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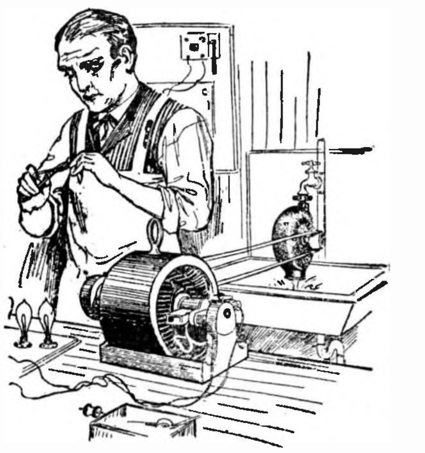
CONTENTS

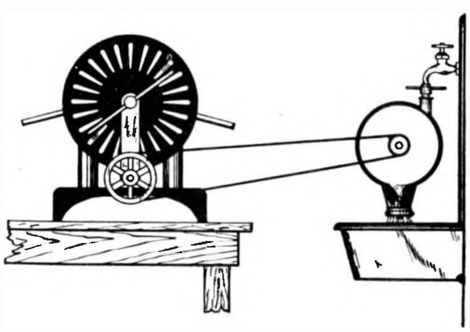
"The Experimenter's Magazine"

motor. The secret of designing a good motor is getting the double buckets correct, which are covered by many patents. In a 4-inch and 6-inch motor to sell at a few dollars, it is impossible to make the small buckets single, and bolt them to a central wheel on account of the cost of the many small pieces; but "Hercules" patented construction permits the making of the buckets and the wheel ALL IN ONE PIECE, (see Fig. 2). The shape and dimensions of the case enclosing the bucket wheel must be correctly designed to carry away the water from the bucket wheel and prevent back pressure. The size of a water motor is measured by the diameter of the bucket wheel, NOT by the size of casing.



Driving a Dynamo.

The E. I. Co., are not the originators of the double reacting buckets; they have been in common use for years by several large makers of water wheels for power plants, such as the well-known Pelton and Doble wheels, in many plants furnishing thousands of horsepower for mining, electric light and power, trolley roads and running factories, especially in California and other mountainous countries where high heads are available.



Driving an "Electro" Static Machine.

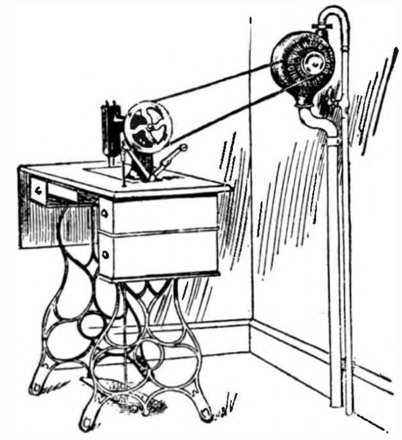
The "Hercules" 4-inch motor with a water pressure of 80 lbs. from a ¾-inch pipe line will easily develop ¼ horsepower. With a water pressure of 40 lbs. it will develop about 1/10 horsepower.

The 6-inch "Hercules" water motor on a ¾-inch pipe line, at a water or hydrostatic pressure of 80 lbs. will yield an output of about ½ horsepower and with a pressure of 40 lbs. an output of about 1/6 horsepower. Of course at higher water pressures, greater horsepower outputs are naturally obtained, as this output is dependent approximately upon the square of the water pressure in lbs. per square inch. The velocity of the water through a nozzle is dependent upon the small and large diameters, and the water pressure in lbs. per sq. in. in the pipe line, roughly.

"A table of the horsepower of water motors at various heads and pressures is given here. This data is for specially built wheels, of the finest mechanical construction, and while it does not cover the low priced "Hercules" type wheels, it is extremely interesting to us, as the various quantities involved are balanced against one another, giving a clear idea of their "mutual relation."

A Lathe Belted Up to the "Hercules" Water Motor.

On small size turbines, which resemble a windmill wheel in action, fitted with many properly spaced steel blades, of a certain exact angle, etc., the power developed is really remarkable, considering the small size of the turbine rotating element. At Fig. 3, is illustrated a 12-inch "Jonval" type water turbine, with water inlet gate for controlling the amount of water used, and consequently the amount of power developed at the turbine shaft. The exhaust or water outlet of this turbine takes place at the base of same. This turbine is supplied at $98.00 by the E. I. Co., and is used considerably for driving electric generators, air compressors, wireless plants, etc. It develops a greater amount of energy for a given consumption of water in cubic feet per second, than any ordinary water wheel. This is at once apparent from the figures given in Table 2, where the equivalent horsepowers developed at varying heads of water, and spindle speeds in R. P. M. are given.



Motor Driving a Sewing Machine.

Referring to this table No. 2, the cubic feet of water discharged per minute, of course gives also the volume of water that has to be *supplied* the turbine per minute. This is found by multiplying the velocity of the water in feet per minute through the pipe or penstock feeding the turbine, by the wet cross-sectional area of the pipe line in square feet. This matter is best figured out by reference to any Mechanical Engineers, or Hydraulic hand-book. For those interested in small and large size "Hydro-Electric Plants" a book with that title, by Kolster, at $5.25 is supplied by the E. I. Co.; Kent's "Mechanical Engineers' Hand Book" at the same price is also highly recommended to our readers.

Several illustrations are given here, showing the application of the "Hercules" water motors to various industrial requirements; such as driving lathe, a dynamo, sewing machine, and an "Electro" No. 9000 Static Machine, which is furnished with a wooden belt pulley, instead of handle, for driving it, at 25c above the catalog price.

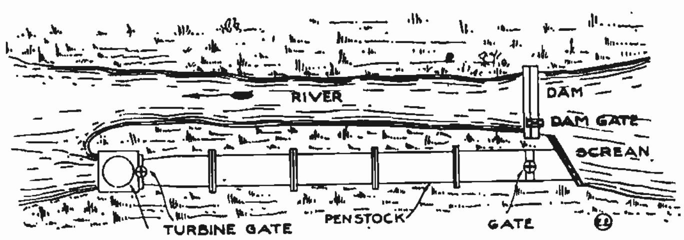


FIG. 5

A complete direct connected Hydro-Electric plant, of neat pattern, is seen from the cut, Fig. 4. This is the E. I. Co., No. 1 electric-lighting outfit. It comprises a 9 Light, 75 Watt, Lighting outfit, and is a complete Hydro-Electric Plant, similar to the large plants in use throughout the United States and abroad. A perfectly built and self-contained unit, mounted rigidly on common iron bedplate. The dynamo is very powerful and develops 25 volts and 3½ amperes on 90 lb. water pressure from an ordinary ¾-inch faucet. On 70 lb. pressure, the output is 20 volts and 3 amperes, etc. At full capacity, the dynamo will light 9 to 10 8-C. P. tungsten lamps. The water motor is strongly built, and the dynamo is supplied shunt wound, suitable for recharging storage batteries. The shipping weight of the outfit boxed is 34½ lbs., and the price is $16.00.

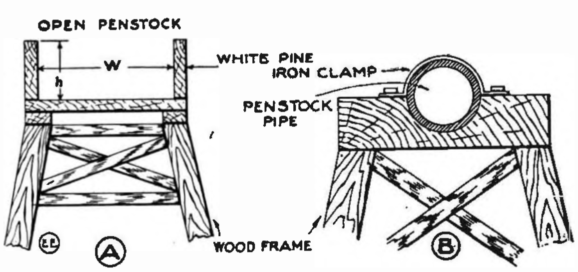


FIG. 6

(Continued on page 6)

Experimental Electricity Course

By S. Gernsback and H. W. Secor.

EXPERIMENTAL ELECTRO-PHYSICS.
LESSON NO. 10.

THE physics of electricity would not be complete, without a brief summary of the early history of the art, and so the opening paragraphs have been devoted to the more interesting epochs in this connection.

Many centuries ago, before scientists had begun to even faintly understand the phenomena or meaning of electrical manifestations as they occur in nature, it had been observed that when *amber* was rubbed with certain other substances, so that friction was created, the amber exhibited a new property, viz: that of attracting and holding small bits of thread, hair, straw, etc. At that time, it was thought to be some mysterious force, and was referred to as "harpaga," signifying the harpies, or "a thing that clutches." The origin of this odd cognomen, was due to the discovery by the women of Syria, that the amber distaffs or spindles, forming part of their spinning wheels, tended to attract small particles of thread, straw, etc., when the spinning thread had brushed against the amber for a short while.

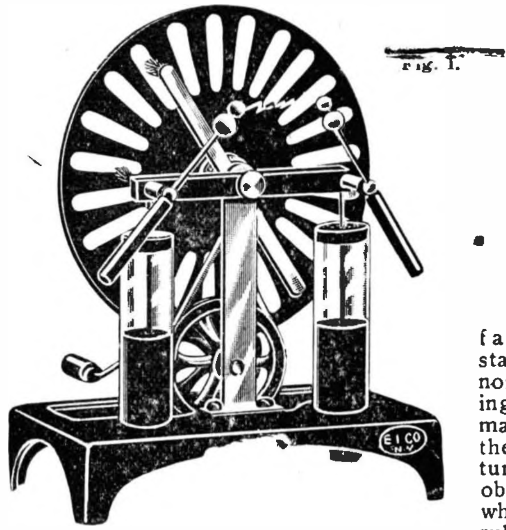


Fig. 1.


FIG. 2

The word amber, and its derivation has not been established positively, but it has been ascribed to either one of two sources; viz:—The Arabic word *"amber,"* signifying *"ambergris,"* and the German verb, *"anbrennen,"* meaning, "the thing that will burn."

Lodestones or natural magnetic ore, as found in the earth, were not unknown to the ancients either, having been mentioned in the writings of Aristotle, who ascribed to Thales of Miletus, chief of the Seven Wise Men of Greece, and who was the contemporary of Aesop, the view that the action of amber and the lodestone suggests the existence of an "alter ego," or soul, in these substances, meaning undoubtedly when philosophically interpreted and construed, an inherent force independent of any external agency.

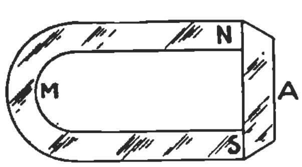


FIG.3

According to the legends and traditions of the Chinese, who were at one time the wisest people on the earth, the properties of the lodestone or natural magnet, were known fully two thousand years before the dawn of the Christian era. Humboldt relates, in his "Cosmos," that the Chinese employed the lodestone magnet to direct their caravans in voyages, the magnet having been used to actuate a small revolving device, which was caused to point continually in the same direction. All the ancient writings on the subject, however, were of little practical significance, and it was not until the 14th century, that the scientific application of electrical phenomena took any definite shape.

FIG.4

As nearly as known, it was about 1320, that Flavia Gioia, a native of Naples, Italy, invented the compass that we actually have record of. This instrument varied from the true north, but Christopher Columbus and Sebastian Cabot added to this knowledge, that which can certainly be claimed as important scientific facts. From time to time, other scattered facts and phenomena were observed and discussed, but to Dr. William Gilbert, born in 1543 at Colchester, about 50 miles northeast of London, England, is due the credit of first publishing a book, giving a connected account of electromagnetic phenomena.

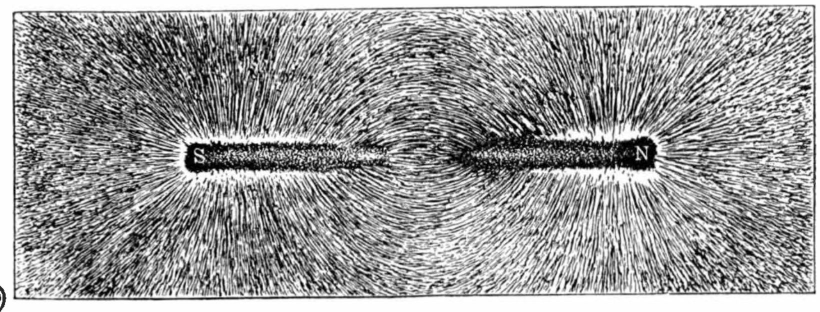


Fig. 5.

Among the foremost of Dr. Gilbert's discoveries, was that our globe, the earth, was in itself a great spherical magnet. For this important discovery, Gilbert received great praise from the eminent astronomers, Galileo and Kepler, and many others.

Static electricity is the usual form met with in nature, and is distinguished from voltaic or galvanic electricity, by its exceedingly high voltage or potential, and small current value. In its nature, static electricity is the same as any other form. Electricity in other form usually flows in currents continuously, but static electricity is accumulated in condensers and its discharge is instantaneous, as when lightning passes from one thundercloud to another. The static generator and experiments with it are treated exhaustively in another chapter.

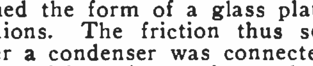


FIG. 6

The first scientist to build a frictional machine for the generation of electricity, was Otto von Guericke, a German. About the year 1750, he constructed a rather crude machine, comprising a rotating ball of sulphur, which when held between the hands, produced electricity by the friction incurred.

From this experiment, the static generator was slowly improved, until it finally reached the form of a glass plate rotating between leather cushions. The friction thus set up created electricity, and later a condenser was connected to the machine to collect the electricity. A cut of a modern static electric generator is shown in Fig. 1.

Other sources of electricity besides the static machine, are as follows:—

Percussion.—If a violent blow is struck by one substance upon another, opposite electrical states are produced on the two surfaces. Vibration can produce electricity, as demonstrated by Bolpicelli, who showed that vibrations set up within a rod of metal, coated with sulphur or other insulating substance, produced a separation of electricities at the surface, separating the metal from the non-conductor. Disruption and Cleavage:—Tearing a card apart in the dark produces visible sparks, and the separated portions when tested with an electroscope, will be found to be electrically charged. Lumps of sugar crunched between the teeth in the dark exhibit pale flashes of light. The sudden cleavage of a sheet of mica also produces sparks, and both laminae are found to be electrified. Crystallization and Solidification:—A number of different substances, after passing from the liquid to the solid state, exhibit electrical conditions. For instance, sulphur fused in a glass bowl, and then allowed to cool, becomes strongly electrified, as made evident by lifting out the crys-

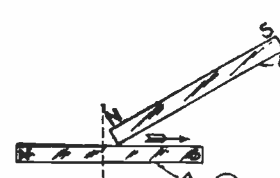


FIG.7

talline mass, with a glass rod. Another substance becoming electrified during solidification is common chocolate. When arsenic acid crystallizes out from its solution, in hydrochloric acid, the formation of each crystal is accompanied by a flash of light, due most likely to an electrical discharge. *Combustion: — The generation of electricity by combustion was demonstrated by Volta. A piece of burning charcoal placed in connection with the knob of a gold-leaf electroscope, will cause the leaves to diverge. Evaporation: —When liquids are evaporated, electrification often occurs, the liquid and the vapor assuming opposite states. Atmospheric Electricity:—This is closely allied with electricity of evaporation, and is the atmospheric charge always present in the air, and due, in part at least, to evaporation going on over the oceans. Animal Electricity:—A number of species of creatures inhabiting the water, have the power of producing electric discharges by certain portion of their organism. The most well known of these are the "Torpedo," the "Gymnotus," and the "Siluris," frequenting the Nile and the Niger Rivers. The "Raia Torpedo," or electric ray, of which there are three species inhabiting the Mediterranean and Atlantic, is provided with an electric organ on the back of its head. This organ consists of laminae composed of polygonal cells to the number of 800 to 1000 or more; and supplied with four large bundles of nerve-fibres. The under surface of the fish is negatively electrified and the upper side positively. In the "Gymnotus Electricus," or Surinam eel, the electric organ extends the whole length of the body, along both sides, as seen in cut 2. It is able to give a most severe shock, and proves itself a very formidable antagonist when it has attained its full length of 5 or 6 feet.

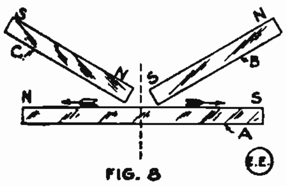


FIG. 8

It has been shown that the nerve excitations and muscular contractions of human beings, also produce feeble discharges of electricity. There is also the electricity of vegetables, thermo-electricity, contact of dissimilar metals, and other sources.

Magnetism, the basis of most all commercial electrical apparatus to-day, is a very interesting subject. As aforementioned, the properties of natural magnets or lodestones was found in Magnesia, Asia Minor, and was called the magnet stone, owing to the name of the country in which it was found. The properties of the lodestone may be conveyed to other substances such as iron or steel, by friction or rubbing. Nickel and cobalt are also slightly influenced by magnetism.

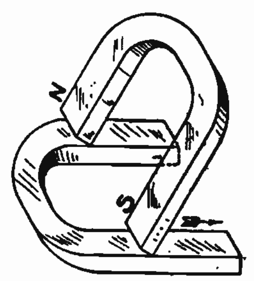


FIG. 9

Steel was found to have the greatest retentivity or holding power for magnetism, and hence it was always employed for magnets and needles in mariners' compasses, in the early days as well as now. Magnetism, like electricity, requires matter as its medium through which to manifest itself, and the present theory is that it is a mode of molecular motion generated by vibration of the molecules, and undulations of the all pervading luminiferous ether, which permeates all matter and fills all spaces not already filled by other substances or matter. The speed or velocity of propagation of electricity through the ether is 186,000 miles per second, or in the metric scale, it is equivalent to 300,000 kilometers or 300,000,000 meters.

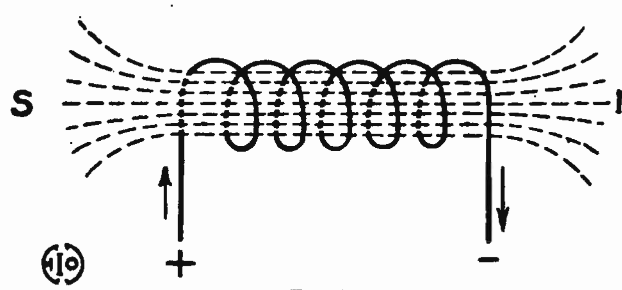
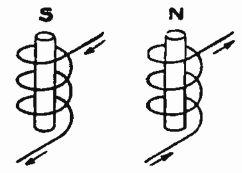


Fig. 10.

There are two common forms of permanent steel magnets in use, one being the horseshoe shape and the other the straight bar. The former is seen at Fig. 3, and the bar magnet at Fig. 4. Magnets, no matter what their shape, are always surrounded by a "field of force," as it is termed, caused by the magnetic flux or lines of force tending to return from the north pole to the south pole. To realize the maximum efficiency and life, the magnet should have a complete path through iron, and so an armature or keeper A, is supplied with horseshoe magnets, and when not in use the keeper supplies a low resistance path for the flux, thus preserving the magnet's power.



POLARITY OF ELECTRO MAGNETS

Fig. 11.

The appearance of the field of force about a magnet is seen at Fig. 5. Such a flux diagram is easily made for any magnet by sprinkling fine iron filings on a piece of glass, and placing the magnet under the glass. Tapping the glass gently will serve to make the filings evenly distribute themselves, when they may be photographed, or a print may be made direct by placing the printing paper under the glass, and exposing it to the light.

Every magnet has two poles, each of opposite polarity or nature. They are designated respectively, as the north and south poles. Like poles repel each other, and unlike poles, attract each other. The end of the compass needle magnet seeking the earth's north magnetic pole, is really the south pole of the needle magnet, but is often referred to as the north pole of the needle. *North-seeking pole* is more correct. The principle of every magnet having two dissimilar poles is made more manifest, by breaking a bar or other permanent magnet, with the result shown at Fig. 6. As seen every individual magnet has assumed two unlike poles at the ends. The best way in which to observe the changing action of the magnet poles, is by means of a small compass or magnetized needle, pivoted, so as to swing freely about a fixed point. The north pole of the magnet is usually marked in some way, either by an arrow head, or by bluing it. If such a needle is presented to the poles of the horseshoe magnet seen in Fig. 3, the north and south poles of the needle will be attracted alternately. The poles of an electromagnet can thus be tested also.

There are two methods of making permanent magnets from hardened steel bars, by direct touch with another permanent magnet. The first is known as the single touch method, and consists in stroking the steel bar A, from the centre to the end, in the direction of the arrow, removing the magnet B, returning it through the air to the centre, and (with the same pole) again stroking it to the end. The polarity induced in the bar A, is of course opposite to that existing in the magnet pole B, as indicated by the polarity signs in the sketch. Usually 15 to 20 strokes are sufficient, when the other half of the steel bar is stroked with the opposite end of the magnet B, from the centre to the end, as previously, and a similar number of times. Magnetizing by double touch is accomplished by using two magnets, as in Fig. 8, and both poles (of opposite sign) are moved from the centre outward, simultaneously. About 15 to 20 strokes are sufficient. The steel used for making permanent magnet should be very hard, such as Tungsten steel. The harder the steel, the greater the retentivity, also the strength.

Steel magnets are best magnetized, by placing in contact with the poles of a powerful electromagnet. This is the method pursued in most commercial uses of them, especially for magnetos. Sometimes they are magnetized, by winding a coil of insulated copper wire around them, and then passing current through the coils. U-shaped magnet bars may be magnetized by direct touch with another U-shaped magnet as shown in Fig. 9, stroking the new magnet from the poles to the U-bend, or vice versa.

All electrical conductors when carrying current, are surrounded by a magnetic field of force, as depicted in Fig. 10. Here the current (direct current) is shown passing away from the observer, that is, the end nearest him is positive, and then the whirl of magnetic force or flux is right-handed or clock-wise; facing the near end of the conductor. If the current were coming toward the observer, the whirl of magnetic flux would be left-handed, or opposite to that shown.

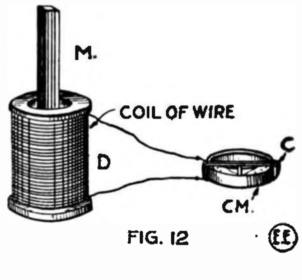


FIG. 12

The effect of winding the conductor into coils about magnet poles of soft iron, gives the result seen at Fig. 11. This shows that if the current passes around the coil clock-wise the resultant magnetic pole is south; but if it passes around

*See Lowe's Compendium of Applied Electricity.

the coil counter-clock-wise; then the resultant magnetic pole is north. This is one of the most frequently occurring rules in electrical work of all kinds, and should be well memorized.

Probably one of the most interesting and important laws in electro-physics, is that there is a direct relation between magnetism and electricity. Magnetism and electricity are reciprocal or interchangeable and can produce each other, which may be readily shown by suddenly plunging a permanent steel bar magnet into the interior of a solenoid, or coil of wire, as in Fig. 12. Connected to the coil of wire is a galvanometer CM, which is easily made by winding a coil of a dozen turns of fine wire about a small compass case as seen from the detail, or the Telimcometer at 50 cents, can be employed. The coil of wire is placed parallel to the needle of the compass. This makes quite a sensitive galvanometer.

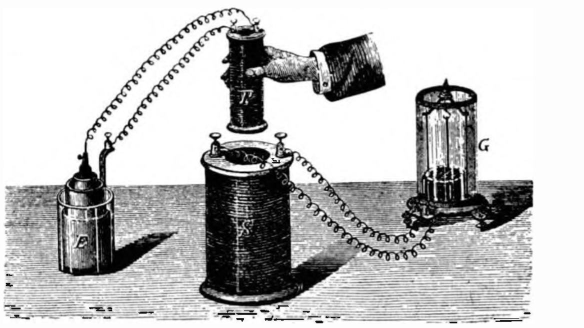


Fig. 12A.

Now if the steel magnet bar M, is suddenly plunged into the coil of wire D, a deflection of the galvanometer needle will be noted. Upon withdrawing the magnet bar from the coil D, another deflection of the galvanometer needle will be noted, but in the opposite direction, to that of the first deflection, occurring from the insertion of the magnet. This is the principle upon which transformers and induction coils operate, the second coil of wire being placed outside the coil D, shown here. Instead of moving a permanent steel magnet, in and out of the coil; the magnetizing current in the coil D, is made to pulsate or alternate giving the same results. The core is stationary and of the softest iron, so as to lose all the magnetism possible, at each change in the current. Instead of using a steel magnet, a soft iron core wound with a magnetizing coil, may be used as at Fig. 12 A.

This shows the generation of electricity from magnetism. To demonstrate the production of magnetism from electricity, it is only necessary to pass current from a battery or other source through the coil D, when the magnetic force created within the coil, will suck in an iron bar. A permanent iron core fastened within the coil, makes it an electromagnet and this is the basis of the action of the great generators, and motors turning the wheels of commerce to-day. When an electric bell sounds, an electromagnet has actuated the hammer. When a spark several inches long leaps the gap connected across a transformer, electro-magnetism has been responsible for it.

To Michael Faraday, we are indebted for a greater part of our knowledge concerning magnetism and electricity and their close inter-relationship. Faraday was the first to show how magnetism could be changed into, or made to give electric current, when a magnet was acted upon by mechanical motion. He discovered that a coil of wire when moved to or from a permanent steel magnet or active conductor had induced in it another current, and of opposite direction to that of the inducing current. This great discovery by Faraday, was taken up by others, and the real development of electrical apparatus employing these principles, had been started on its way.

(To be continued)

SMALL WATER MOTORS AND THEIR PRACTICAL APPLICATION.

(Continued from Page 3)

In the cuts showing the application of the "Hercules" water motor to various machines, the common method of belting the two devices mechanically, is indicated. The highest efficiency of such mechanical drives is realized when the prime-mover, in this case the water motor, and the driven device are rigidly connected together on a common bed-plate, similar to the E. I. Co., No. 1 Hydro-Electric plant. All belt drives lower the gross efficiency of the plant, and a single leather belt drive, without a counter-shaft, usually causes a loss of 20 to 30 per cent. in the power delivered to the driven device.

Therefore all such belt drives should be carefully arranged and lined up to cause the belt to drive evenly, and the belt should be an endless one, e. g., one having a lapped and cemented joint. Round belts are very well joined together by a piece of hard brass lacing wire, or by means of belt hooks, purchaseable from any hardware dealer.

Resuming the subject of developing water-power we may turn to the commonest arrangement met with in practice; that of harnessing a brook or small river to a turbine. One of the simplest ways of doing this is seen at Fig. 5, where a dam is placed across the stream far enough up-stream from the turbine to get sufficient head in feet to operate it. Every foot head of water creates a pressure of .433 lb. per square inch. Hence a 20 foot head or drop in the water, would give 8.66 lbs. pressure per square inch, etc. This relation is clearly shown in table No. 1.

One of the first considerations in placing a water-power plant is to see whether or not a sufficient quantity of water is available in dry seasons, etc., to operate the wheels or turbines. Firstly, the gallons or cubic feet of water per second or minute, required to operate the turbine is required to be known. This is given in the tables here presented, or also it may be obtained from the manufacturers of turbine wheels.

Secondly, the amount of water available per second or minute, etc., from the brook or stream, is to be ascertained, if the plant is to run regularly, regardless of dry seasons and the like. We know that the cubic feet of water flowing per second is found by multiplying its velocity by a given point, in feet per second, by the cross-sectional area of the stream at that point, or the "wet-perimeter" as it is termed.

Hence, if we place a wood float consisting of a round stick, weighted at its base so as to just clear stones, etc., at the bottom of the stream, and we time this float as it is carried down-stream, from one fixed point to a second fixed point; then its speed, and also that of the current of water is readily deduced. A common figure for streams is 6 to 15 second feet; meaning that the float, when timed, traversed a distance of 6 feet, etc., in one second. Several time values should be observed at various times of the season, and an average of the lot taken. Sometimes the minimum value reached is taken. The current velocity having thus been found, the volume of water passing per second in cubic feet, is found by multiplying its value by the average width and depth of the stream at the section timed.

The quantity of water is generally measured on small streams by means of the "Wier," which is explained together with formulas for its use, in any text-book on the subject.

The plant lay-out is shown at Fig. 5. An over-flow gate is best placed in the dam, but some builders arrange for the water to spill over the dam only, when the lake is full. The dam can be made of concrete, stone, or stone and earth, wood, etc., as convenience dictates. The penstock feeding the turbine or water wheel enters the stream as shown; preferably placing a gate at the head of it; and a screen of iron bars in a wood frame to prevent sticks, stones, etc., from entering the penstock is placed ahead of the gate, as shown. The penstock is depicted at Fig. 6, A and B in detail. It can be either open or closed. The open ones are commonly made of white pine tongue and grooved planking, concrete, steel, etc., and the closed ones are usually of steel pipe, or wooden staved pipe, strengthened with iron hoops around it. Of course the penstock must have a pitch downward toward the turbine, and it is carried sufficiently far downstream, so that the pressure head obtained at the turbine wheel is sufficient to drive it at the required speed and torque. The head in feet is the "vertical height" the water drops through in descending from the entrance to the penstock, to the turbine wheel. For small plants, it is well to figure the penstock to carry about twice the cubic feet of water per minute required by the turbine, as the penstock probably will not always flow entirely full.

It is very important that the tail-race or passage-way provided for carrying away the discharged water from turbines or "Hercules" motors, be made sufficiently large, so that the water can readily pass away without causing back pressure on the turbine. This is noticeable in the illustrations we show of the "Hercules" water motors, and the discharge pipe if provided, should be as large at least as the discharge opening in the motor. No great pressure is present here, so a sheet iron pipe is sufficient for small motors.

Some useful data is given below regarding strength of shafts, etc.:

Electrical Units.

Volt—The unit of electrical motive force. Force required to send one ampere of current through one ohm of resistance.

The loss in transmission depends on the size and length of the wire.

Ampere—Unit of current. The current which one volt can send through a resistance of one ohm.

Watt—The unit of electrical energy, and is the product of the ampere and volt. That is, one ampere of current flowing under a pressure of one volt gives one watt of energy.

One electrical horse-power is equal to 746 watts.

One kilowatt is equal to 1,000 watts.

To find the watts consumed in a given electrical circuit, such as a lamp, multiply the volts by the amperes.

To find the volts, divide the watts by the amperes.

To find the amperes, divide the watts by the volts.

To find the electrical horse-power required by a lamp, divide the watts of the lamp by 746.

To find the number of lamps that can be supplied by one electrical horse-power of energy, 746 by the watts of the lamp.

To find the electrical horse-power necessary, multiply the watts per lamp by the number of lamps and divide by 746.

To find the mechanical horse-power necessary to generate the required electrical horse-power, divide the latter by the efficiency of the generator.

Horse-Power of Shafts for Given Diameter and Speed.

We publish herewith a table used in general practice for the transmission of power where shafts are properly supported.

When shafts are used for conveying power from one point to another without any of the bending strains of pulleys, gears, etc., the next smaller size may be used.

This table must not be confounded with tables of actual strength of shafts published by other authorities.

Diameter of Shaft, Inches	Revolutions Per Minute									
	100	125	150	175	200	225	250	300	350	400
$1\frac{3}{16}$	2.4	3.	3.6	4.2	4.8	5.4	6.	7.2	8.4	9.6
$1\frac{7}{16}$	4.3	5.4	6.5	7.6	8.6	9.8	10.8	13.	15.2	17.2
$1\frac{11}{16}$	6.5	8.	9.7	11.2	13.	14.6	16.	19.4	22.4	26.
$1\frac{15}{16}$	10.	12.5	15.	17.5	20.	22.5	25.	30.	35.	40.
$2\frac{3}{16}$	14.	17.8	21.	24.5	28.	31.5	35.6	42.	49.	56.

It is well to say in this connection, that no matter what general rules are adopted, there are frequently special cases in which the engineer or designer must depart from his rules, and use his judgment in determining both the size of the shaft and the number and location of bearings.

Rules to Determine the Size and Speed of Pulleys or Gears.

The driving pulley is called the driver, and the driven pulley the driven.

If the number of teeth in gears is used instead of diameter, in these calculations, number of teeth must be substituted wherever diameter occurs.

To Find the Diameter of Driver, the diameter of the driven and its revolutions, and also revolutions of driver being given: Multiply the diameter of driven by its revolutions, and divide the product by the revolutions of the driver; the quotient will give the diameter of the driver.

To Find the Diameter of Driven, the revolutions of the driven, also diameter and revolutions of the driver being given: Multiply the diameter of driver by its revolutions, and divide the product by the revolutions of the driven; the quotient will give the diameter of the driven.

To Find the Revolutions of the Driver, the diameter and revolutions of the driven, also diameter of the driver being given: Multiply the diameter of driven by its revolutions, and divide the product by the diameter of driver; the quotient will give the revolutions of driver.

To Find the Revolutions of the Driven, the diameter and revolutions of the driver, also diameter of the driven being given: Multiply the diameter of driver by its revolutions, and divide the product by the diameter of driven; the quotient will give the revolutions of driver.

TABLE NO. 1.

POWER OF WATER MOTORS.

(Extracts from Kent's Handbook, page 598)

Size	Head in Feet	Pressure	Spouting Velocity Ft. per Min.	Revolutions per Min.	Horse Power
6 inch	20	8.66 lbs.	2151.97	684	.05
6 "	30	12.70 "	2635.62	837	.10
6 "	40	17.320 "	3043.39	969	.15
6 "	50	21.65 "	3402.61	1038	.21
6 "	60	25.98 "	3727.37	1185	.28
6 "	70	30.31 "	4026.	1281	.35
6 "	80	34.64 "	4303.99	1368	.43
6 "	90	38.97 "	4565.04	1452	.51
6 "	100	43.30 "	4812.	1530	.60
6 "	120	51.96 "	5271.30	1677	.79
6 "	140	60.62 "	5693.65	1812	.99
6 "	180	77.94 "	6455.97	2049	1.45
12 "	80	34.64 "	4303.99	684	1.00
12 "	140	60.62 "	5693.65	906	2.33
12 "	180	77.94 "	6455.67	1024	3.39

To get the power it is only necessary to increase the size of jet, thereby delivering more water to the motor just as it is necessary with a steam engine to give more steam to get more power. The smallest jet necessary to give the required power should be used.

TABLE NO. 2.

12-INCH REGULAR TURBINE WHEEL (JONVAL TYPE).

This Wheel Uses Eighteen Square Inches of Water.

Head in Feet.	Cubic Feet Discharged per Minute.	Revolutions per Minute.	Horse Power.
3	103.8	256	.44
4	120.0	287	.68
5	134.4	319	.95
6	147.0	368	1.25
7	159.0	378	1.58
8	171.0	403	1.92
9	180.6	428	2.32
10	190.2	451	2.70
11	199.2	472	3.11
12	208.2	493	3.55
13	216.6	512	4.00
14	225.0	540	4.47
15	232.8	558	4.96
16	240.6	576	5.47
17	247.8	594	5.99
18	255.0	612	6.52
19	262.2	629	7.07
20	268.8	644	7.65
21	275.4	659	8.22
22	282.0	673	8.81
23	288.6	686	9.43
24	294.6	699	10.04
25	300.6	711	10.67
26	306.6	724	11.32
27	312.6	736	11.99
28	317.4	747	12.62
29	324.0	758	13.35
30	329.4	768	14.03

SIGNALS VIA WIRELESS 6,000 MILES.

Communication was held recently between the wireless station at Nauen, Ger., and one at Windhoek, Cape of Good Hope, South Africa. The messages that passed were clear and distinct. The distance between Nauen and Windhoek is approximately six thousand miles. At various times there have been reports of messages traveling six thousand miles or more, but very few, if any, of these have been direct communications. March seems to be a favorable month for the making of long distance records. In March of last year the Naval Radio Station at Newport heard two wireless stations in the Argentine Republic exchanging messages, and these stations were said to have been from seven to eight thousand miles distant. Direct messages from Germany to this country have been sent frequently, and on February 11 the first through test of wireless communication between New York and Berlin was made.

JAIL FOR RADIO FRAUD PROMOTERS.

Judge Hunt, in the Criminal Branch of the Federal District Court recently sentenced James Dunlop Smith to a term of eighteen months' imprisonment and to pay a fine of $5,001, and Elmer E. Burlingame to a term of two years and six months imprisonment and to pay a fine of $10,100.

They were convicted of being concerned in a conspiracy operated through the mails to swindle investors in the stock of the Radio Wireless Telephone Company and its subsidiaries. The frauds ran into the millions and the prosecution of Smith and Burlingame cost the government a considerable sum.

Judge Hunt also fined the Ellsworth Company, which handled the stock, $10,500.

WIRELESS STATIONS TO AID IN RAILROAD CONSTRUCTION.

Wireless telegraphy is to be used in connection with railroad construction for the first time in North America, when two stations are erected at the terminals of the proposed Hudson Bay railroad for the ordering of materials and labor.

One will be built at Le Pas, Manitoba, and the other at Port Nelson, on Hudson bay, which is cut off from Ottawa during nine months of the year.

Wireless was used successfully during the building of the Madeira Mamore railway in Brazil for communication between the offices at Manaos and Porto Velho, 1,000 miles away and accessible only by boat.

Design and Construction Details of Radio Antennae

PART II.

A short discourse on the construction and design details for wireless telegraph aerials to be used for small transmitting and long distance receiving sets, of interest to experimenters particularly.

By H. Winfield Secor.

THE construction of radio antennae properly concerns, and is directly related to, the natural or fundamental wave length of same. For instance, where an experimental station is to be erected, and a licensed sending set is to be operated, with a radiated wave length of 200 meters, and not more; it has been found that if the aerial is designed and built to have a natural wave length of say 160 meters, etc., and about 200 meters vibration period when the helix or oscillation transformer winding is connected in series with it, that the most efficient transmission is obtained. Where the antenna has a natural period or wave length greater than these figures, its capacity must be reduced, as regards the whole aerial system, by connecting a high-tension glass plate or other type condenser (preferably adjustable), in series with the ground lead, and close to the ground connection proper. The E. I. Co., No. 530 or 531 adjustable condensers are adaptable to these requirements very nicely. This arrangement reduces the total or joint capacity of the aerial system by the well-known rule that when condensers are connected in series, their joint capacity is inversely proportional to their reciprocals, as explained in all electrical and wireless text-books, or see Lesson No. 19 of the "Electro" Wireless Course in 20 lessons, given free with purchases made of them, at the rate of 1 lesson for each dollar's worth of goods bought.

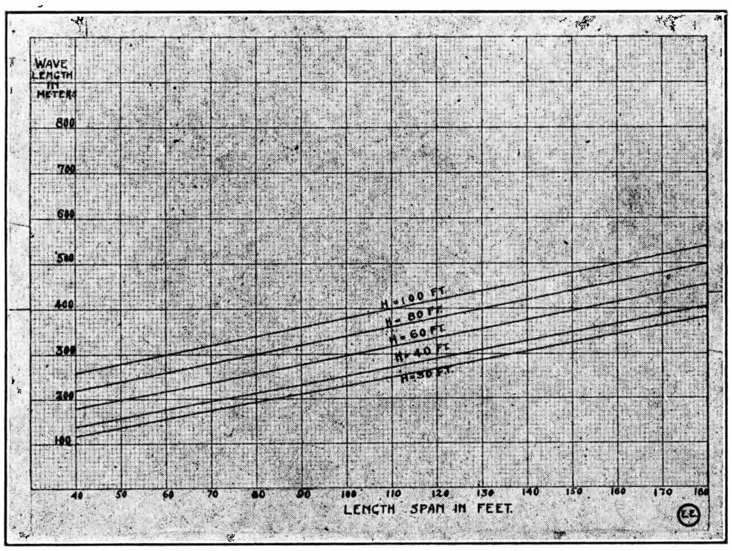
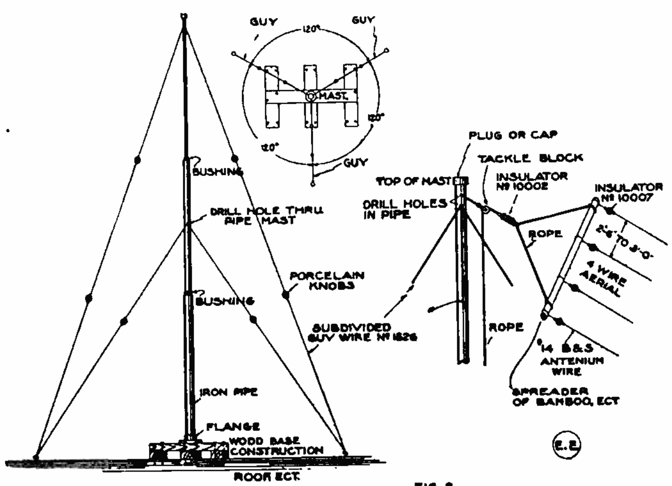


Chart Showing Fundamental Wave Lengths of 4 Wire Aerials.



Having decided upon the approximate size of the aerial to be erected, one of the first problems besetting the radio station builder is suitable and substantial masts or means for supporting the aerial spread or flat-top. At Fig. 2A, we show a substantial skeleton wood mast, which anybody can build at a cost of a few dollars. In this design of mast, where the total height is not much over 75 feet, the width of the base section or foot may be about 10-12 feet. Of course, the wider the base, the more secure the mast will be against high wind pressure, etc. This form of mast is widely employed for commercial stations, and a wood or metal pole of suitable size is placed at the apex of the base section. The skeleton base-frame height is usually made about 2/3 the total

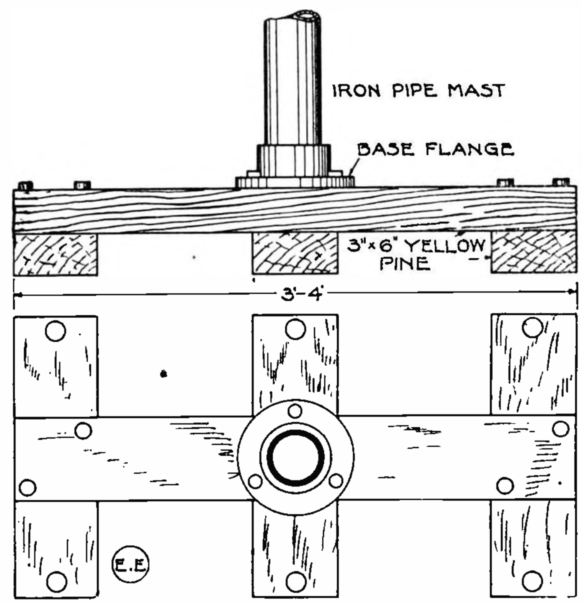


FIG. 1

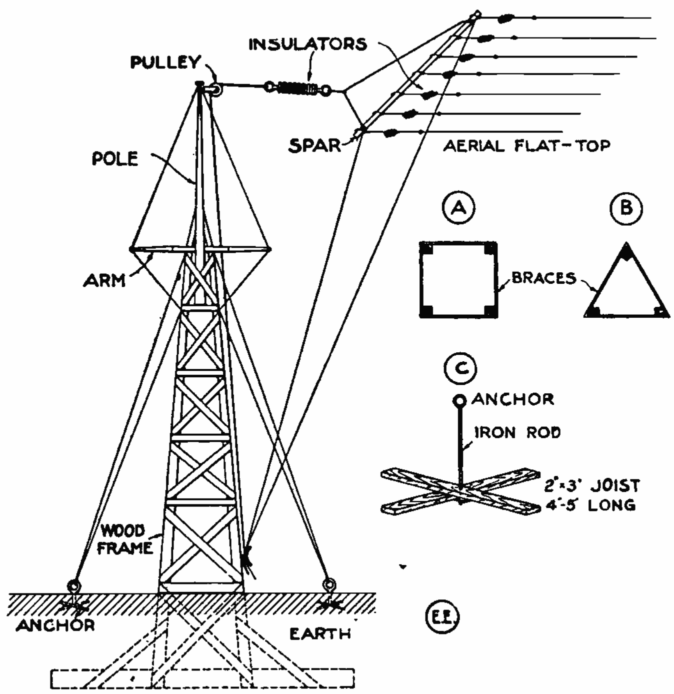


FIG. 2-A

height of the entire mast; and this base may be made of triangular or square cross-section, as indicated at Fig. 2A and B. A good form of guy anchor is easily made of two pieces of joist, with an iron eye bolt passing through their centers. The wood base of same should be buried about 6 to

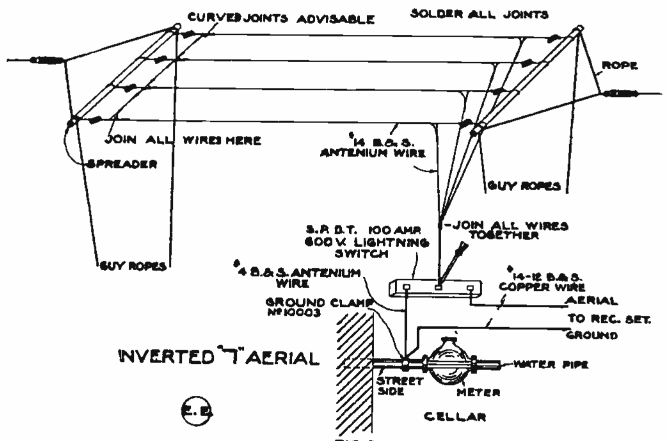


FIG. 3.

8 feet in the ground. Three guys are the least number permissible for guying such a mast in position; and four guys are best. The guys are best made of E. I. Co. stranded steel guy cable No. 1526, formed of 6 No. 18 B. & S. wires, twisted together, and well galvanized, which comes in coils of 100 feet at 35 cents per coil.

Another type of skeleton steel mast, easily made by the amateur from a few lengths of steel "angle iron" bar, such as 1½ x ¼ inch stock, is seen at sketch, Fig. 3-A, is not advisable for lengths of masts exceeding 25 feet, but where a small

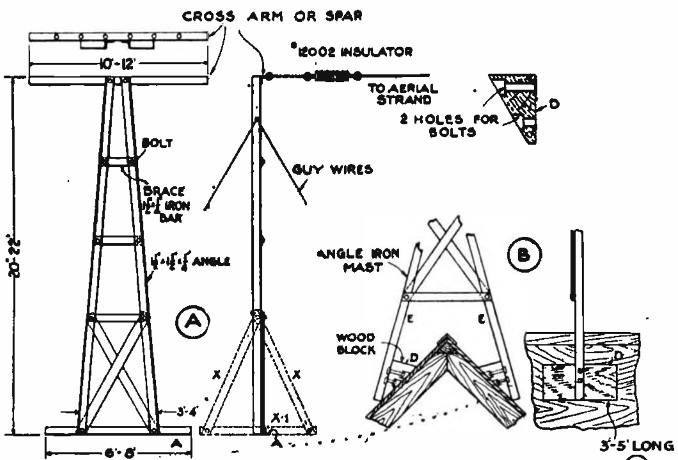


FIG. 3-A

light structure is desired, it is satisfactory, and besides it is readily erected and maintained in position. The base may consist of a piece of angle iron A; or X X, angle braces may be arranged as shown and secured to two cross-feet X1 X1.

To begin with, we will consider the set of wave length curves which have been plotted. These were computed and drawn from formulae due to Dr. Louis Cohen, of the U. S. Bureau of Standards, and are very close to the exact values, which, it may be stated here, can never be exactly calculated,

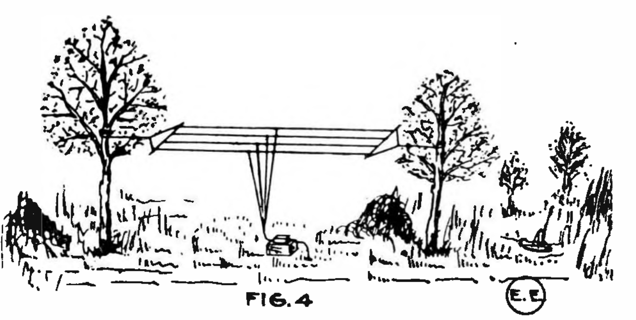


FIG. 4

due to the effect of metallic bodies or structures near the aerial, etc., etc.

This set of 5 horizontal curves are all for 4 wire flat top aerials, of the inverted "L" type, composed of No. 14 solid copper or phosphor bronze conductors, with 2 foot spacing between the strands. By reading off the desired length of

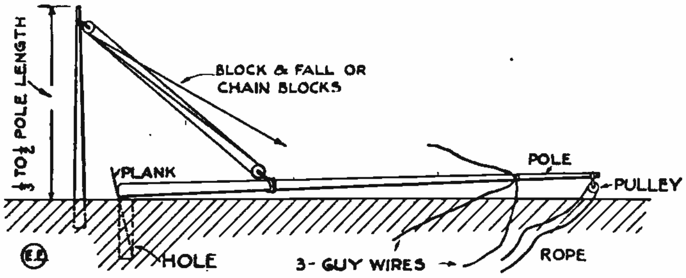


FIG. 5

the span between spreaders, along the lower base line of the chart; and then following upward, the corresponding vertical chart line until it reaches the proper aerial height "curve"; the natural wave length is at once found on the column immediately to the left of the aforesaid intersection, of the "curve" and vertical chart line. These values have been carefully calculated from the exact inductance and capacity of the flat-top and of a vertical lead-in cable, composed of 4 strands of No. 14 B. & S. copper wires, bunched together, and leading directly down from one end of the aerial flat-top, and terminating 10 feet from the ground. The ground lead from the instruments should in this case be about 10 feet long, and the same size as the lead-in cable described above. The total natural wave length of any flat-top aerial and lead-in is thus readily found from this chart.

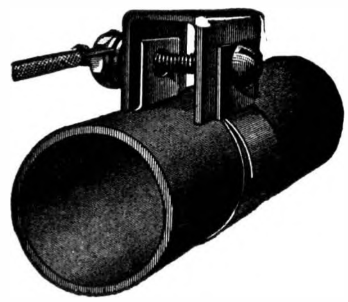


Fig. 6.

To more clearly elucidate:—Suppose it is desired to know the fundamental wave length of a 4 strand flat-top aerial of the inverted "L" type, having a span of 100 feet between

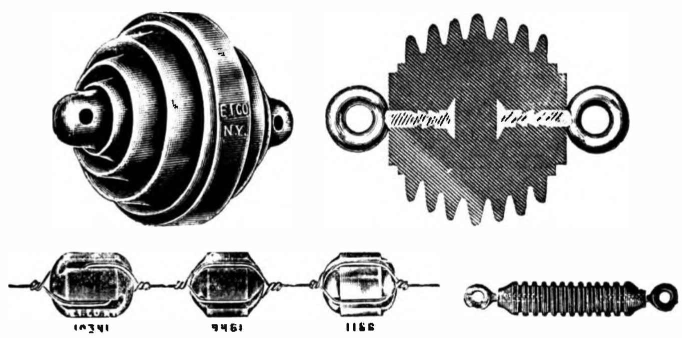


Fig. 7.

spreaders, with 2 foot spacing and elevated 80 feet above the earth, connected by a vertical lead-in cable as outlined above. Looking at the chart for a flat-top 80 feet high, and with a span between spreaders of 100 feet, the natural period or wave length of same is seen to be 340 meters. That is, if this aerial was excited by a buzzer or a spark coil connected to a break in the vertical lead-in wire, it would vibrate at a natural or fundamental wave length period of 340 meters. Of course the Radio law, affecting amateur stations, exacts a sending wave length of not over 200 meters, and the above is only cited as an example in the use of the chart. The above 340 meter aerial system, could be reduced to 200 meters, by the connection of a suitable condenser or capacity in series with it. Long lengths of water pipes used for grounding in buildings, must be considered, as they also influence the wave length directly.


No 6271 CLEATS
FIG. 8

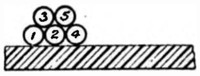
Aerials of greater spread, i.e., having more strands, can be judged approximately from the chart, as they do not differ in wave length value so radically, for an ordinary size aerial. In designing a sending station antenna, it must be borne in mind, that some allowance for the wave length of the necessary oscillation transformer secondary winding must be made. Hence, if upon looking over the chart, the designer finds a suitable length of flat-top and lead-in to give the 200 meter wave length required by the law; he should select an aerial

(Continued on Page 15)

WIRELESS DEPARTMENT

THE WIRELESS SOCIETY OF LONDON.

At the meeting held on March 3rd, the discussion on "Tuning Inductances" was opened by Mr. Russell Clarke, K.C., in a very able speech, and the members debated the subject with keen interest. The following points were brought out. That to obtain the best results the maximum inductance must be attained with the least possible length of wire, and to do this the diameter of the drum on which the wire is wound shall not exceed its length, the absolute maximum being when the length is equal to 0.4 of the diameter, but for practical purposes the former ratio mentioned is quite good. The chief losses in inductances are due to high-frequency resistance, and eddy currents which can be minimized by using stranded cable formed of enameled wire of small gauge. The extent to which this sub-division is carried is limited by the cost, and that there was little advantage in using a cable of more than twenty-seven wires formed by twisting first three wires together then three of these strands, thus making a nine-wire cable, and finally twisting three of these strands together to form a 27-wire cable. It was pointed out that, say, a 37-wire cable laid up in the usual manner was not so effective, as the wires were not sufficiently intermeshed, thus allowing the H.F. currents to circulate in the outer layer of wires only. Other losses are due to the self-capacity between the adjoining turns of wire and the capacity of the "dead" or unused wire on the coil. For this reason it was advised to use several tuning coils according to the wave-length to the signals being received. The necessity of using a thick cotton covering over the enameled wires to keep the turns of the inductance well separated, or winding with an air space between the turns, was insisted upon, as this also diminishes the capacity effect between the turns. The method of winding and tapping off in definite sections was fully explained, and both samples of wire and tuning coils were exhibited. One of these coils was wound on the double-layer system, which enables twice the length of wire to be wound on a drum of the same size wound in the usual method. The method of carrying this out is to wind two turns on the drum and then cause the wire to mount on to the top of these for the next turn, then descend again on to drum, after which the wire is caused to ascend and descend alternately till the winding is finished (see Fig. 1, in which the first five turns of a coil wound in this manner are numbered in the order in which they are put on). In this method, although the coil is wound in two layers, there is a very small difference in potential between adjacent turns, and the capacity effect between the two layers is reduced to a minimum. Of course, it goes without saying that heavily insulated wire must be employed if this method of winding is used, as it is not possible to leave an air space between the turns. The wire employed by Mr. Russell Clarke consisted of 81/40 enamel wire double cotton-covered and braided. It was also mentioned that a considerable air space must be left between the primary and secondary coils to prevent the capacity effect between the wire on the two drums. In the quite informal discussion which followed, the fact was established that the best results were obtained when a relatively large inductance and small capacity were employed to tune in to a given wave-length, it being pointed out that only just sufficient capacity to form a true oscillating circuit should be employed, but no speaker present seemed inclined to risk an offhand statement as to the relative values of these two items. As, however, these items are easier to find by experiment than to calculate, the omission of this bit of information was not greatly missed by the meeting.



Mr. William Dudell emphasized the importance of keeping before one the kind of loss one wished to keep down and more especially the loss due to di-electric strain between turns of wire. This loss is rather to be appreciable.

He advised the spacing of the turns with at least one-half millimeter of air, and was of opinion that when using a high-resistance detector eddy current losses were not so important as di-electric losses.

Mr. Fogarty agreed with the author that by keeping down ohmic resistance sharper tuning can be effected, but that even with low-resistance coils sharp tuning of stations emitting damped waves was hardly possible.

A few remarks were made by Mr. Wilson Noble, Prof. Ernest Wilson, Mrs. Delves Broughton, and Mr. Coursey. The latter proposed the use of a jigger with only just a sufficient number of turns on both the primary and secondary to establish the necessary coupling and to add extra inductances to both the primary and secondary coils as required, thus obviating the presence of unused wire in the proximity of the wire in use, the extra inductances being entirely disconnected when not in use, either by a double-pole switch or by a system of plugs.

Much amusement was caused by a gentleman who wished to explain to the meeting some wonderful invention by which he could control a gramophone at a distance by means of wireless, but that not being the subject under discussion the chairman ruled him out of order.

HERTZIAN WAVE COLLISIONS.

By V. W. D.-B.

SAYS *Electricity* (London): "An interesting theory is propounded by a French engineer, in a recent issue of the *Journal,* to the effect that the meeting or crossing in space of Hertzian waves from high-power wireless stations may be responsible for some of the disastrous explosions which have occurred within recent date. He instances the Volturno disaster as happening at the junction of the Eiffel Tower and Glace Bay routes; the Senghenydd mine explosion, in the course of the Clifden - Paris emanations; and the Jena and Liberte battleship explosions at Toulon, in the track of Paris-Bizerta wireless. This constitutes a happy sequel to the intentional firing of powder magazines and other large stores of explosives by wireless, with which we were threatened a short while since, but which has not yet materialized."

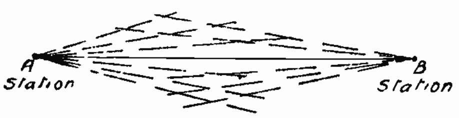


Fig. 1.

So allow me to say a few words concerning my ideas of "Hertzian collisions." I cannot say that I disbelieve in the danger, but I equally cannot see how any danger can arise. Neither can I see how the collision can be confined to any particular point or points. Explosions have occurred and fires started in inexplicable ways long before wireless was invented, and they will continue to recur after wireless has been superseded by the next wonderful invention.

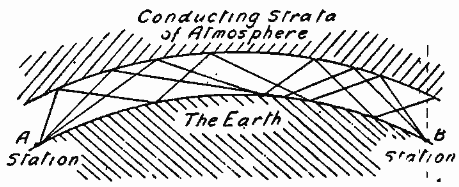


Fig. 2.

If we are to expect explosions wherever two stray waves happen to meet it will be no longer safe to carry matches in our pockets, as within five miles of this house there are at least fifty wireless stations, five or six often working simultaneously and each radiating considerably more energy at this range than would be found, say, halfway between the stations of, say, Clifden and Glace Bay. Before expressing a definite opinion I should like to see a slightly more definite and technical explanation of the line of thought followed by this French engineer. This new theory is somewhat analogous to the now famous F-rays invented by that Italian engineer which are capable of being directed to a specific tin of explosives with the result that they can be detonated with certainty at ranges up to some 5 or 10 miles according to the power available. I have not had the pleasure of meeting anyone capable of either explaining what F-rays are or how they are generated.

I have looked into the question of "Hertzian collisions" and cannot see anything in it. Waves will be colliding all over the world wherever two stations happen to be working, and collisions would be equally likely to occur at any point on either side of the B line between the stations as well as in the direct line (see Fig. 1). If collisions do occur, I cannot reason out any source of danger on that account, as it must be remembered that the energy of the waves at any appreciable distance from the stations can only be measured in billionths of a watt.

Also the probability is that the waves pass one another without creating any disturbance, just as the sound waves can be heard by a person standing between a locomotive whistle and a chime of bells as two sounds distinct and separate. Then, again, the waves transmitted from one powerful station to another follow the track indicated above in Fig. 2, alternately reflected from the surface of the earth or sea and from the conducting portion of the atmosphere.

Then, again, I believe it is simply impossible to get a wave to penetrate into any conductor, so how could the gases underground have become ignited by any form of ethereal wave?

HOW-TO-MAKE-IT DEPARTMENT

This Department will award the following monthly prizes: FIRST PRIZE $5.00; SECOND PRIZE $2.00; THIRD PRIZE $1.00.
The idea of this department is to accomplish new things with old apparatus or old material, and for the most useful, practical, and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best ideas submitted, a prize of $5.00 will be given; for the second best idea a $2.00 prize, and for the third best a prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings.

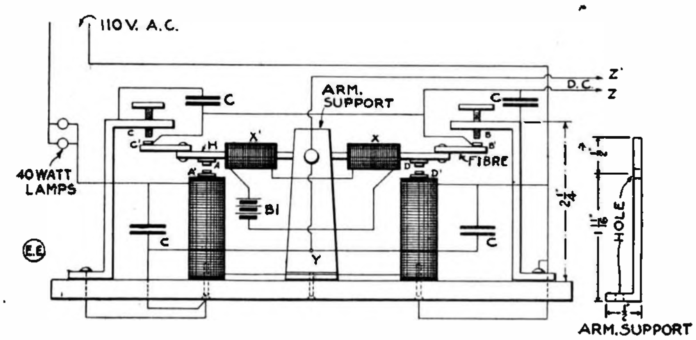
FIRST PRIZE, $5.00.

A Vibrating A. C. to D. C. Rectifier

By Ralph Hiteshew.

I give you herewith a description and diagram of a simple vibrating rectifier. The rectifier will charge batteries and can be used for experimental purposes, for those who have only A. C. available.

The alternating current passes through an 80-watt lamp resistance and magnets F. F. The coils X and X are wound on a soft iron armature, H. These coils receive current from a battery, B-1. The armature is pivoted between two "L"



General Arrangement of Rectifier.

supports of brass. At every one-half wave of the A. C. the swinging coil is attracted to one side; then the other, of the device. The armature carries a reversing circuit arrangement, H. C. B.; so as to reverse the connections in the alternating current circuit, because contacts B & B-1 and A & A-1 are in contact at one wave of the current; and contacts C & C-1; D & D-1 are in contact at the other wave or of the alternation current; thereby keeping the current in wires Z and Z-1 always in the same direction. The two magnets carrying the alternating current are 4 ohm telegraph sounder magnets. The core is ⅜ in. diameter by 1½ inch long, and each coil wound with 78 feet No. 24 cotton insulated wire. Holes are drilled at the center on the ends, to fit No. 6036 platinum iridium contacts. On the other ends they are drilled and tapped to fit No. 8-32 screws. These magnets are connected in series. The E. I. Co. No. 01107 magnets will do if they are rewound for 4 ohms, as explained above. The pivot "L's" and brackets for adjusting screw, are made from ⅛-inch brass ⅝-inch wide. The dimensions are given on drawing. The magnets are screwed on a hardwood board, being placed so that the screws which hold them are 3 inches apart. The standards holding the armature are placed midway between the magnets. Coils X and X-1, each contain 50 feet No. 24 magnet wire and are wound on the iron armature, which is 4¼ x ¼ x ⅛ inches. These coils are wound on a space ¾ inch long and ½ inch from the center pivot.

Contacts B-1 and C-1 are E. I. Co. make, and are riveted in pieces of fibre; which are screwed to armature as shown. Contacts C and B are E. I. Co. fastened to adjusting screws by drilling hole in screws. These screws should be adjusted to allow as short a vibration of armature as possible. The connections are shown in drawing; the condensers C, C, etc., each having a capacity of ¼ microfarad. Care should be taken to have the armature well balanced.

SECOND PRIZE, $2.00.

A ROTARY GAP AND PANEL SET.

I give herewith two drawings: one of a simple rotary spark gap for use with spark coils or small transformers; the other a drawing of Switchboard on "Panel" sending set. I will first describe the rotary spark gap.

First we will get a No. 179 "O. K." E. I. Co. motor costing $1.45, or a No. 100 motor at 85c. Mount the motor on a block of wood so that it sets about 2 inches above the base. Next we will need about ½ square foot of ⅛ of an inch fibre, or better, hard rubber. Now draw with a compass a circle 5½ inches in diameter; then cut around this circle, so that you have a true disc. Next take some threaded brass rod No. 8-32 and cut it into lengths of ¼ inch. It does not make much difference how many, but 12 is about the right number. Now screw a brass cap nut, first drilling a hole

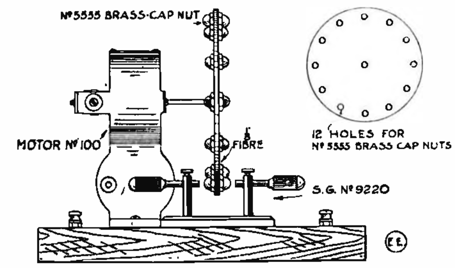


Fig. 1.

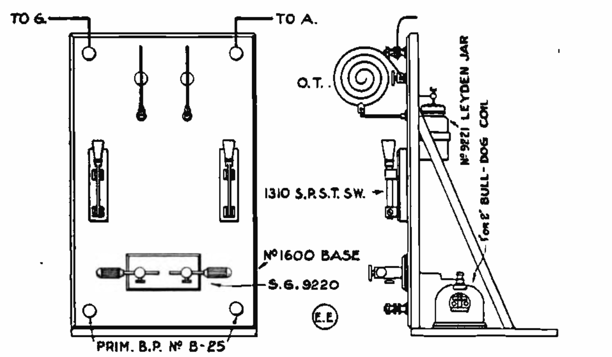


Fig. 2.

through the fibre about ¼ inch from the outside for the threaded brass rod to pass through the fibre, on each side of the fibre. I used a plain Electro No. 9220 zinc spark gap, as shown in the drawing.

We will next consider the sending set.

The list of the materials employed is as follows:

A 1 or 2 inch "Bull-dog" spark coil.
Two No. 9221 1 pint Leyden jars.
A No. 9220 zinc spark gap.
One pound of No. 6 B. & S. aluminum helix wire.
Four No. B2 double binding posts.
Four No. B25 binding posts.
Two No. 1310 S.P.S.T. switches.
One No. 1600 oak base.

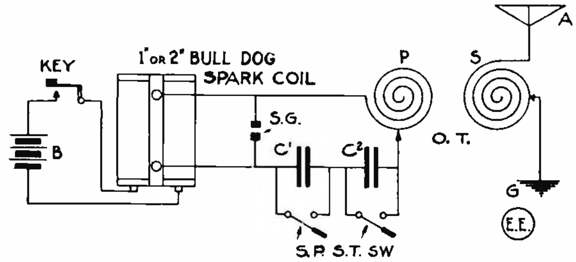


Fig. 3.

I do not think this needs much description, for the drawing is quite clear. Contributed by Lyndon B. Walkup.

[Ed. Note:—The above materials can all be purchased from the E. I. Co., including the oak base No. 1600 at $1.50.]

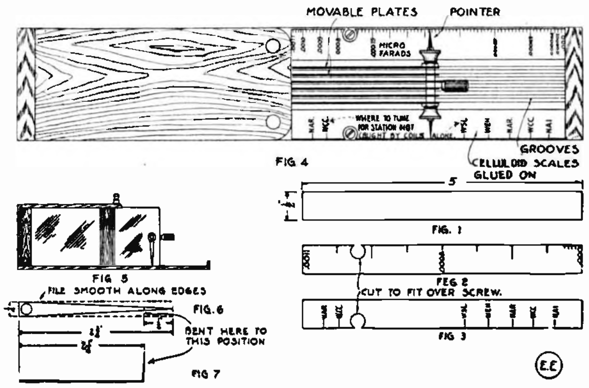
THIRD PRIZE $1.00.

HOW TO CALIBRATE E. I. CO. SLIDE PLATE CONDENSERS.

Procure two (2) strips of celluloid 2 x 5½ inches. Lay these along the sides of the condenser and mark the position of the screw holes. Then cut the hole in the celluloid at this point. See Fig. No. 3. Now scrape the strip to allow the ink to flow smoothly when calibrating it. Glue the strips to the base as shown in Fig. No. 4. Fig. No. 1 shows the dimensions of the strip. Figure No. 2 methods of calibrating.

To Make Pointer.

Two strips of thin metal are required, 2¾ x ¼ inches. Punch a hole large enough to fit on the binding posts at one end. Then, with sharp shears, cut the strips to a point like Figure No. 6. Now bend one end, the pointed end, to a right angle, making the bend ½ inch from the end, Fig. No. 7. To fasten to movable plates, unscrew the two nuts on each side of the plates, and slip the pointers on, one on each side. Replace the nuts over the indicators. See Figs. No. 4 and 5.

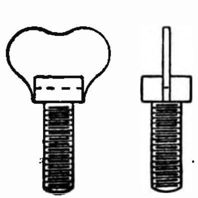


To Calibrate.

The Condenser has its maximum capacity when the plates are entirely intersecting the fixed plates; therefore, if they are pulled half way out, they will only have one-half the capacity. If the capacity is .0011, which it is (approximately), for the E. I. Co. No. 9240 Condenser; when the plates are half-way out the capacity is .00055 microfarads. Where the pointer marks the celluloid strip mark this. From this the rest of the points can easily be marked on the scales. The other strip can be used to mark approximate wave lengths, but I use mine to mark the place to adjust the plates; in order to get stations not receivable on the coupler alone as in Fig. No. 3. Figures No. 4 and 5 show the assembled Condenser.

This is a very useful and ornamental addition to the Condenser, increasing the appearance alone about 50 per cent.. besides being extremely useful. Contributed by C. Laager.

IMPROVED THUMBSCREWS.



Take a fillister-head screw, measure the thickness of the slot in the head, procure a small piece of sheet steel to make a tight fit in the slot, cut to shape shown in sketch, and drive into head tightly; file up after and polish with emery. This forms an easily-made thumbscrew.—*Model Engineer and Electrician.*

THE CARELESS USE OF INDUCTION COILS.

While the average experimenter may think that he has gained a fair knowledge of electricity, the old saying, "safety first," is still a good law to obey. About eighty per cent. of the electrical fatalities which occur annually might be traced to some little carelessness on the part of the victim or the operator.

Nearly every electrically inclined boy in the land owns a small wireless outfit, or has one in mind. If such is the case, so much the better, because a bright boy can learn in a few hours more pertaining to wireless than weeks spent in reading voluminous books.

The induction coil and its effects seem to have a great fascination for most boys. The ordinary one-inch coil can be used to good advantage for quite a number of interesting experiments. But, remember, you are playing with a very high voltage. The fact that it takes an electrical pressure of 20,000 to 21,000 volts to jump across an air space of one inch, is a good idea to impress upon your mind; although this current is of fairly high frequency and we seldom receive the full pressure. I once knew a boy who owned a small wireless set, and being tired of experimenting with wireless, thought he would try "something new." The induction coil was of the "one-inch" variety. He grounded one secondary terminal of the coil, and the other he ran out to his mother's metal clothes-line. When she went out to hang up clothes, he started the coil in operation. Well, as Providence would have it, the other end of the line happened to be fastened to an iron post leading to the ground. This, of course, made a short circuit. Had the line been clear, something of a serious nature would probably have occurred.

In the future we trust that our young "Experimenters" will not use their spark-coils for shocking others.

Contributed by STANLEY RADCLIFFE.

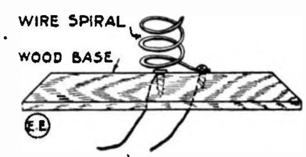
A SIMPLE VARIABLE CONDENSER.

To make an efficient variable condenser take two brass tubes six inches long, and ⅛ inch thick. The first should have an outside diameter of 1¼ inches, the second 1½ inches. Wrap the first tube with shellacked paper until the second will just slide easily over it. Attach binding posts to the tubes. To improve the appearance, mount it on a suitable base. One of my friends and myself have used one of these condensers with success.

I hope to have more and better material for your excellent magazine in the future. Contributed by George Bruce Palmes, Jr.

HOW TO MAKE A MINIATURE LAMP SOCKET CHEAPLY.

While doing some temporary wiring for illuminating purposes, I ran out of sockets. Being rushed for the lights I hadn't time to send to a supply house for more, so I tried to make a few myself, which proved satisfactory. I made them in the following manner: First securing a short length of No. 10 copper wire and winding it around a mandrel the size of the lamp base, I then removed the mandrel and fastened the spiral of wire to a small block of wood by two small staples.



In the center of the block I placed a small flat headed screw which forms a connection with the lamp. Then boring two holes through the block, I inserted two short pieces of flexible wire and soldered one to the screw and the other to the spiral of wire. These I used as terminals for connecting up.

Contributed by Stanley Radcliffe.

BOSTON TALKS WITH NAGASAKI BY WIRELESS.

The extraordinary feat of receiving and sending wireless messages a distance of about 8,000 miles, nearly one-third way around the earth, has been accomplished by the Marconi station on the top of the Filene building, at Boston, Mass.

The operator, Harry R. Cheetham, picked up a short message, signed by the Marconi man on the Pacific mail steamer Mongolian.

Out of curiosity, Cheetham answered and asked the Mongolian her position. He nearly fell off his operating stool when the answer came, clear and distinct, "200 miles east of Nagasaki, Japan." A hasty consultation of his world maps showed Cheetham that the snapping and sputtering of his machine had "made talk" which spanned clear to the other side of the globe.

U. S. Radiotelegraph Inspector Henry C. Gawler, stationed at Boston, in discussing the phenomenal wireless span, said that it could only be explained as a freak message that happened to fall upon extraordinarily favorable atmospheric conditions.

"It was late in the evening, when conditions are most favorable," he said, "and the S.S. Mongolian was at a point so nearly half-way round the earth's circumference, that the radiations probably split about equally as they left the respective instruments, traveling both east and west.

"Wireless vibrations travel at a rate that would take them clear around the earth's circumference about four times in a single second, so the two split portions of this message struck the receiving apparatus from each side, practically simultaneously, thus somewhat emphasizing its registering strength. But it was nothing but a freak message, for as a matter of fact, the Filene apparatus is only equipped with power to command a 300-mile radius under ordinary conditions."

AMONG THE AMATEURS

NEWS OUT OF THE AIR.

With the organization of the Central Kansas Radio club the first experimental wireless system for the purpose of transmitting news is being formed. The organization is composed of young men interested in wireless telegraphy and who will furnish the smaller papers of the state with the news from neighboring towns. The service will be given free by the wireless operators, who are seeking proficiency rather than money.

The scheme is the outgrowth of the wireless enthusiasm of Henry Goodel, a high school boy of Topeka, and Lee Henry, a photographer at Minneapolis, Kan. They have been sending radiograms to each other for several weeks, increasing the length of their messages steadily until now they can send news stories.

The boys expect soon to arrange for the relay of messages that will have to travel over forty or fifty miles, that distance being about the capacity of the smaller instruments.

TEACHERS TRY OUT WIRELESS.

Physics teachers at the new Central high school, Minneapolis, Minn., tried out the recently installed wireless system there recently and succeeded in snatching messages out of the air from as far away as Key West, Fla.

C. J. Eide and A. P. Andrews, teachers, with members of the Minneapolis Wireless club, took turns at the receiving ends and intercepted numerous messages sent out by the Minneapolis stations and one from the Key West station, believed to have been a press message to some vessel, as each word was given twice.

There are about a dozen privately owned wireless plants in Minneapolis.

Mr. George M. Martin, Capt. 16 Co., C. A. C., Fort Moultrie, S. C., says of the E. I. Co. apparatus, in a recent letter: "I have used your instruments and supplies *in my regular work for some years,* and have found them *as represented without exception.* I ask you at this time for a copy of your latest catalogue, as I contemplate purchasing a set of instruments for my own use, and experiments."

Editor *The Electrical Experimenter*:

As a subscriber and reader of your journal, I beg leave to ask through your columns for information as to practical devices for transforming direct to alternating current or vice versa, for experimental laboratory work, using voltaic or storage batteries, or ordinary house lighting D. C. or A. C. supply, at 110 volts, 60 cycles. Also suggestions for simple devices for changing the frequency from 60 to 25 cycles, etc.

It is believed that such data will prove of interest to the numerous readers of your journal.

The Standard Handbook for Electrical Engineers describes: A Synchronous Converter, (a rotary converter), which converts an alternating to a direct current, or vice versa. But, query, are there not cheaper devices for so doing, for short time experimental work?

Again the Standard Handbook describes a "Frequency Converter," which converts from an alternating current of one frequency, an A. C. system of another frequency. Can such small ones be purchased for laboratory equipment?

Yours respectfully,
A WIRELESS EXPERIMENTER.

[Ed. note:—All replies and suggestions should be mailed to Technical Editor, *Electrical Experimenter*.]

CHECKERS BY WIRELESS.

A number of students in the public schools of Cumberland County, N. J., are erecting wireless telegraph stations at their homes.

The most ingenious use to which the system has been put was at Vineland, where two lads are engaged in a checker tournament by wireless.

Franklin Lamb, one of the young operators, being confined to his home by illness, called up his friend, Leslie Adams, who also has a station, and asked him to play a game of checkers.

The series was the result, and, it is reported, the contests are very exciting.

NEW WIRELESS CLUB OF ROCKVILLE CENTRE, N. Y.

The Experimental Wireless Association has been formed by the youths of the village interested in wireless experiments. Arrangements have been made to exchange and forward private messages in the villages of Rockville Centre, Lynbrook, East Rockaway and Freeport.

LAD STARTS WIRELESS SYSTEM.

Howard Robie, aged 16 years, son of Mr. and Mrs. Charles H. Robie, of Williamson, N. Y., has completed a wireless station. He has received a permit from the authorities at Washington, to use the instruments he has made, which have been approved. He is the third person in Wayne county to receive such official recognition. Mr. Robie will receive the daily Arlington wireless station report.

RADIO CLUB OF DELAWARE.

The regular meeting of the Radio Club of Delaware was held recently at the Y. M. C. A. and it was decided to erect a high powered station at Concord Heights, near Wilmington. The club proposes the erection of a 120-foot tower to hold its aerial structure.

Only modern equipment will be used. The membership of the club now includes about twenty-five of the best Amateurs in the city. It is the desire of the club to have branches throughout the state, and anyone outside the city interested in wireless is invited to confer with it regarding a subsidiary organization. Application for membership in the Wilmington club should be made to the Radio Club of Delaware in care of the Y. M. C. A.

H. J. E. Knotts, of Illiopolis, Ill., writes the "Electro" people:—"I have one of your No. 8050 ½ K.W. Transformer Coils that I use successfully to talk 24 miles to the Observatory of the Illinois Watch Company at Springfield, Ill."

LAKEWOOD, O., WIRELESS CLUB.

The boys of Lakewood, Ohio, have organized a Wireless Club, having at the present time eight members, two of which have E. I. Co. ½ K.W. transmitting sets. The club holds a meeting every Friday night in the upper part of a member's garage, where a telegraph line connecting most of the members will be installed. The club elected Ira Beasley as President, and Alvin Weller as Secretary and Treasurer.

BOYS SUCCESSFUL WITH WIRELESS.

Carroll Dunham of Worthington ridge and Leroy Seibert of Farmington road, Conn., pupils at the Worthington Grammar school, have erected wireless stations at their respective homes with which they can easily receive and send messages. Both boys have been working for some time on schemes of their own and, after persevering and building their own instruments, their efforts have finally been attended with success.

Young Dunham has a sending outfit in a play room at his home and the Seibert boy has a receiving station. The bright little boys have studied the Morse code of telegraphy and when Dunham deftly ticks off a message to his playmate, the latter readily deciphers it and calls him on the telephone immediately to ascertain whether or not he has it correct. The boys' parents, being naturally skeptical, have dictated messages to the embryo Marconis and were greatly surprised to learn that they had actually succeeded.

RECEIVES MESSAGES FROM NEWPORT NEWS.

Elwood Ashey, son of Mr. and Mrs. Edward J. Ashey, Rawson street, Leicester, Mass., has completed his wireless and has received messages from Newport News, Va.

Although a grammar school student, he fully understands how to receive and take messages.

He learned to operate the wireless at Leicester academy, under Prof. David Hill.

YOUNG MEN INTERESTED IN RADIO.

A number of young men around Provo, Utah, are interesting themselves in wireless telegraphy. Arnold Robison, the 18-year-old son of Dr. Geo. E. Robison, and a student at the B. Y. U. has installed a wireless apparatus at his home, with a sending capacity of about 50 miles and a receiving capacity up to 700 or 800 miles, which frequently intercepts messages sent from other stations. Mr. Robison is devoting considerable time to the study and practice of wireless.

Elwood Bachman, another young Provo man and an expert electrician, who has assisted Mr. Robison in installing his apparatus, is installing one of his own; other young men are becoming interested in wireless and will probably install apparatus in different towns and cities in the county.

ATTENTION!!! This is the first number of Vol. II of *The Electrical Experimenter*. Do you like the style of the articles as now presented? Drop us a card, stating briefly your likes and dislikes, for our mutual benefit.

QUESTION BOX

This department is for the sole benefit of the electrical experimenter. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. At least one of the questions must deal with "E. I. Co." apparatus or instruments, or "E. I. Co." merchandise.
2. Only three questions can be submitted to be answered.
3. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
4. Sketches, diagrams, etc., must be on separate sheets. Questions addressed to this Department cannot be answered by mail.

WIRELESS CURRENTS ON METALLIC CONDUCTORS.

(124.) Earl G. Reed, Vermont, asks the following questions:

Q. 1. How far would it be possible to send an oscillating current such as used in wireless along an insulated wire, if the sending outfit consisted of a ½ K. W. closed core transformer No. 9281, "Electro" Commercial Spark Gap No. 9225, high tension Adjustable Condenser No. 531, and an "Electro" Sending Helix No. 8272?

Would it be possible to send oscillating currents through insulated wire parallel with ground further, if a wire was placed each side of the secondary and connected with a 110 volt alternating current as in the sketch shown?

Would the wireless wave from the secondary flow between the secondary and the primary conductors if wired as above?

A. 1. We have never had any practical experience in transmitting an oscillating current from a wireless set excited with ½ K. W. closed core transformer on 110 volt A. C. circuit, etc., over long metallic conductors; but from experience on fairly long circuits that we have encountered from time to time in radio work, we believe that you could transmit this current in a fair quantity, up to 1,000 feet or more.

Of course the wires carrying such a high tension oscillating current will have to be very well insulated, especially if placed under ground, and such conductors when so charged would have a very powerful electro-magnetic field surrounding said conductors, and this field would in turn induce currents in a third conductor, arranged in the manner you show in diagram. This high tension current can be controlled in two different circuits, as indicated in your second diagram, by means of a high voltage switch, having about a 4 to 6 inch clearance at the break at least, etc.

In general, this high tension, high frequency, current leaks off the wires very rapidly and while we do not know the exact nature of your experiments or intentions, etc., we would suggest that a similar problem to this has been solved some time ago, by Major G. O. Squier, of the United States Army; but in his experiments he utilized a low voltage high frequency A. C. or Oscillating current, and from the experiments which he conducted, the claim is made that these currents such as he employed, can be readily transmitted through a copper conductor, such as used for telephone and telegraph work over such distances as 6,000 miles, etc.

The E. I. Co. build special electro-magnets, solenoids, etc., to order, and shall be pleased to give you a figure on same, upon receipt of your drawings or further specifications covering the exact size of same.

STRENGTH OF ALUMINUM.

(125.) George C. St. Louis of Fresno, Cal., asks:

Q. 1. Can I obtain sheet aluminum from the "E. I. Co." and what is the weight per cubic foot of ordinary commercial aluminum?

A. 1. Yes. The weight of commercial aluminum per cubic foot is 167.11 pounds.

Q. 2. Kindly give the values for the ultimate tensile strength, as well as the ultimate compressive strength, per square inch, for commercial aluminum; also shearing strength.

A. 2. The ultimate tensile strength is 15,000 pounds per square inch and the ultimate compression strength is 12,000 pounds per square inch. The ultimate shearing strength is 12,000 pounds for one square inch cross section.

RADIO QUERIES.

(126.) Chas. C. Corneille of P. Q., Canada, sends us the following queries:

Q. 1. Could the "E. I. Co." 7 strand Antenium aerial cable be employed successfully as guy wire for buying a 60 foot wood mast?

A. 1. Yes, as it possesses remarkable strength.

Q. 2. What size "Bull-dog" spark coil would you advise me to use in connection with a 50 foot "grid aerial," 60 feet high at its uppermost point, a Rotary Spark Gap and H. T. Condenser, etc., to cover a distance of about 20 miles over comparatively level country, with one mountain about 1,000 feet high, located half way between the two stations?

A. 2. Most probably a 3 inch "Bull-dog" spark coil will cover the distance alright; but of course a 4 inch coil is much to be preferred for all around work, especially during the day.

Q. 3. I have had for some time, a Peroxide of Lead Detector and circular Potentiometer to use with battery in conjunction with same; and have never been successful in hearing any stations with them, although I have received a number of stations with a Silicon Detector. Can you suggest what might be the cause of this?

A. 3. We might mention firstly that you check up your connections carefully to see that the carbon battery terminal connects to the binding post marked "Positive" with a plus mark on the base of the detector, as otherwise you would not hear anything; and also if you have had the Peroxide of Lead Tablet for some time, it may have become very much dried out and you can obtain a new tablet from the "E. I. Co." for 15c; and it would thus be advisable to order a few of them and try various tablets until best results are obtained, as these tablets are very difficult to make so that they will manifest equally the maximum sensitivity for Radio Detector purposes, and the only way to pick out a really good specimen, is by trial in most cases.

PERMANENT MAGNETS.

(127.) Mr. Chas. W. Stone of Lockport, N. Y., writes:

Q. 1. I wish to obtain for certain purposes a very strong permanent steel magnet in the form of a bar or horse-shoe, and which can weigh as much as 15 pounds. This magnet is to hold as much weight as possible for demonstration purposes, and if the "E. I. Co." can supply same, kindly tell me about how much weight such a magnet could lift?

A. 1. Answering your question relative to purchasing a strong permanent magnet, will say that the "E. I. Co." 8 inch size steel horse-shoe magnet, weighs 18½ ounces and will lift from 18 to 22 ounces.

A number of these may be placed together, forming a laminated magnet, which will have a considerable lifting power, proportionately.

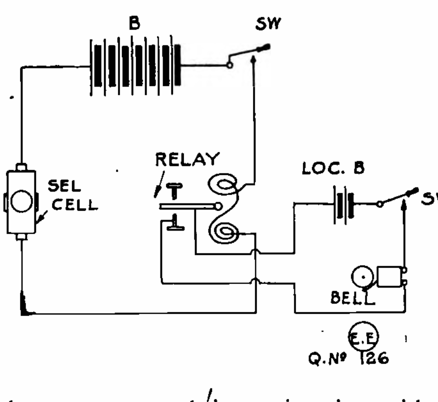
SELENIUM CELLS.

(128.) The Selby Shoe Co. of Ohio, writes us as follows:

Q. 1. Kindly let us know if the E. I. Co. can furnish us with a selenium cell to be used on 110 volts, direct current. This cell as we understand it, is somewhat like an incandescent lamp in appearance, but the filament is made of the metal known as selenium. The resistance of same varies in proportion to the amount of light thrown on it.

If the "E. I. Co." handle this cell, kindly submit us price on same, if not, please advise us where we can procure one of them?

A. 1. Replying to your query, relative to selenium cells as described in the "Electro" catalogue, at $5.00 each, would advise that their resistance varies in proportion to the amount of light admitted to same. Of course a small current, preferably not more than .01 of an ampere, is to be passed through them; and usually they are operated in conjunction with a sensitive polarized relay of about 500 ohms resistance, with about 6 to 8 dry cells connected in series with the circuit, as shown in the diagram herewith.



NEW WIRELESS COMPANY.

The Polyacousticon Company, Inc., with a capital of $1,000,000, was granted a charter on March 19, at Dover, Del. The new company proposes to erect wireless stations on the Atlantic Coast for the receipt of messages and press aerograms.

DESIGN AND CONSTRUCTION DETAILS OF RADIO ANTENNAE. PART II.

(Continued from Page 9)

whose dimensions will give about 12 to 15 per cent. less wave length for its natural period, to allow for the extra wave length added by connecting the O. T. secondary winding in circuit.

It may be remarked that the total length of the aerial is taken as equal to the length of the flat-top plus the vertical lead-in length for an inverted "L" type. In reference to the commonly used wave length factor for aerials of the "T" or inverted "L" types, it may be stated that for small aerials this factor has a value very closely approximating 4.5. The natural period or wave length of a "T" type aerial, is always less than the same size "L" connected type, due to the fact that while the flat-top section in the "T" connected type has sensibly the same capacity as in the "L" system, its inductance is less.

It is sufficiently accurate for rough calculations to figure on the total length of a "T" connected aerial as equivalent to the lead-in length plus the mean length of the flat-top.

Thus, suppose a "T" aerial has a lead-in length of 100 feet, and the vertical lead-in cable connected to the center of a 200 foot span flat-top. Then the total effective length of this aerial system would be assumed at 100 feet, plus 100 feet for the flat top; and 4.5 times this gives us 900 feet wave length, which divided by 3.28 gives 274 meters.

Angle iron bars may be purchased of most any blacksmith or at any steel and iron dealer. At Fig. 3B, is detailed an idea for arranging such a light steel mast on a peaked attic roof. Here two wooden cross-bars, D, D, several feet long, and cut so as to fit the roof pitch, are firmly bolted to the steel mast legs, E, E. These base pieces, D, D, should be quite heavy, if possible, and oak is a good material for them. All woodwork on such exposed structures, needless to say, should be painted or varnished with "Val-spar," etc. In the mast design shown at Fig. 3A, a piece of angle iron across the top, and drilled with the proper number of holes for the aerial strands, may be used for the flat-top spreader or spar. All iron work should be painted with some heavy body paint, mixed with plenty of linseed oil. Red lead is usually put on iron for a base coat. All bolts used in fastening the parts of the mast together, may be ⅜ inch standard square head iron bolts, with nuts. Plenty of oil should be used in drilling the angle iron, and a breast drill can be employed with a regular machine twist drill. Machine shops and blacksmiths will do this work at a nominal cost also.

Iron pipe masts are often used for aerial construction purposes, and the "Electro" prices on these masts complete, without spars or guy wires, are as follows:

16 ft.	$ 3.50
24 ft.	4.50
36 ft.	7.00
45 ft.	12.00
60 ft.	14.00
75 ft.	24.00
100 ft.	45.00

These prices are for the pipe sections of sufficient strength for the individual heights; together with base flange for foot, and reducing bushings for fastening the varying lengths of pipe together. These round steel masts are extremely rigid, and when properly guyed by 3 or 4 guys as at Fig. 2, will stand a high wind stress, and besides they make a good appearance. These masts, as supplied by the E. I. Co., are not drilled for guy wires, or tackle blocks; but this can be done by the purchaser at small costs. Metal masts are invariably insulated from the earth, so as not to unduly absorb any Radio wave energy, and a wooden platform or base frame somewhat after the fashion outlined at Fig. 1, may be constructed to fulfill this function. Where metallic guy cables or wires are used, and their length exceeds about 25 feet, they should be broken up into individual or isolated sections, by strain insulators interposed in them, as indicated at Fig. 2. This is to prevent waste of energy by surges being set up in the metallic guy wires. Some stations, such as the Telefunken, utilize the metal mast section, as a part of the Antenna, and, of course, the base of the steel mast is thoroughly insulated from the earth in such cases; even where the height reaches a value as great as 820 feet, as do the towers erected at Tuckerton, N. J., Sayville, L. I., Elivese, Germany, etc.

For small antennae, however, it is recommended to insulate the metallic aerial mast, and to keep the aerial proper insulated from them. When long masts or sections are to be raised and placed in a hole in the ground, a method of raising them is illustrated at Fig. 5. A short *stub* pole, about 1/3 to ½ the height of the pole to be raised, is best used; and to this a tackle block or chain block, is attached as indicated. About three guy ropes or wires are secured near the top of the mast, and as it is raised, these are manned by several men, so as to have control of the pole, and thus keep it from falling to one side. A piece of 2 x 8 inch plank should be placed in the side of the hole, and this allows the base of the pole to slide down it and into the hole, without breaking away the dirt, and thus interfering with properly and quickly raising same. It may be remarked that poles as high as 50 feet are raised by short pike poles and guy ropes, by construction gangs on the road, without the aid of any stub poles or tackle blocks. This requires some little care and skill, however, and 6 to 8 men can raise a pole 40 feet high, quite readily, if the job is done right. The pike poles for this work are provided with steel points, and one stout pole should have a semi-circular steel piece on its end, to place under the pole as it is raised, and thus give a secure and steady support, while the other men are getting a new hold with their pike poles, which are jabbed into the wooden main pole. Once the pole is vertical, some dirt should be filled in the hole, with some stones if available, and a pail or two of water may be dumped into the hole to make the dirt and stones pack more tightly around the pole bases.

The general arrangement of the aerial proper is seen from Fig. 3, and all joints on such construction ought invariably to be soldered, using a blow torch, and some solder with flux, etc., such as is obtainable of the E. I. Co. It is a good idea to form curved joints on the aerial, as the current is of very high frequency, and this joint construction is perceived on the sketch, Fig. 3. The lead-in wires may be the same as on the aerial proper, and after being led down aways, they should then be twisted into a cable, and this leads on down to an "Electro" 100 ampere, 600 volt, lightning grounding switch, as shown. From the grounding jaw on the switch, a No. 4 B. & S. Copper or "Antenium" wire leads down to a first-class ground or earth terminal, which is commonly the water pipe. The ground wire should be run on the outside of the building on porcelain knobs, in as straight a line as possible, and may enter a cellar window, to connect to a water pipe. Ground clamps are used for making such connections to water pipes of the form illustrated at Fig. 6.

Returning to the aerial itself, several forms of efficient insulators are seen in Fig. 7. These are all "Electro" designs, and for transmitting purposes, the long ribbed Electrose style should be used to prevent undue leakage, or also several smaller ones may be placed in *tandem* or *series* to give a high insulation between the aerial and ground. Our sketch, Fig. 8, shows how a few porcelain cleats are sometimes used for receiving purposes only, but those are no good for the best receiving results or for transmitting sets above a ¼ inch spark coil.

Aerials may be properly insulated and supported in a great many cases from some natural elevation, such as: water towers, smoke stacks, trees, etc., and a tree supported antenna is seen in our illustration, Fig. 4. Sometimes, where roofs are of wood shingles, and the like, the aerial may be supported under it. This is recommended for receiving, but for transmitting with larger than 3 to 4 inch coils, and medium distances can be negotiated in this way for receiving purposes, under good conditions, under wood, slate or paper covered roofs.

Various kinds of metallic conductors have been, and are employed, for aerial construction, among them being: copper, aluminum, and phosphor bronze. Aluminum wire is not suited for this work, as it is very difficult to solder joints on same, and moreover it is comparatively weak on long spans. A new wire brought out by the E. I. Co., is their Antenium Wire, which is the strongest conductor for its size that can be purchased. Joints with it are very easily soldered with any common flux, such as rosin, or "Solderall," etc.

The commercial aluminum composition wire is notoriously weak and ruptures at 75 lbs., for the No. 14 size. A sharp bend causes it to break almost immediately; it cannot be soldered except with the greatest difficulty; it always makes poor contact, on account of its natural oxide film. So many complaints were made to the E. I. Co. on aluminum wire, that they decided to develop an aerial wire that did not have any of the above objections. They finally found it in ANTENIUM wire, which not only has none of the objections cited, but has a great many excellent points, making it highly desirable for aerials.

ANTENIUM wire is a 30 per cent. copper wire of enormous strength, even surpassing phosphor bronze in strength. The No. 14 wire stands a rupture test of 330 lbs., against 75 lbs. of Aluminum wire. It can be soldered like ordinary copper wire. It can be bent back and forward and is so tough that it cannot be broken, except with difficulty. It makes excellent contact and does not oxidize readily. Foot for foot it is as cheap as aluminum wire and three times cheaper than copper wire.

In appearance it is exactly like copper wire, as a matter of fact it cannot be told apart from copper wire.

It has about 50 per cent. less skin resistance than Aluminum wire.

One pound No. 14 B. & S. ANTENIUM wire has about 125 feet.

The End.

THE E. I. C^o NEWS

NEW YORK, MAY 1st, 1914

Pre-Inventory Sale

As every year at this season, our Stock Department is preparing for inventory, we are closing out at cost prices the articles below, which we no longer catalogue or in which we are overstocked.

The quantity of the BARGAINS listed below is limited and we urge you to send in your orders today if you want to profit by our closing out sale. No order for less tha 50 cents accepted, except compass.

TWENTIETH CENTURY MOTOR

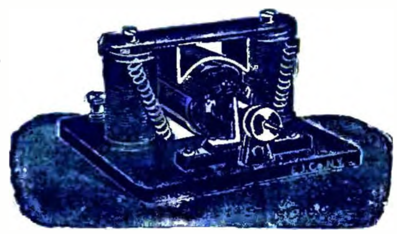
1880

These motors are discontinued models, but for quality stand in a class by themselves. Our No. 1880 is a very powerful little machine working on two volts, 5 amperes minimum and takes about two dry cells. The maximum current that should be used is 6 V. 10 amperes. This motor is built with the utmost care and has all the latest improvements. It has an adjustable rocker arm so that the brushes can be changed to any angle, making it possible to get almost any speed. The base as well as the casing is entirely of metal, not a particle of wood being used. Only metal and hard fibre enters in its construction. The armature is of three sections and the commutator is very heavy. The bearings are of brass and very solid. The fields are wound with enamel wire after the latest standard in motor building. The motor itself is air cooled and furnished with a handsome brass plate, same as large motors, giving the voltage and amperage; the base and casing is finished in bright red enamel. Our illustration does little justice to this motor and it must be seen to appreciate its beauty. The weight is ¾ lb.; size 3¾x3¾x2¼ inches.

No. 1880 Twentieth Century Motor, as described. Price now.... **$1.50**

Shipping Weight 1 lb.

TWENTIETH CENTURY MOTOR



1881.

This motor is of a similar construction as our No. 1880 except that it is not encased and that it is somewhat lighter. Its power, however, is about the same as No. 1880. It is built entirely of metal and fibre, no wood entering in its construction. There are two heavy electro-magnets, field and the armature is of three sections, having heavy commutator. The brushes are adjustable and the tension can be adjusted quite readily. The motor is built in such a manner that the connections can be changed to either series or shunt, simply by loosening two nuts. The bearings are quite heavy and are all brass. We greatly recommend this little motor to drive models for instruction, experimenting, etc. This motor runs well on battery and will develop astonishing power on three dry cells.

The base is of heavy metal, finished in bright red enamel. The electro-magnet standards are likewise finished in bright red enamel, all of which greatly enhances the beauty of the motor. Weight, ¾ lb.; size, 3¾x3¾x1¾ inches over all.

No. 1881 Twentieth Century Motor, as described, each, price now **$1.00**

Shipping Weight 1 lb.

10¢ ASTOUNDING BARGAIN!

In order to get you acquainted with us, we will, for a limited time send prepaid this high-grade compass, warranted to be accurate, for the ridiculous price of 10c. This compass sells everywhere for 25c. It measures 1¾" in diameter, glass cover, nickel plated band, dial in two colors. Instructions tell how to use this instrument for orientation purposes, telling polarity of magnets, tells if an electric wire is "alive" or "dead," making a voltmeter with this compass, etc., etc. You cannot afford to be without this wonderful little instrument, AND at no extra charge we will send you absolutely free our famous comprehensive electrical cyclopedia No. 12 containing over 450 illustrations and over 1600 electrical apparatus and supplies. Book contains 16 page "Treatise on Wireless Telegraphy" also 16 page copy of the new magazine "The Electrical Experimenter." Ask for our **FREE** 160 page "Wireless Course" in twenty (20) lessons.

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All metal, steel, nickel finish. Each tool has been carefully tested for accuracy before leaving the factory. Warranted best made. No. 6142 6 inches square, each, **17c**

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Sample Spool

The most important sale of enameled wire ever held. This wire is manufactured by the **Western Electric Company**, and we have secured so much of it at a special price, that we must let you in at special prices, in order to dispose of the enormous quantity we have on hand. **All this wire is absolutely new, unused, and guaranteed. Your money back, if you do not like the wire in any respect.** It comes on one and two pound spools. **This wire is just the thing for wireless coils, etc.** You will never again get such bargains in enameled wire as these. You save positively 300% on your enameled wire.

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No. 35 B. & S. enameled wire, regular price, $1.86 lb.; now, lb. 80c

No. 36 B. & S. enameled wire, regular price, $2.12 lb.; now, lb.......90c

Shipping weight (including spool and packing) per lb., 20 oz. (2 lbs. by P.P.)

USE THE ADJOINING COUPON TO GET THIS FAMOUS BOOK

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New York City.

I enclose herewith 10c in stamps for which please send me the compass above described and your 212 page electric cyclopedia number 12, containing 450 illustrations and over 1,600 articles and valuable information on Electricity and Wireless. Book also contains 20 free coupons for our 160 page wireless course in twenty lessons.

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Operates Photographic Films!

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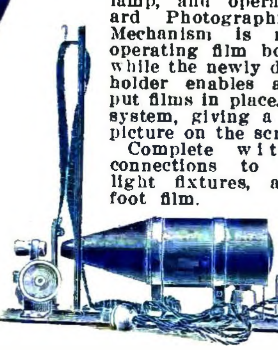
The Electric Cinematograph. A Marvel for the Price.

This instrument is a wonder. It is lighted by an Edison 100 candle power lamp, and operates Standard Photographic Film. Mechanism is reversible—operating film both ways—while the newly devised film holder enables a child to put films in place. Fine lens system, giving a Four-Foot picture on the screen.

Complete with electric connections to attach to light fixtures, and one 5 foot film.



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(Extra Films cannot be furnished through us, as we have only the instruments and one film for each on hand.)

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The manufacturer of these "Movies" has invented a new model and wants to get rid of his stock as quickly as possible, to put his new model on the market, and for this reason we can offer you this instrument at the below mentioned price.

Catalogue Price Everywhere, $7.50.

No. H118 Our Special Bargain Price, **$2.50**

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A small neat wrench for light work. Extra strong and has a good, firm grip. 5 inches long. Price each **17c**

Ship. Wght. 1 lb.

PHOSPHOR BRONZE Aerial Wire

Admittedly the best thing in the world for an aerial. Cost—others charge $16.00 per 1,000 ft. for the seven strand, we charge $7.00 per 1,000 ft. Four strand: others ask $10.00 per 1,000 ft., we ask $4.00 per 1,000 ft.

This cable is guaranteed to be pure bronze throughout, made of 4 and 7 strands No. 22 B. & S. Gauge, not less than 100 ft. sold. Prices below apply for short time only and subject to changes after July 1st. Make your order out now.

No. 2509 7 Strands Antenium SOLID BRONZE Cable, per 100 ft. **75c**

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Rupture test, 1,000 lbs.

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No. 2510 4 Strands Antenium SOLID BRONZE Cable, per 100 ft. **45c**

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Rupture test, 600 lbs.

Shipping Weight 1 lb. per 100 feet.

This wire is guaranteed for tensile strength, conductivity, non-corrosive and lasting qualities. Send 2c stamp for sample.