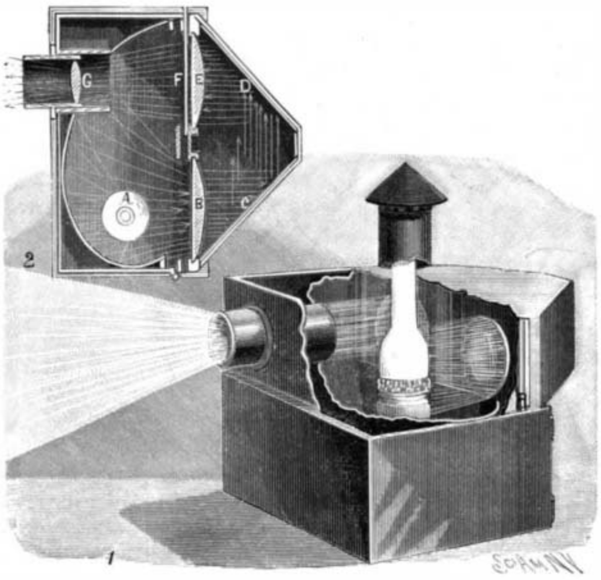
reconstruction commenced in earnest. The value and quantity of relics which are buried beneath these structures can only be conjectured.

IMPROVED PICTURE PROJECTING APPARATUS.

Heretofore magic lanterns have been devised either for projecting transparent pictures only, or for projecting opaque pictures only. Some transparency projectors, however, have been provided with an attachment whereby the same may be converted into a projector for opaque pictures. While this is suitable for certain classes of exhibition it nevertheless falls short of the requirements when it is desired to exhibit transparent and opaque pictures interchangeably; for considerable time is consumed, and trouble involved, in making proper adjustments necessary to effect the change from one class of picture to the other. Moreover, certain specially interesting pictures or objects—viz., those partly transparent and partly opaque—cannot be projected by such lanterns. With these conditions in mind Mr. George W. Smith, of Evanston, Ill., has recently produced and patented an apparatus which will project any class of picture or object without requiring any special adjustment. The invention is applicable to any kind of magic lantern, but more particularly to the form commonly known as the megascope.



IMPROVED PICTURE PROJECTING APPARATUS.

As shown in our illustration, the invention comprises a lantern box, at the rear of which is hinged a reflection chamber having vertical walls arranged obliquely with respect to the front wall of the box. A light, *A*, for example a Welsbach light, is located at one side of the lantern box at one focus of an ellipsoidal reflector, the picture or object to be projected being inserted at the other focus. On the opposite side an opening is formed in the reflector for the admission of the objective tube. Rays from light, *A*, pass through a condensing lens, *B*, to one of the oblique walls of the reflector chamber. Reflectors, *C* and *D*, are provided on these walls and they act to reflect the rays back through a condensing lens, *E*. A transparent lantern slide, *F*, when placed before the lens, *E*, intercepts the rays and permits the proper gradations of light and shadow to be projected by lens, *G*, onto the screen. Such is the effect when a transparent slide is used. When an opaque slide is to be projected, the direct rays from lamp, *A*, and also the indirect rays concentrated by the ellipsoidal reflector, illuminate the front of the slide, and the proper image is thus reflected through lens, *G*, to the screen. If the slide be partly opaque and partly transparent or translucent, the lantern will operate simultaneously as a megascope and sciopticon combined, thus, without any change, producing unique effects in a very simple, inexpensive and yet satisfactory manner.

The lantern should be very useful for scientific purposes for the reason that the same object may be projected by reflected light alone or by transmitted light alone, or by both simultaneously without removing the slide or changing the adjustment of the projector.

MOVING LARGE TREES.

An Iowa inventor has devised a very effective machine for lifting and moving heavy and cumbersome objects. The machine, which we illustrate herewith, though primarily designed for lifting rocks and bowlders, has nevertheless been found equally useful for raising and transplanting large trees. A description of this tree-lifter should prove of great interest to landscape gardeners, for it provides them with an easy and comparatively inexpensive means for transplanting and setting out large trees without injuring them. Our engraving shows the machine handling a tree 1 foot in diameter and 30 feet long. This, however, does not illustrate the full capacity of the lifter, for it has easily transplanted trees as large as 20 inches in diameter. The frame of the machine is V-shaped, the rear wheels of which support the outer ends of the frame while the apex rests on the front truck. Thus it is possible to back the machine up to the tree which it is desired to move so that the two arms of the frame will straddle the trunk. When the machine has been backed sufficiently to bring the hoisting drum into contact with the trunk, the front truck is swung around at right angles to the rear wheels so as to give a firm anchorage for the machine when the hoisting mechanism is operated. The horses are now detached from the machine and are hitched to the hoisting gear. A connecting rod is fastened across the rear extremities of the V-shaped frame, and serves the double purpose of increasing the rigidity of the machine and of supporting the trunk when the tree is drawn out of the ground. A padded roller on this connection serves to prevent injury to the trunk. A bar-chain is now placed around the roots of the tree, which have been previously cut loose from the surrounding earth. This chain is attached to the lifting-drum and the tree is slowly drawn up until the roots clear the ground. At the same time the trunk gradually sinks back until it is supported by the padded roller. The power for thus raising the tree is supplied by the team, which, as stated above, is hitched to the hoisting mechanism. The tree is locked in this position by a ratchet wheel and is now ready for transportation.

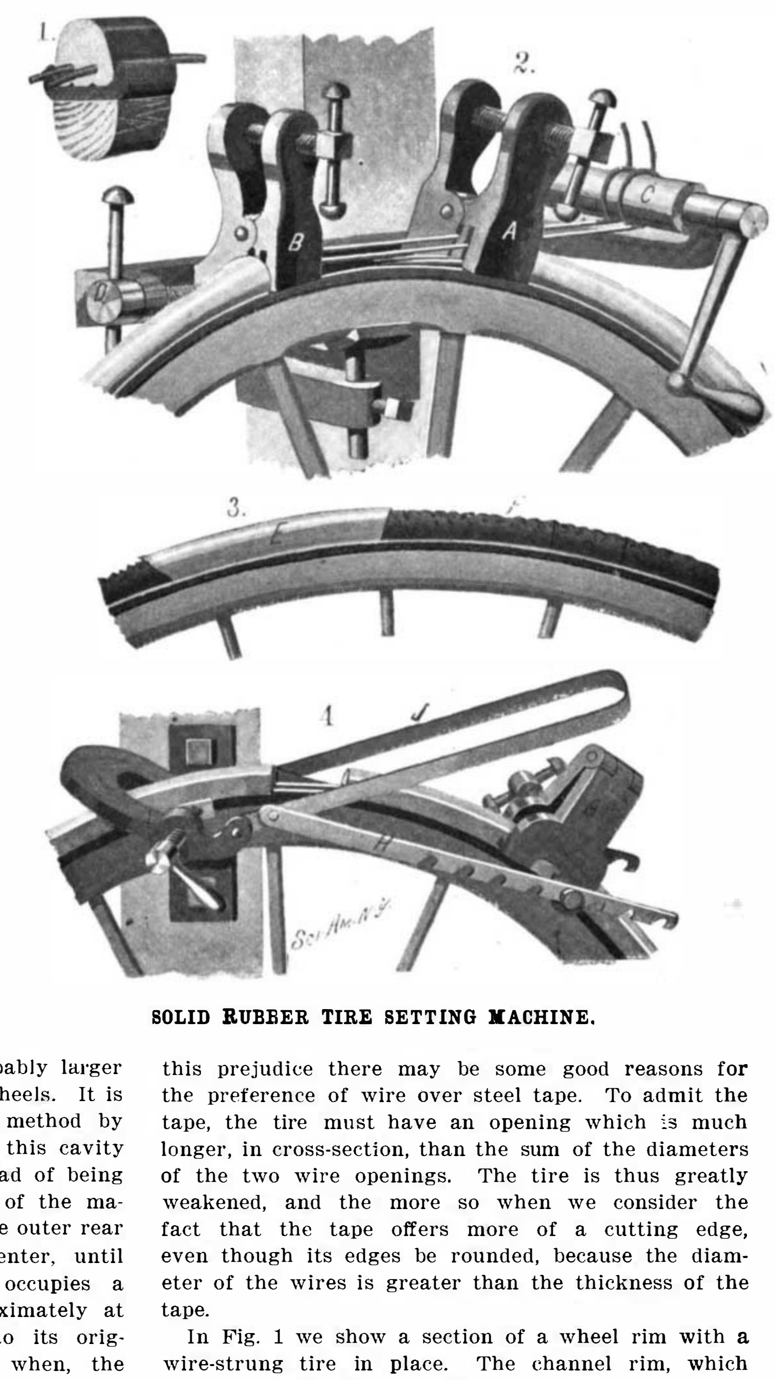
It is evident, of course, that a large hole has been left in the place which the roots of the tree occupied, a hole probably larger than can be safely straddled by the rear wheels. It is interesting, therefore, to note the novel method by which the machine is moved away from this cavity without its wheels sinking therein. Instead of being pulled directly forward the front wheels of the machine are first circled around the hole on the outer rear wheel as a center, until the machine occupies a position approximately at right angles to its original position, when, the hole having been cleared, the tree can be transported to any desirable locality. It is evident that by this method any hole can safely be avoided whose diameter does not exceed the distance between either of the rear wheels and the inner wheel of the front truck when turned at right angles. With the machine shown a hole of 14 feet diameter may thus be circled. When replanting a tree the same method must be pursued to avoid the cavity into which the roots are to be planted. When the hole has been sufficiently circled to bring the roots directly over the center, the tree is slowly lowered under control of a friction brake. In our illustration the operator of the machine may be seen grasping the lever of this friction brake. As soon as the roots have been lowered into the cavity, the machine is drawn forward, thus gradually raising the tree into an upright position. Guy ropes are then fastened to secure the tree in place, after which the rear connection is swung open and the machine is drawn off.

POWERFUL MACHINE FOR MOVING LARGE TREES.

The frame of this tree-lifter is very strongly constructed of Washington fir, white oak and hickory with very heavy iron bracings. It has a direct lifting capacity of over 50,000 pounds, and it will, therefore, readily be seen that the machine would prove serviceable for moving heavy objects of all descriptions.

SOLID RUBBER TIRE SETTING MACHINE.

Solid rubber tires are ordinarily secured to carriage wheels by a steel tape or a pair of wires which run longitudinally through the tire, near its under surface. At present the wires seem to meet with more favor than the steel tape, and the reason for this lies probably in the fact that the tape first used was not heavy enough for the purpose, and soon broke or rusted away. Heavier tape is now used with better results; but a prejudice once formed is hard to overcome and wired tires still hold the lead. Aside from this prejudice there may be some good reasons for the preference of wire over steel tape. To admit the tape, the tire must have an opening which is much longer, in cross-section, than the sum of the diameters of the two wire openings. The tire is thus greatly weakened, and the more so when we consider the fact that the tape offers more of a cutting edge, even though its edges be rounded, because the diameter of the wires is greater than the thickness of the tape.



SOLID RUBBER TIRE SETTING MACHINE.

In Fig. 1 we show a section of a wheel rim with a wire-strung tire in place. The channel rim, which is secured to the felloes of the wheel, has a flange along each side, between which the tire is set and held by the two wires. The manner of stretching these wires and splicing their ends together, so as to form endless rings, is very interesting. A number of different machines have been designed for this purpose, among the simplest of which is the mechanism here illustrated. In Fig. 2 we have the machine for setting and splicing the wires together, after which the rubber must be straightened out and set by the device shown in Fig. 4. Both mechanisms are very compact and take up almost no room, because they can be fastened to the side of the wall, or against a post or column of the repair shop.

The wire-setting device consists of two clamps, one clamp, *A*, being stationary. The other clamp, *B*, is movable, being mounted on the tightening screw, *D*, by which it can be made to travel along the tracks on the main frame. A bracket projects out from the frame a short distance below the two clamps, and on this the wheel is hung, the felloe resting in an adjustable support which is raised sufficiently to bring the rim of the wheel against the bottom of the clamps. Clamp *B* is first drawn away from clamp *A*, to its extreme position, and then the tire, which has been previously strung with a pair of wires, is loosely fitted into the channel rim, its two ends being held back by the clamps, but the wires projecting through their jaws.

The wire ends which project through the clamp, *A*, are gripped by its jaws, but the other ends projecting between the jaws of clamp *B* pass freely through clamp *A*, and are wound around the drum, *C*. A block is placed in each clamp between the wires to hold them in their proper positions. The block in clamp *A*, however, is thinned down at its upper end so that the wires which extend to the drum, *C*, will not be gripped when the jaws are closed. These wires are now wound up tightly on the drum, *C*, and secured by closing the jaws, *B*. To attain the necessary tension the tightening screw, *D*, is operated. A powerful pressure is thus brought to bear on clamp *B*, which stretches the wires to their utmost. This done, all superfluous wire is cut away, and the overlapping ends filed on a taper to make a smooth joint. Asbestos is then packed under the wires, and particularly against the clamps, so as to prevent the intense heat, necessary in brazing, from harming the rubber tire. The wires are now brazed together in the usual way, and our first and most important operation is completed.

The wire rings, it will be found, have been drawn so tight that the rubber cannot, with ordinary means, be drawn over the splice, and this brings us to the second operation, which is illustrated in Fig. 4. The wheel is supported by a vise, which grips the rim near one end of the rubber tire, and a clamp, *G*, is secured to the other end. A U-shaped lever, *J*, straddles the wheel rim and is hinged to the vise. Pivoted to each leg of the lever, *J*, near the vise, is a ratchet bar, *H*, which has notches along its lower edge. These ratchet bars are adapted to hook over pins on each side of the clamp, *G*. Now, by drawing back the lever, *J*, the end of the tire which is held by the clamp is drawn, little by little, up against the end secured in the vise. Any unevenness or bunching of the tire is then in a similar manner straightened out, after which the wheel is ready for service.

The process for tape-strung tires is the same except, of course, that no separating block is necessary in the clamps, *A* and *B*. Inserting the tape into the tires is, however, rather difficult, because the tape is sure to bind along its edges. It has been found necessary to attach a force pump at one end of the tire opening, which is operated while the tape is inserted from the other end. The air pressure inflates the opening and permits a freer passage for the tape.

Car tracks, and particularly their switches, cause most of the damage to carriage tires. A terrible wrenching strain is received when the vehicle is suddenly swung out of a car track. Sometimes the rubber is so badly torn that it is necessary to patch it with a section of new tire. This is easily done, as shown in Fig. 3, the new section, *E*, being inserted in the old tire, *F*, and all made secure by the retaining wires.

ELECTRICAL RESONANCE AND ITS RELATION TO SYNTONIC WIRELESS TELEGRAPHY—I.

BY A. FREDERICK COLLINS.

The recent transference of the Pupin electrical resonance patents to the Marconi Company has created more than a passing interest in the application of resonance principles to syntonic wireless telegraphy.

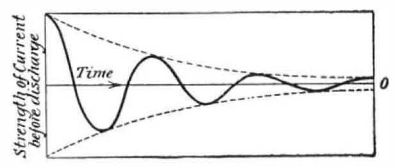
In wireless telegraphy practice it is well known that an electric circuit having definite values of inductance, capacity and resistance will respond to currents of high frequency set up in a circuit of the same dimensions.

This phenomenon is termed *electrical resonance*, taking its name from the similarity of the action produced and the means by which it is accomplished to the resonance in acoustics where the sound waves cause a sympathetic vibration in a suitable medium. As a familiar illustration of acoustic resonance, let two tuning forks of the same size, pitch and form be placed a given distance apart so that the waves set in motion by the vibrations of the first fork will impinge on the second, when a vibratory reaction will take place and it will then respond to the fundamental tone and a second train of waves will be emitted.

The co-efficients of an electric circuit are its inductance, its electro-static capacity and its resistance, and upon these three factors the size of the circuit depends. Inductance is the effect of a current flowing in a straight conductor or a coiled wire on itself; the inductance of a wire is virtually electric inertia, since a current does not start or stop instantly, but requires the element of time to do either. Capacity is the quantity of electricity which must be impressed upon a circuit in order to increase its potential, or raise its pressure to a given value. The capacity of an electric circuit may be compared to that of a gas tank, the quantity of gas the tank may contain depends on the pressure with which the gas is forced in as well as on the size of the vessel; likewise the higher the electromotive force or pressure of the current and the smaller the capacity of the circuit, the smaller the quantity of electricity required to charge it to a given potential. The resistance of the conductor is the reciprocal of the electrical conductivity, or the ratio between the electromotive force of a circuit and the current it carries forward. The resistance of a circuit may be taken to be the sum of the opposition offered to the flow of the current.

The effects of these co-efficients vary considerably according to the nature of the current employed in

FIG. 1.

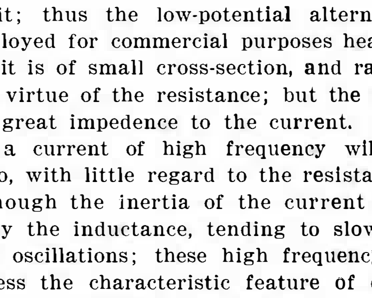


the circuit; thus the low-potential alternating currents employed for commercial purposes heat the conductor if it is of small cross-section, and radiate heat waves, in virtue of the resistance; but the inductance offers no great impedence to the current. Oppositely disposed, a current of high frequency will oscillate to and fro, with little regard to the resistance of the circuit, though the inertia of the current is greatly affected by the inductance, tending to slow down or damp the oscillations; these high frequency currents also possess the characteristic feature of dissipating nearly all their energy in the form of electro-magnetic waves.

ELECTRO-MAGNETIC THEORY.

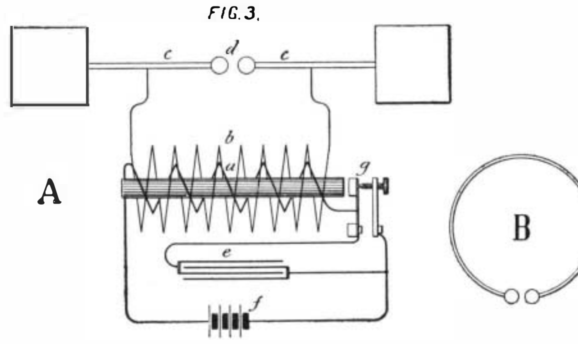
The electro-magnetic theory of light was invented by Michael Faraday, who was enabled, after a series of

FIG. 2.



laborious and difficult experiments, to demonstrate by physical methods that light, electricity and magnetism were allied to each other in a definite way. This he did by placing a cube of heavy glass of his own manufacture in the field of a powerful electro-magnet in such a way that when a pencil of light was passed through the glass the line of wave propagation was parallel to the lines of magnetic force.* Before the electro-magnet was excited an analyzer, similar to those used in polariscopes, was arranged to intercept all the waves of light. When the magnetic field was produced by the rotational current of electricity the light waves were twisted or turned through an angle sufficiently to permit them to filter through the analyzer. Proof was thus established that light and magnetism are closely related. Of electricity and magnetism the

FIG. 3.



same is equally true and more easily proven; for instance, when a current passes through a coil of wire it assumes all the characteristics of a magnet exhibiting the same curved lines of force, attraction for magnets of the opposite sign and repulsion for those of the same sign, and other phenomena of a like nature. This classical experiment and the researches of Faraday on the dielectric stresses in insulating mediums under electric strain led James Clerk-Maxwell to subsequently deduce by a delicate synthesis of Legrange's co-ordinate system† the mathematical evidence that undulatory motion in dielectrics is due to transverse vibrations of the ether or polarizations, and these polarizations are produced by changes of electric charges rapidly shearing the ether; the more rapid the movement of the electric charge, or period of oscillation, the greater will be the dissipation of energy in the development of the waves. The electric charge of an atom weighing one micromil in diameter may oscillate 434 trillion times per second propagating waves 271 ten-millionths of an inch in length, producing the sensation of red light, or the charge may vibrate with a frequency of 740 trillion times per second and send out a train of waves each measuring 165 ten-millionths of an inch in length, giving the color value of violet light; or the charge may vibrate between the limits of 271 and 740 trillion times per second, the varying wave lengths resulting in orange, yellow, green, blue or indigo light. Having determined that light-waves are electro-magnetic disturbances in the ether, caused by oscillating charges of electricity, it was not difficult to imagine a larger charge moving at a much slower rate in its reversals than atomic charges, and therefore emitting longer waves. Maxwell came to this conclusion, but to explain all the phenomena of wave emission and propagation by one ether he assumed that the velocity of transmission was in every case identical. By calculation and direct experiment this has been ascertained to be 186,500 miles per second.

Wave length as shown by a spectrum in Maxwell's time was not as extensive as it is to-day. Added to the visible spectrum discovered by Newton were band-showing waves shorter than the visible violet, and these were termed ultra-violet, and at the opposite end of the spectrum were band-indicating waves longer than the visible red; these waves were emitted by heat and were termed radiant heat or infra-red waves. That there were shorter waves than the ultra-violet and again others longer than the infra-red were postulated, but yet remained to be demonstrated.

ELECTRIC WAVES.

The present method for producing light waves by combustion is empirical and very wasteful, and the range of available wave lengths is limited by the ten-millionths of an inch. In 1888 the mathematically predicted electro-magnetic waves of Maxwell were observed by Hennrich Hertz, of Karlsruhe, Germany, who at the same time discovered the necessary apparatus for their production. The method for the production of the electric waves, employing the terminology of Hertz, is that of oscillating an electric charge of a mass instead of an atom. Prior to 1888 Prof. Fitzgerald described the conditions by which electric oscillations in masses could be set up; this was to "utilize the alternating currents surging in a circuit when an accumulator was discharged through a small resistance." This is the only method known where a longer wave than that produced by atomic vibration is desired, but Fitzgerald was unable to construct a physical apparatus to fulfill these requirements, yet the method as well as the apparatus is exceedingly simple, consisting of a Leyden jar charged by a frictional machine or electrophones and then discharged through a wire of small resistance by means of a spark-gap. When this action takes place the positive and negative charges of the Leyden jar or accumulator oscillate to and fro through the circuit formed by the wire and the spark in the air-gap, which has then a very small resistance, or mathematically expressed, the oscillations will take place if $R < \sqrt{\frac{4L}{K}}$, where *K* is the capacity of the circuit in Faraday, *R* the resistance in ohms and *L* the inductance in heneries. Fig. 1 shows in rectangular co-ordinates the curves described by an oscillatory discharge. The number of oscillations per second, or frequency, is determined by the equation

$$2\pi n = \sqrt{\frac{1}{KL} - \frac{R^2}{4L^2}}$$

If the resistance of the circuit is large there will be no oscillations, but the discharge will represent a smooth curve as in Fig. 2 or by the formula $R > \sqrt{\frac{4L}{K}}$

Thus the oscillations of a pint Leyden may number 18 million per second emitting waves 16 meters in length.

The Leyden jar arrangement gave a few oscillations at each discharge and then required recharging. Hertz greatly improved upon this by employing a Ruhmkorff coil and an oscillator system shown in Fig. 3, *A*, to keep up the potential. Here a direct current was passed through the primary of the inducting coil, *a*, and automatically interrupted; this set up low-frequency, but high-potential currents in the secondary coil, *b*, the terminals of which were connected to the oscillator, *c*. The oscillator system and the currents set up in it must be regarded as absolutely distinct from the secondary coil and the currents induced in it by the primary; the oscillator and secondary coil are connected, but the purpose of the secondary currents is to charge the oscillator system automatically, and the high-frequency, high-potential currents set up by the disruptive discharge cannot flow into the secondary coil, in virtue of its great inductance. The oscillator Hertz employed consisted of two brass balls, a centimeter in diameter and separated from each other by an air-gap a few millimeters in length; these spark-balls were attached to two brass rods ending in metal

* Dr. Bruce Jones. Life and Letters of Faraday.
† Maxwell's Electricity and Magnetism.