the indicator. But telegraph operators soon found that they did not need to see these letters on the paper, for the ear quickly became educated to detect the letters by sound alone; so the paper was discarded, and now they hear, instead of see, the dots and dashes.

THE TELEPHONE.

It is found that, if by any means you change the strength of the magnetism in a permanent magnet, you will at the same time change the strength of a current of electricity passing through a coil of wire surrounding the magnet, and it is upon this principle that all the modern telephones are constructed. If in front of such a magnet a thin sheet of iron is fastened, and if the plate of iron is then approached a little nearer to the end of the magnet, the magnetic center is brought a little nearer to the extremity of the magnet, and hence the magnetic power at this point is increased; at the same time a similar increase is induced in the current of electricity passing through the coil of wire surrounding the extremity of this magnet; and now, if in the same circuit of wire there is a second similarly arranged apparatus, the increased strength of the current passing through the coil surrounding the second magnet will induce an increase in its magnetic power, and hence the second plate of iron will be attracted closer to the end of the magnet. In the same way a slight withdrawal of the first plate from the end of the first magnet would cause a weakening of the magnetism in the second, and cause its iron plate to spring backward again. So, in speaking in front of the first plate, at every vibration of the air produced by the voice the plate vibrates in harmony, and a precisely identical sort of vibration is produced in the plate of the apparatus at the other end of the wire, and these vibrations can be heard as the sound of a voice. This is all there is to the Bell telephone, and it is the principle on which all telephones are constructed.—*N. Y. Medical Journal.*

Canadian Indian Medicines.

The Marquis of Lorne, in his lecture at the Society of Arts on "Canada and its Products," speaks of some of the cures effected by Canadian Indian squaws and medicine men. Although many of their medicines are known to medical men, and in spite of the *hocus pocus*, or incantations, practiced in their application, he believes that there are many herbs which would well repay the examination, and possibly lead to the discovery of valuable remedies.

Civil Service for Conductors.

"Suppose a passenger having a ticket dies on my train, would it be proper to lift it?"

"What—the train?"

"No; the ticket."

"A full first-class ticket is required for a corpse," is the answer.

"Yes; but then it travels in the baggage car. The circumstances in the case I state are unusual. What must I do?"

"You have no authority to touch anything on the body. The coroner is the proper person to take up the ticket and deliver it to the company," explained the instructor, clearly.

Fifteen men sat at desks in a rear wing of the vast building of the Pennsylvania Railroad on Fourth Street every day last week undergoing the usual inquisition which determines their capabilities. The above and many similar dialogues occurred during the week's examination, and so far from appearing humorous or ridiculous to the preceptors, such inquiries were encouraged.

"Almost anything is liable to happen on a train," explained one of the tutors to a *Times* reporter on Saturday. "A thorough knowledge of the rights of the company and the passenger is essential. In the case you overheard, the responsibilities of the company undergo a complete change by the sudden death of a passenger from natural causes. You can see that a conductor may be called on, in an emergency, to decide some very important and knotty questions."

Beginning this morning, fifteen more applicants, coming chiefly from the ranks of brakemen and gatemen, will be examined for prospective conductorships. Six applications are already filed for next week. The method pursued in the week's examination is varied somewhat from time to time, but takes this general shape: The candidate is first asked to write a letter. Then he is tested as to his knowledge of mathematics. A statement more or less intricate, and involving numerous whole and half-fare tickets and rebate coupons, is read to him. He is told to render an account. The time consumed in making up his statement is noted to a fraction of a minute. At other times a statement is required of the miles traveled by passengers on a mythical train that makes lightning trips to all parts of the main and leased lines. The candidate is then lectured for two days, generally Tuesday and Wednesday. All the kinds of tickets are described. The rights of passengers and of the corporation are defined; local, first-class, thousand-mile, commutation, school, limited excursion, workmen's, and stock-shippers' tickets are carefully described. Samples of the various tickets are shown the candidates, and some of the interpretations put on the language of the ticket by the nascent conductors are novel, interesting, and often startling. Not much time is wasted over free passes, for the company incurs no responsibility for a passenger traveling on tickets of that kind. About this point, a budding conductor asked several days ago: "Suppose a man goes to Pittsburg on a return pass and dies there, will his pass be good to bring the body back?" The answer was in the negative, though circumstances might secure a waiver of the company's rights.

By Thursday the applicant is expected to know every station on the main line, the points at which branch roads deflect, the crossings where connections are to be made, and the names of all the leased roads in New Jersey and Pennsylvania. The rest of the week is devoted to questioning and drilling him in the details of his daily work.

Finally, on Saturday a tabulated statement is made of the candidate's grade. The successful men are rated first, second, or third class. All ranking below the latter grade are dropped. Men of the first or second classes are appointed to main line trains; those of the third class are only placed in charge of trains on branch lines. When the applicant has been unfortunate in his early education and is naturally intelligent, he is urged to try again, and is allowed a year or more to prepare for his re-examination.—*Philadelphia Times.*

Hydrogen by Electrolysis.

Of all possible methods for the production of hydrogen that of the decomposition of acidulated water by dynamo-electric machines would appear, on the face of it, to be the most extravagant. Yet the question has often been put to the editor of *La Nature*; and in a recent issue the process is explained, and its practicability denied once for all. Supposing a perfect dynamo—that is to say, a machine capable of converting all the work of a motor into electrical energy; and also a perfect voltameter, having no resistance and using all the current in producing electrolysis of the water. Under these theoretically perfect conditions, a horse power developed by a steam engine will in an hour decompose exactly 166 grammes of water, and set at liberty 18·5 grammes of hydrogen, measuring 296 liters, or 7·27 cubic feet. Supposing that practically the chemical action really utilized by the voltameter represents 70 per cent of the total energy, it follows that a horse power can only produce 13 grammes, or 146 liters, of hydrogen per hour. The production of a cubic meter of hydrogen per hour would therefore require the total energy of about 7 horse power. Thus the production of 1,000 cubic feet of pure hydrogen by this method would be effected by the expenditure of nearly 200 horse power for an hour; and the probable cost of the process may be left to the reader's imagination.

Streets on Tops of Houses.

To convey what I mean, says Dr. B. W. Richardson, let us move to the best constructed, as well as the most beautiful street of this metropolis, if not of the world—Regent Street—in the part called the Quadrant. That is laid out for such a design as if it had been prepared for the experiment. All the houses are of the same height, and the height throughout is just right for a city like ours. It is sufficient to be handsome and commodious without being overwhelming, and without excluding the light from the streets. The roofs of Regent Street, at this part, are flat in comparison with other roofs. They are utilized here and there by photographers' studios, which, although temporary structures, stand firmly and well, in ready communication with the houses on which they are placed. The studio, where it exists, seems naturally to form and become a part of the house. When we glance along the line of roofs, as on a level terrace, the idea of reconstruction of all roofs, and of the readaptation of them, becomes most distinct and suggestive. The width of most London houses averages, as near as I can estimate, about 25 feet from front to rear. Here, then, is good space for a terrace for foot passage. Imagine along two lines of long streets a terrace of this kind, with handsome railing on each side, and perfectly level floor surface of wood; and, at intervals, light bridges spanning from one terrace to another, and you have an upper-day London which might almost relieve all the pressure from foot traffic in the streets below. Each house would have its own exit, or door, at the upper as well as at the lower parts; and, at convenient spaces, each terrace would be accessible from the street, as the Holborn Viaduct is at the present time.

It suggests, at first, a revolution of ideas to conceive such a change. It suggests much out of which a humorist can for a moment make capital. I know all this very well. But there is, in point of fact, nothing more in it than in the first idea of making a tunnel under the streets or under a river. When the suggestion is looked at bit by bit, without prejudice, it offers more of sanitary advantage for the purification of the atmosphere, the protection of property, the comfort of the people in transit, the lodging of the people, the exercise of the young, and the beautifying of the whole city, than could be entertained on a mere general statement of the proposition.

In the first place, for every house in connection with an upper terrace, there would be the most perfect through and through ventilation of air. The staircase would no longer be a closed cupola for holding and storing all the emanations from the basement upward.

In the second place, the fact of having terraces on the upper surface of London would lead to immediate arrangements for the purification of the air from smoke. So soon as the roofage was accessible as a terrace, the plan which Mr. (now Sir) Spencer Wells projected for the removal of smoke from every house, by laying down horizontal conducting tubes with central exits and smoke consuming furnaces, would be easily practicable, presuming always that some smokeless fire be not invented, or that coal gas does not become the fuel of the people. These terraces would then be the healthiest parts of London; charged with flowers and trailing evergreens; they would be the empyrean gardens of the great city.

The terraces, with their light intercommunicating cross bridges in the long thoroughfares, would be more than pleasant foot ways and shady lanes for the foot travelers or travelers in light, noiseless vehicles, like tricycles; they would be most useful for other purposes. Along them the electric lines would pass and enter the houses direct; and from them the letter carriers would most easily deliver their letters.

These terraces, while relieving the traffic in the streets below, would remove all necessity for the fire engine, and would make London practically safe from fire. From them water would be supplied readily, a trained police for this upper London being ready at every moment to go down and extinguish fire in every domicile, carrying his hose with him, or plying it from above.

I think that no one who reflects will fail to see that all these changes would be advancements of great value for the health of a city like ours. They are, however, not the chiefest advantages. If any one will take the trouble to go observingly through the busy parts of London, where there are long miles of roadway—along Whitechapel and Mile End, for example—he will see the most jagged, hideous lines of roofage. Here a row of houses two stories high; there a row of three or four stories; then a single house five or six stories; and so on, over and over again, like a set of bad teeth. If the plan here suggested were carried out, all this would be rectified. A street like Regent Street expanded into a straight line would extend from the Marble Arch to the City, and from the City to the extreme East End. The line of terrace pitched at five stories would necessitate the building up to the same level of all the houses in that line, by which at least one-fourth more housage would be supplied, with arrangements for giving comfortable and healthy homes, beyond what now exist, to a fourth of the present population. The suspension cross bridges would not be without their compound service. They would be bearers of electric lines along their side ways, and would probably soon be utilized as centers from which electric beacons would be suspended to light the streets beneath.

Imagine the metropolis turned into a fairy land by this adventure of science into the domain of art, and art reciprocating the idea with all her rich resources, and we see in our mind's eye what our children, when we are all of us gone, may really see, and, perhaps, thank us for proposing for their benefit.

Objections will be made about mechanical and architectural difficulties. I heard them all made when the Holborn Viaduct was projected; I saw them all melt way as Colonel Haywood's practical mind came into work, and his unthanked skill and industry and responsibility and genius carried all before him.

CARYATID IN MAUSOLEUM OF CHAACMOL, YUCATAN (FRONT).

It will be objected that flat roofed houses are not weather tight. In the year 1835 the then Parisian Asphalte Company roofed two houses with asphalt in Hinde Street, Manchester Square. I lived in one of those houses for twenty-eight years, and a better roof I never knew; but for the London smoke, it would have been made into a garden. Men working upon it, walking over it, communicated no sound whatever into the rooms immediately below.

It will be objected that houses will not bear the weight of superimposed suspended terraces for foot walks. If they will not, they ought. In no direction would the sanitary improvement for the purification of a great city be more useful, as a side improvement, than in so reconstructing defective houses as to make them capable of bearing an equalized weight, which, carried by many, would, as we know from the bearing of ice, be comparatively light and practicable.

Of the many plans which have been suggested for giving space to crowded cities, such as terraces in the streets opposite to first floor windows, and tunnels subterranean, none seem to me to be half so practical, half so likely to secure the purification of atmosphere, as this, which I have now for the first time, after some years' hesitation, ventured to sketch out, not as expecting ever to see such a project realized in my own time, but foreseeing as even a necessity and practicability in the times to come.

Restoration of Faded Photographs.

It is only to immerse the yellowed print in a dilute solution of bichloride of mercury until all the yellowness disappears. It is then well washed in water to remove the mercurial salt. If the print be a mounted one, it is by no means necessary to unmount it previously to treatment. All that is required in this case is to keep it in intimate contact for a time with blotting paper charged with the bichloride; indeed, this is the plan originally suggested by Mr. Barnes. By the bichloride treatment no lost detail is actually restored, as some have imagined. It is simply that the sickly yellow color which, as it were, buried the delicate half-tints, or what remains of them, is removed, and thus renders the picture bright and clear. Pictures which have been treated with the mercury always possess a much warmer tone than they did originally, as the purple or black tones give way to a reddish brown or reddish purple—more or less bright according, probably, as gold or sulphur had been the principal toning agent. Here a question very naturally arises with regard to the future permanence of pictures which have been thus "restored," seeing that negatives intensified with mercury or transparencies toned with it are so prone to change. In answer to this we may mention that they appear to be permanent—at least that is our experience with some that have been done for many years. There appears to be no further loss of detail, and the whites retain their purity. Indeed, since undergoing the treatment with mercury, no alteration is yet perceptible.—*Br. Jour. of Photo.*

DR. LE PLONGEON'S LATEST AND MOST IMPORTANT DISCOVERIES AMONG THE RUINED CITIES OF YUCATAN.

(*Continued from page* 240.)

THE MAYA PEOPLE.

We have been among the ruins since September 20, continuing our studies of the grand though now crumbling edifices of the ancient and highly civilized Maya people.

With abundant reason the Spanish soldiers and priests were amazed at the magnificent white stone houses which they saw on their arrival at Yucatan, in the fifteenth century. They little thought to find such edifices among people whom they regarded as savages, but who, in fact, were most civil, and so warlike and determined that they resisted the invaders for twenty years. True it is that at that time the inhabitants of the peninsula were a degenerate people, owing to the admixture of races which resulted from the invasion of nations inferior to the Mayas. Nevertheless, Spanish writers who had every opportunity for knowing tell us that the Europeans found the country thickly populated by most polite people, who enjoyed and appreciated the refinements of life; people who had current coin, though not metallic; who had just laws and upright judges; who considered it an unpardonable offense to lie; who were so honest that no document was needed to make a contract binding, nor doors to keep intruders from their houses, which, according to the historians, were commodious and tasteful, though not luxurious as we consider things to-day. Their wise men were learned; the Spanish father burned their books without knowing what they contained. In their foolish estimation they had a right to destroy that written knowledge because the authors did not believe in their particular divinity! How narrow is human intellect where theology is concerned!

The Maya artisans were clever, the laborers industrious. As for that virtue *which covereth a multitude of sins*, in every city there was an asylum for the aged, crippled, and infirm, policemen being employed to look for them, and conduct them to the desired shelter. The strong and healthy worked together in community, sharing equally the result of their labor.

Regarding their amusements, Father Cogolludo, who has written a most interesting work on Yucatan, tells us that they were clever actors, remarkably witty, and very sarcastic, often telling hard truths to their superiors, and in such language that no one could accuse them of having done so—at times converging their whole meaning in a single word. But it is to the historian Herrera that that we are indebted for a description of some of their pastimes. They had large