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February, 1908

ELECTRICIAN AND MECHANIC

INCORPORATING AMATEUR WORK

CONTENTS

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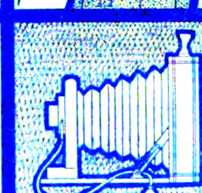

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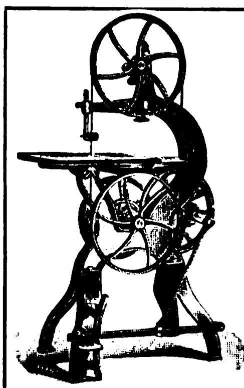

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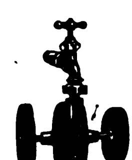

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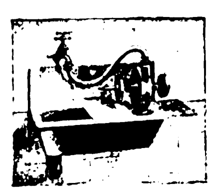

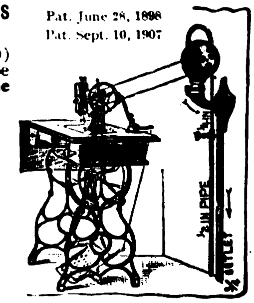

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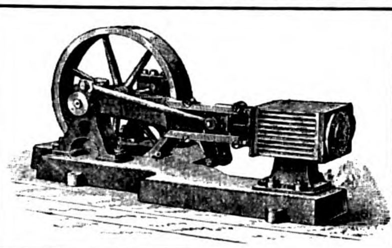


The Earning Power of Money Invested in Kornit

Most Satisfactory Progress Being Made At Our New Factory

HERE is a Financial Opportunity to make an investment in an up-to-date, energetic, money-making industrial manufacturing company, which owns all the United States patents, processes and exclusive rights for producing Kornit, a product never before manufactured nor sold in this country. The demand for Kornit is great and the profit of manufacturing and selling is ENORMOUS. Read every word of this announcement and ACT AT ONCE.

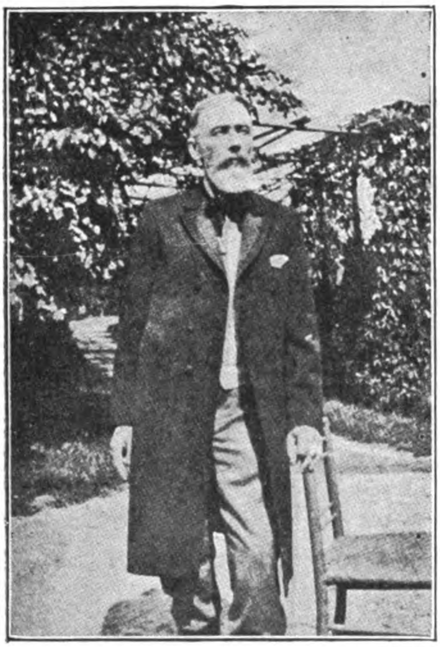
THE STORY OF KORNIT

By President CHARLES E. ELLIS

KORNIT was invented by JOHANN GUSTAV BIERICH, a subject of the Czar of Russia, residing at Menkenhof, near Lievenhof, Russia, and is a homogeneous Horn or Hoof substance. Kornit is produced by grinding horn and hoof shavings and waste into a palpable powder and then pressing under heavy hydraulic pressure with heat into a homogeneous slab. This slab produces a substance which can be sawed or turned the same as ordinary wood. It is of a beautiful black consistency and IS EXTREMELY VALUABLE as a NON-CONDUCTOR FOR ELECTRICAL SUPPLIES. It is a matter of record that the electrical industry in this country AT THIS TIME DOES NOT HAVE a satisfactory material for heavy or high insulating purposes. A slab of Kornit one inch thick was tested in Trenton, New Jersey by the Imperial Porcelain Works and was FOUND TO HAVE RESISTED 96,000 VOLTS OF ELECTRICITY. It may be interesting to note here that the heaviest voltage which is transmitted in this country is between Niagara, Buffalo and Lockport, New York. The voltage transmitted by this company is between 40,000 and 50,000 volts. Kornit is equally as good as a non-conductor for electrical purposes and supplies as is hard rubber.

The average price of hard vulcanized rubber for electrical purposes is to-day considerably over one dollar per pound—at the present writing something like $1.25 per pound.

KORNIT CAN BE SOLD AT TWENTY-FIVE CENTS PER POUND, and AN ENORMOUS profit can be made at this price, so that it CAN EASILY BE SEEN that where Kornit is EQUALLY AS GOOD and AS A MATTER OF FACT, in many instances, a BETTER non-conductor than hard rubber, it can compete in every case where it can be used with great succes on account of its price. For electrical panel boards, switchboards, fuse boxes, cutouts, etc., there are other materials used, such as vulcanized paper fibre, slate, marble, etc. A piece of vulcanized paper fibre, 3x4x1 inch, in lots of 1,000 brings 20 cents per piece. A piece of KORNIT of the SAME DIMENSIONS could be sold with the ENORMOUS PROFIT OF OVER 100 PER CENT at ten cents. The absorptive qualities of Kornit render it such that IT IS FAR PREFERABLE to that of vulcanized fibre. It will not maintain a flame. Of all the materials which are now in the electrical market for supplies and insulators there is, as we have stated above, none that are satisfactory. Kornit will fill this place. Its tensile



MR. JOHANN GUSTAV BIERICH, THE INVENTOR OF KORNIT, IN HIS SUMMER GARDEN AT MENKENHOF, RUSSIA.

strength per square inch averages from 1,358 pounds to 1,811 pounds, which the reader can readily see IS MORE THAN SATISFACTORY. This test was made by a well-known electrical engineer, who is now acting in that capacity for the United States Government, with a Standard Reihle Bros. Testing Machine.

Waste horn and whole hoofs are being sold by the ton today principally only for fertilizing purposes. There is one town alone, Leominster, Mass., where they have an average of eight tons of horn shavings every day. These waste horn shavings are now only being sold for fertilizing material. These eight tons of horn shavings manufactured into Kornit and sold for electrical purposes would easily bring $3,000. At this price it would be selling for less than one-fifth of what hard rubber would cost, and about one-half what other competitive materials would sell for, even though they would not be as satisfactory as Kornit.

Kornit has been in use in Russia about four years. In Riga, Russia, which is the largest seaport town of Eastern Russia, the Electrical Unions there are using Kornit with the greatest satisfaction, finding it preferable to any other insulating material.

The expense of manufacturing Kornit from the horn shavings is not large, as the patentee, Mr. Bierich, has invented an economical and satisfactory process which produces an article that in the near future will be used in the construction of almost every building in this country.

Besides electrical insulators Kornit can be used for the manufacturing of furniture, buttons, door handles, umbrella, cane, knife and fork handles, brush and sword handles, revolver handles, mirror backs, picture frames, toilet accessories, such as fancy glove boxes, jewel cases glove stretchers, shoe lifts, etc., office utensils such as paper knives and penholders, ink stands, pen racks medical instruments such as syringes, ear trumpets, etc., etc., pieces for games, such as draughts, chessmen, dominoes; checkers, counters, chips, cribbage boards, etc.; telephone ear pieces, stands, etc., piano keys, typewriter keys, adding machine and cash register keys, tea trays, ash trays, scoops, mustard and other spoons, salad sets, cigar and cigarette cases, cigar and cigarette holders, match boxes, and hundreds of other useful and ornamental articles, all at a large and remunerative profit

The Great Demand for Kornit in this Country

THERE is one manufacturer ALONE here in New York that uses 60,000 square feet of insulating material for panel boards every year. He is now using slate and marble, but IT IS NOT SATISFACTORY, for the reason that in boring and transportation IT BREAKS SO EASILY. KORNIT WILL ANSWER THE PURPOSE OF MANUFACTURING PANEL BOARDS VERY MUCH MORE SATISFACTORILY. On 60,000 square feet of Kornit there would be a net profit of over $30,000, or 50 cents for every square foot used. THIS ONE EXAMPLE is cited to show you THE ENORMOUS PROFITS which can be made. There are a great many other panel and switchboard manufacturers in this country. You may be interested to know that a panel board is a small switchboard. There is one or more on every floor of all large buildings where electricity is used. They each have a number of switches mounted on them, so that those in charge can turn certain lights on or off, and by these panel boards all the electrical power in the building is controlled. They must be of a reliable non-conducting material. Kornit can be used for this purpose almost exclusively. The largest electrical manufacturing concerns in Riga, Russia, ARE USING

KORNIT ONLY FOR THIS PURPOSE, after having tried all other so-called non-conducting compositions. The electrical trades alone can consume a great many tons of Kornit every day in the year. If only two tons of Kornit is manufactured and sold every working day in the year IT WILL ENABLE THE KORNIT MANUFACTURING COMPANY TO PAY 16 PER CENT. DIVIDENDS EVERY YEAR. Of course, if four tons a day are sold the dividends would be 32 per cent. per year. THIS IS NOT IMPROBABLE. AN EXPERT ELECTRICAL ENGINEER who holds one of the most responsible positions here in New York City, made the statement, after thoroughly examining and testing Kornit for electrical purposes, that in his most conservative estimation there can be ten tons of manufactured Kornit sold every working day in the first year. This would mean that the Kornit Manufacturing Company would pay a dividend out of its earnings the first year of over seventy-five per cent. (75%). This is probably more than will be paid the first year, but there certainly seems to be a good prospect of paying a large dividend the first year.

THERE WILL BE SUCH AN ENORMOUS DEMAND FOR KORNIT AFTER IT BECOMES INTRODUCED THAT FROM YEAR TO YEAR THE DIVIDENDS EARNED WILL BECOME LARGER AND LARGER. THIS IS THE BEST OPPORTUNITY TO MAKE AN INVESTMENT THAT YOU HAVE EVER HAD.

It is a well-known fact that THE MOST LEGITIMATE and PROFITABLE way to MAKE MONEY is by manufacturing some product that is "NECESSARY" and ONE THAT CAN BE FULLY CONTROLLED so that nobody else can manufacture the same article. Look at Sugar (which is protected by a high tariff); at Standard Oil, the Telephone, the Telegraph, and we might go on and enumerate many more monopolies. THEY ARE THE BIG MONEY MAKERS OF TO-DAY. KORNIT CANNOT BE MANUFACTURED BY ANYBODY IN THIS COUNTRY EXCEPT OURSELVES OR OUR AGENTS. We own all the patents issued by the UNITED STATES GOVERNMENT to the inventor, MR. JOHANN GUSTAV BIERICH, IN RUSSIA. These patents HAVE BEEN BOUGHT from Mr. Bierich, and ARE DULY TRANSFERRED TO THE KORNIT MANUFACTURING COMPANY, and the same is DULY RECORDED IN THE PATENT OFFICE OF THE UNITED STATES.

KORNIT FACTORY, NEWARK, N.J. (BELLEVILLE STATION), ENTIRELY CONSUMED BY FIRE, MARCH 1, 1907.

We are Building A Fine Factory

ON March 1, 1907, our Factory, which had just been thoroughly equipped and completed, was burned to the ground!

Since that time we have purchased the Real Estate and are now building OUR OWN Factory. It is promised that it shall be finished and in working order during the present month. All our machinery is ordered and the greatest part is already completed ready to install as soon as our new Factory Building is ready.

A few shares obtained now may be the foundation for a fortune of the much-desired income for support in the unknown years that are to come. We leave it to you if it would not seem good judgment to take immediate advantage of this opportunity. Anyway, please write me at once and let me know just what you will do. If it is not possible for you to take shares now, write me and tell me how many you would like and how soon it will be convenient for you to do so, provided I will reserve them for you. As soon as I receive your letter I will answer it WITH A PERSONAL LETTER AND WILL ARRANGE MATTERS AS YOU WISH TO THE BEST OF MY ABILITY.

REMEMBER, I HAVE A GREAT MANY THOUSAND DOLLARS INVESTED IN THE KORNIT MANUFACTURING COMPANY, and the minute you buy a share or more in this Company, we become CO-PARTNERS, as CO-SHAREHOLDERS. It is for our mutual benefit to watch and guard each other's interests. I WILL BE GRATEFUL IF YOU WILL WRITE ME TO-DAY, so that I may know just what you will do.

I know you will agree with me that you have never had presented to your notice a better opportunity to make an investment where such large profits can be made because of the exclusiveness of control and the great demand and the low cost of the raw material, which is now almost practically thrown away. Join me in this investment, and I assure you that it is my sincere belief that in the near future you will say, "That is the day I made the most successful move in my whole life."

My Offer to You To-day

THE KORNIT MANUFACTURING COMPANY is incorporated under the laws of New Jersey, and is capitalized with 50,000 fully paid non-assessable shares at $10 each. It is my intention to sell a limited number only of these shares at the par value of $10 each. Ten dollars will buy one share. Twenty dollars will buy two shares. Fifty dollars will buy five shares. One hundred dollars will buy ten shares. One thousand dollars will buy one hundred shares, and so on. After you have bought one or more shares in the Kornit Manufacturing Company you may feel, as I do, that you have placed your savings where they will draw regular and satisfactorily large dividends.

I should not be a bit surprised if these shares paid dividends as high as one hundred per cent. in the not far distant future. Consequently, a few dollars invested now in the shares of the Kornit Manufacturing Company will enable you in the future to draw a regular income from the large profits of the Company as they are earned. The dividends will be paid semi-annually, every six months, the first of May and November of each year. This is one of the best opportunities you will ever have presented to you in your whole lifetime. I have invested a great many thousand dollars in the Kornit Manufacturing Company, and I feel sure it is one of the best investments I have ever made. I can truthfully say to you that I fully believe that you will be more than pleased with your investment and that you will never be sorry. Remember, that you have here an opportunity to become interested in a large industrial manufacturing concern manufacturing a product with an exclusive monopoly, which has never before been manufactured or sold in this country.

Remember, that it is by no means an experiment, as it has been successfully manufactured and sold for over four years in Russia at a large profit, and the manufacturer and inventor recently wrote that the demand is increasing every day beyond the capacity of their manufacturing facilities.

Now is the time for you to take advantage of this magnificent opportunity to make an investment in these shares. I EARNESTLY BELIEVE that in a few years THESE SHARES WILL BE WORTH FROM FIFTY DOLLARS TO ONE HUNDRED DOLLARS each on account of THE LARGE DIVIDENDS which the company will earn and regularly pay each and every six months. It is a well-known fact that shares that pay fifty (50) to one hundred (100) per cent. dividends will readily sell in the open market for $50 to $100. THE OUTLOOK FOR THE KORNIT MANUFACTURING COMPANY is such that it seems impossible for the earnings to fall far short of these figures. If the company only makes and sells two tons of Kornit a day for the first year and made a profit of only $200 per ton it would mean a profit of over sixteen per cent. (16%) the first year. If this business were doubled the second year, of course the earning capacity would double and the dividends would be over thirty-two per cent. (32%). Prominent and well-known Electrical Engineers assure me that this product cannot help and is bound to make enormous profits. I would recommend that you send for as many as you wish at once. You, in my conservative opinion, can safely count on the large earning capacity of these shares. I will at once write you a personal letter with full information, and send you our illustrated book "A Financial Opportunity," containing a score of photographs of the Kornit industry, taken in Russia. Please let me hear from you.

Yours very truly,

CHARLES E. ELLIS

President

607a West 43d St., New York City, N.Y.

Mr. Ellis, besides being President of this company, is also President of two other large and successful companies, owning shares therein valued conservatively at over $250,000. Mr. Ellis has other investments in New York City real estate, bonds, stocks and mortgages to the amount of many more hundreds of thousands of dollars. Any bank or mercantile agency will tell you his guarantee is as good as gold. This is a successful man who wishes you for a Co-partner, as a Shareholder and Dividend Receiver in this company. Remember, you will do business personally with Mr. Ellis in this matter.

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BUBIER'S POPULAR ELECTRICIAN, ESTABLISHED 1890
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VOL. XVIII FEBRUARY, 1908 NUMBER 8

ELECTRICAL ENGINEERING—Chapter XX.

Alternating Current Measuring Instruments—Recording Wattmeters

A. E. WATSON, E.E., PH.D.

In clear distinction from the classes of galvanometers or measuring instruments in which there is a suspended magnet or a suspended coil is a sort in which there is no permanent magnet at all, nor even any iron. At least two coils are involved, one fixed and the other movable; by the passage of currents through these, magnetic lines of force are set up in the air and the one coil tries to turn so as to let its field merge with that of the other. The absence of iron removes errors due to hysteresis, eddy currents and variation of permeability, so that no hindrance is presented to the accurate measurement of alternating currents.

The defect is present, however, and irremediable, that for weak currents, the field magnetism set up is so weak as to make the first part of the scale useless.

Weber seems to have been the first to construct instruments on this principle, and, to emphasize the absence of a permanent magnet, he called the new sort "electro-dynamometers." His particular arrangement will be referred to under the topic of wattmeters. A simple construction adapted for measuring reasonably strong currents,—therefore being really a sort of ammeter,—was devised by Siemens, and is now commonly referred to as the Siemens' dynamometer. Though not conveniently a portable instrument, this style has great value in being simple, highly accurate, and quite independent of wave forms and frequency of the alternating current. With various modifications and refinements it is still the type of ultimate reference for calibrating the more commonly used instruments.

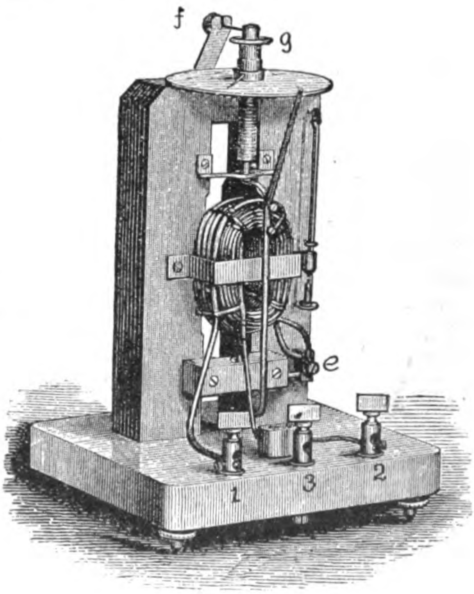


FIG. 99
Siemens' Electro-Dynamometer

An outside view of the form as actually made by Siemens is given in Figure 99, and a diagram of the connections in Figure **100**. The instrument is really double, for it has two stationary coils of different sizes of wire and number of turns, whereby a greater range of small and large currents may be measured. In a familiar case, one coil, marked c, is made

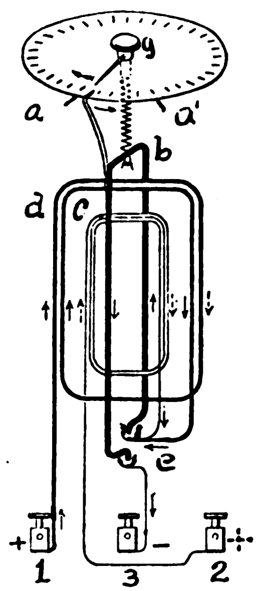


FIG. 100
Diagram of the Siemens' Electro-Dynamomoter

from No. 10 wire, wound around a central wooden block about ¾" x 2" in 12 turns per layer and 5 layers. Over this coil is another, d, of No. 4 wire, of only four turns. With the former coil in circuit, currents up to 15 amperes can be read, and with the other, up to 25 or more. The large wire coil starts at binding post 1, and the smaller at 2; their other ends are joined together at e, and to mercury in a cup in the wooden cross bar. A single loop, b, of No. 6 copper wire, embraces both these fixed coils, its ends dipping into mercury cups, one in the cross bar just mentioned, the other in the base. This latter cup is connected to the middle binding post 3. This loop is suspended by a silk or linen thread extending through a slender spiral spring and wound around a tiny windlass, with a thumb knob at f; by this means the coil may be readily lowered when not in use, and thus lessen the danger of breaking the suspending thread. Attached to this movable loop is a pointer that is limited in its swing to the distance between two stops, a and a', fastened to the edge of a fixed brass circle divided into degrees. One end of the slender spring referred to is attached to the loop, while the other end is fastened to a thumb-piece g, called a torsion-head, free to turn in the centre of the graduated disc. To this centre-piece a second pointer is attached, almost reaching to the first.

With this detailed explanation of the mechanical construction, the action and method of using the instrument will be more readily perceived. With no current flowing, the instrument is levelled, and the two pointers made to coincide with the zero of the scale. Since the pointer on g is adjustable, this coincidence is easily effected. Now if one wire from the circuit in which the current is to be measured is brought to 2, and the other to 1 or 3, current will pass in series through one of the fixed coils and the movable loop. The arrows indicate directions that may prevail at a given instant. The movable loop will try to place itself parallel to the coils, and with the connections shown, it will move in the direction of the arrow at the end of its pointer, but can go no further than the stop a'. The thumb-piece g is then turned in the opposite direction, as indicated by the arrow at the end of its pointer, thereby putting a twist into the spring, but at some particular point the torsion on spring will just balance the torque due to the current, and the pointer on the loop will again be restored to the zero position. The number of degrees through which the pointer has had to be turned will be proportional to the ***square*** of the current. The square root of the number of degrees of each particular reading must therefore be extracted, and to be translated into amperes, this root must be multiplied by the "constant" for the particular instrument. In this respect some similarity to the case of the tangent galvanometer will be recognized. That the torque varies as the square and not as the first power of the current can be seen by the fact that doubling the current doubles the field of force of both members of the instrument, and the resulting force is then four times as much as before. Were the current in one member kept constant while that in the other was varied, the torque would really follow the simple law, and this is the case of the Weston instruments, in which the permanent magnet contributes a constant field strength, while the current in the little movable coil alone varies.

The "constant" must be determined for each particular instrument, and in comparison with some other taken as standard. A common value for the size of dynamometer just described is about .8 for the inner coil and 2.4 for the outer.

As an example of the application of the instrument, suppose with a given current a balance was found when the deflection was 115°, the inner coil being the one in circuit. The square root of this number is 10.7 ; if the constant is .8, the product becomes 8.56, meaning that number of amperes. If the degrees were 315, the current would be 14.2 amperes. If a complete turn of the thumb-piece was insufficient to restore the loop to the zero position, the circuit wire should be transferred from binding post 2 to 1. Suppose then a twist of 100° sufficed. Extracting the square root and multiplying by the other constant, say 2.4, the number of amperes is found to be 24.

To make accurate readings, about the same precautions need to be observed as with a tangent galvanometer. Especially must the presenceof external fields between conducting wires be eliminated by twisting the two together, as in the manner of ordinary lamp cord. With one of these instruments at hand, a person would have accurate means of calibrating the more portable of the switchboard types of instruments. Though usually limited to use with alternating currents, these dynamometers are equally accurate on direct currents, and the constant can even be determined with that sort and still be regularly used for alternating. It is always well to take the precaution to place the instrument so that the plane of the loop is east and west, and when using direct currents to eliminate errors due to the earth's field by reversing direction of current and taking average of the two values.

Voltmeters can be made on the same principle, but using fine wire coils and further putting a large resistance in series with them. A more practical and direct reading instrument, though not having equal divisions, is commonly made, imitating the appearance and construction of the Weston direct current voltmeters. Of course a permanent magnet is inappropriate, but its place is taken by a pair of fine wire coils, the inside diameter being not much over an inch. The movable coil, to which the pointer is attached, is pivoted between these, and is acted upon by the electromagnetic field set up by the current in

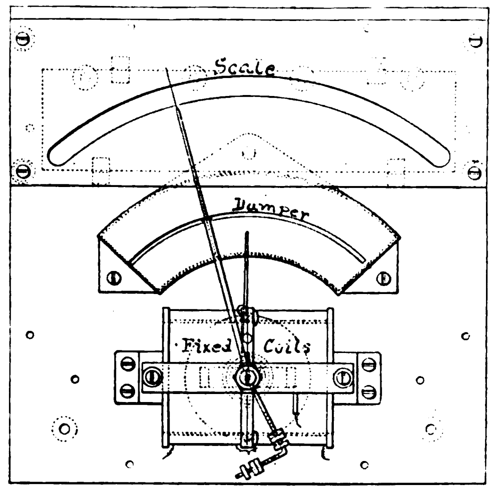


FIG. 101
"Keystone" Voltmeter for Alternating Currents

the fixed coils. The movable coil cannot, however, be wound upon a metal frame, as in the case of the direct current instruments, for in the presence of an alternating field magnetism, short circuit currents would continually flow in such a closed conductor, and produce disastrous heat and a waste of energy. This little coil is wound with a sufficient number of turns and layers, so that when impregnated with varnish and dried, it possesses a surprising amount of stiffness, and can in itself receive the trunnions, or pivots for supporting it in its jewelled bearings. Hair springs can be fitted to these pivots, and serve both to conduct the current and to give the mechanical reaction as usual. The movable system can be made to weigh only a few grams, but even this slight weight will produce some considerable swinging, and so a substitute is sometimes sought in air damping, by means of an aluminum or mica vane attached to the pointer and swinging in a circular trough.

The Weston Company makes a large variety of this class of instruments, but no fundamental patents are in existence, and the market is free to all. The exact construction of a laboratory pattern of the "Keystone" voltmeter is given in Figures 101, showing the plan; 102, showing the longitudinal section, and 103, showing the movable coil. In the plan, the fixed coils are represented as clamped together, with only enou

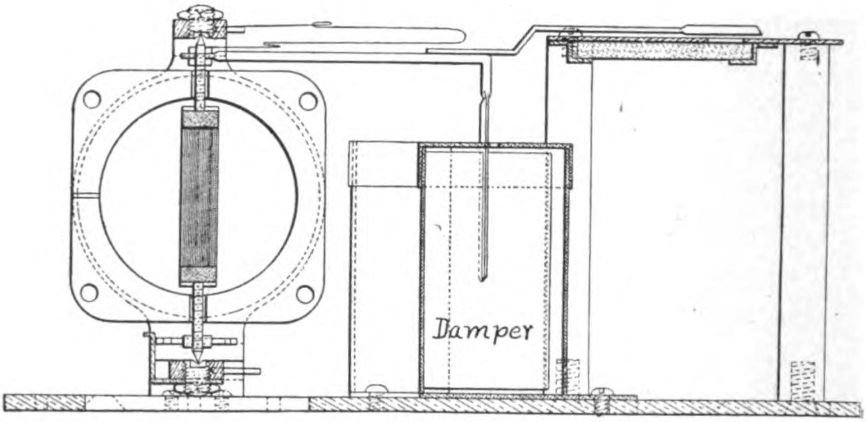


Fig. 102
"Keystone" Voltmeter, Longitudinal Section

opening in the flanges to give egress to the pivots. Inside diameter of the coils is shown by the parallel dotted lines, and the position of the movable coil itself just below the cross bar that carries the jewelled supports. The opening in the annular trough is seen midway between the coils and scale at end of pointer. The shape of the various parts is still further seen in the sectional view, but a peculiarity in this particular make will be noticed in the substitution of a loop spring for the upper spiral one. This is claimed to afford some help in providing more equal divisions on the scale. The simplicity of shape of the movable coil is clearly brought out in Fig. 103, which shows also a part of the counterweight, and a very oblique view of the air damper. Though made thus with delicate workmanship, these instruments require much more energy to operate them than those of the permanent magnet sort; they are not dead-beat, nor free from influence of exterior magnetic fields. An instrument for 150 volts may have a resistance of 500 or more ohms in its fixed coils, 100 or more in its movable one, and be put in series with several thousand ohms externally, but this is far less than is possible with the other kind. Whatever external resistance is used must be of the "non-inductive" arrangement; if in spools, the coils must be looped in the middle, and thus terminating with both ends on the outside layer, or wound on cards and pressed flat in bottom of case. In spite of the fact that a very large number of turns are used in the operative part of instrument, and self-induction varies as the square of the number, the actual value of that factor, due to the relatively small current and the absence of iron, is very small. The act of including the large non-inductive resistance so reduces the angle of lag that the voltmeter as calibrated for alternating currents is correct within a fraction of a per cent. for direct currents.

A further modification of the dynamometer, and indeed, Weber's earliest application, is to make the stationary coils of coarse wire, and thus allow for putting them directly in the main circuit. The movable coil is still in series with a high resistance and connected directly across the circuit, as is customary with a voltmeter. The combination is thus

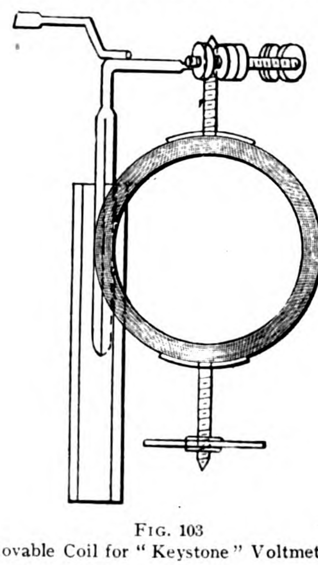


Fig. 103
Movable Coil for "Keystone" Voltmeter

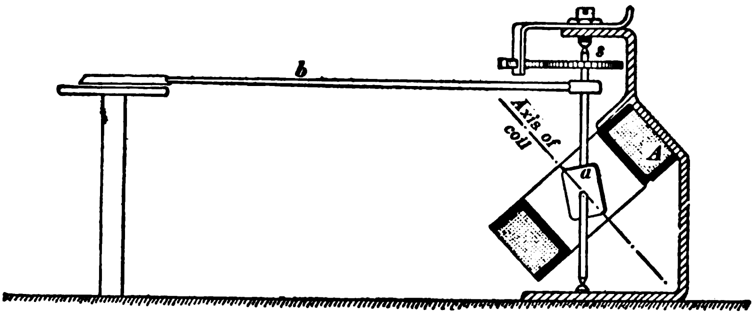


FIG. 104
Thomson Inclined-Coil Alternating Current Ammeter

seen to give all the requirements of a wattmeter. A field of force is set up proportional to the main current, and the current driven through the shunt is proportional to the voltage. A torque results proportional to the product of these two factors, and this product represents the watts. A further extension of this sort of instrument will be discussed under the head of recording meters.

Voltmeters for very high tension alternating currents are not often connected directly to the service wires. Too great and unnecessary personal danger would be involved, so the simple means of transforming a high voltage to a conveniently low one is made use of. "Potential" transformers insulated with all the care desired, are put across the main circuit, so that a secondary current only is led to the instrument. Although the scale purports to show the full voltage, the facts are that a low one, proportional to the main, is really the active one. Likewise, in the case of the ammeter, just the same objection to the high potential being brought to the front of the switchboard still holds, so "current" transformers are put in series at a safe point, and a low voltage current, proportional to the main current, arrives at the indicating part of instrument.

Shunts, such as are successfully used with direct currents, are not appropriate for alternating currents. Errors due to inductance in the shunts or in the movable coils themselves interfere with the accuracy of the readings, and happily, the use of the little transformers just mentioned solves the question of measuring large currents in a much more satisfactory manner.

Some alternating current instruments have iron within their coils, and are useful where a high degree of accuracy is not essential. One of the best examples of this construction is the Thomson "inclined-coil" type. A sectional view of the ammeter is given in Figure 104. A coil of coarse wire, A, is fastened in a position at an angle of 45 with the base, and tipping directly towards the scale; a vertical spindle of non-magnetic material extends through the opening in the coil, and terminates in steel points resting in jewelled bearings; on this spindle, and at the centre of coil is a piece of soft iron, a, itself fixed at an angle of 45°; a pointer, b, is attached in the ordinary manner, and a single spiral spring, s, serves to give the mechanical reaction.

When current flows in the coil, lines of force are set up, and the bit of iron tries to set itself along the direction of these lines. To accomplish this considerable rotation is necessary, and the result is a surprisingly long range of movement of the pointer. Such a construction, however, is not free from errors due to variations of wave form and frequency. The voltmeter made in this manner is especially affected by these causes, and recourse has been taken to the use of an obiquely pivoted fine wire coil with double hair springs for the electrical circuit, as in the case of the dynamometer type. Wattmeters are also made on the inclined coil principle, the fixed coil being of coarse and the movable of fine wire as before.

One of the most interesting and practical applications of the electro-dynamometer principle is in the construction of recording wattmeters. Not a little of the popularity of electric lights and

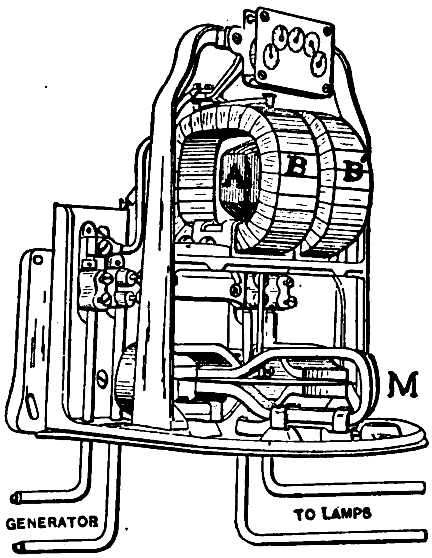


FIG. 105
Thomson Recording Wattmeter

power has been due to the accuracy with which a customer's supply can be measured. Added to the accuracy of the meters is their moderate cost and their freedom from climatic or other external influences.

The most common form of the meter, and readily recognizable from its adoption of familiar parts, is that of Prof. Thomson. A perspective view of one is given in Figure 105, and a diagrammatic yet somewhat constructional view in Figure 106. Two fixed coils, B-B′, are wound of coarse wire and connected in the main circuit; a hollow frame of paper is wound with fine wire, like any drum armature, and has its various loops attached to a tiny commutator, e, having silver segments; the brushes, d, are silver tipped. This armature is seen at A between the fixed coils. Its shaft is supported on jewelled bearings, and carries a worm at the top for actuating the train of indicating wheels, and at the bottom a copper disc, f, that is closely embraced by three retarding permanent magnets, M. In series with the armature winding is an external non-inductive resistance, R, experimentally determined for each instrument, and usually also a small coil of wire, in this same circuit, is placed within the field coil; the function of this latter is to give a small torque to neutralize the friction of the pivots and brushes. It is seen that the combination gives a torque proportional to the load, and the dragging action of the permanent magnets in producing eddy currents in the disc holds the speed proportional to the torque.

Some appreciable energy is consumed in the operation of such meters, for the shunt coil and winding represent a continual leak, and that of course a customer eventually pays for in the established rates.

Another form of recording meter that has lately come into prominence, due not so much to its accuracy as to its cheapness, is dependent upon the principle of the induction motor, and is commonly denoted as the "induction" meter. Differing from the other type, it has iron in its magnetic circuit, therefore introducing errors due to hysteresis and change of permeability under differing degrees of magnetic flux. At best the driving torque is very feeble, so the disc is made small and of aluminum, and in the entire absence of friction of brushes the disc actually rotates at a speed proportional to the load. The principle is that eddy currents are induced in the disc by the alternating flux of the fixed electromagnets, and at a time just right to be acted upon by a second flux from another part of the magnetic system and thus produce an actual torque. The explanation is attended with some difficulty, and involves some of the most fundamental phenomena of transformer action.

The actual arrangement of the parts can be gathered from reference to Figure 107. In the elevation is seen a stack of

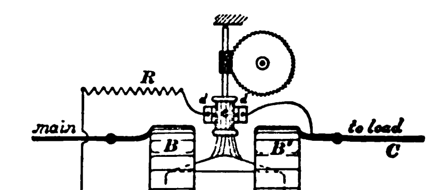


FIG. 106
Diagrammatic View of Thomson Recording Wattmeter

sheet iron, in the shape of a letter E, with poles at B, A, and B′; another stack is close to these poles, and in the narrow crevasse between them the disc revolves.

Pole A is wound with fine wire, and while it has a high self-induction in itself, it is put in series with sufficient other inductive winding so as to be connected without danger, or much loss, directly across the mains. Therefore a current flows through this winding proportional to the voltage of the supply circuit. Further, in consequence of the highly inductive character of this circuit, its current lags approximately 90° behind the phase of the volts. A flux of lines of force through A induces eddy currents in the disc, at a given instant being represented by circles E, and by the principles of induction the maximum value of these eddy currents lags 90° behind the current in this coil. The poles B and B′ are wound with a few turns only of coarse wire and included directly in the main circuit; in consequence of the fewness of these turns there is only a very small lag of its current. There is therefore a flux of lines of force through these poles just in time to experience the eddy currents in the disc, and, by the principles illustrated in Figures 29 and 30 of Chapter VII., to exert on the metal that conveys them a rotative torque. Likewise the flux through poles B and B′ produces eddy currents that could be represented by circles drawn around the poles as centres, and flowing under pole A at just the right time to be acted upon by the flux emanating from that pole. In case there is inductance in the load measured by such a meter, the currents in coils B and B′ will lag to such an extent as to diminish the effectiveness of the torque, and the disc will properly rotate slower. If the current lags in the main circuit by nearly 90°, there will be almost entire absence of current in the disc when there is flux from the poles, and consequently no rotation will be possible. In regular operation there is a "dragging" permanent magnet on the other side of the spindle for producing eddy currents of its own, and retarding the rotation just as in the case of the motor-meter.

The induction meter will run on alternating currents only, while the other sort is equally adapted for both direct and alternating.

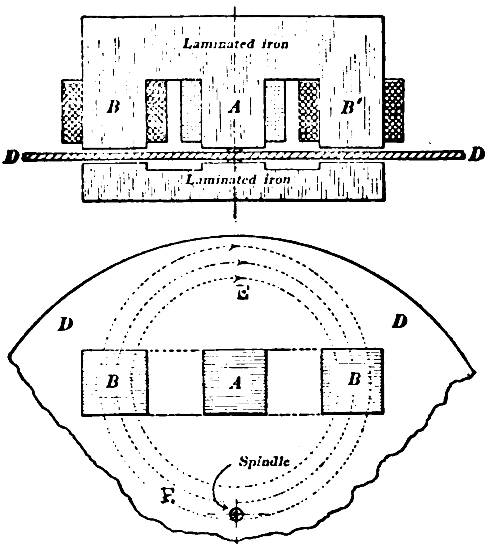


Fig. 107
Disc and Magnet for Induction Wattmeter.

In the most recent types of motor meters attempts have been made to increase the accuracy and sensitiveness by reducing the friction losses; the armature coils are wound open instead of being upon a paper core, and, imitating the historic Thomson-Houston arc dynamo, are made circular in shape. Minimum weight and good ventilation are thereby secured, and by making the commutator only one-tenth of an inch instead of a quarter in diameter, the friction of brushes is diminished. The segments of the commutator are merely stuck to the spindle with very adhesive varnish.

Transportation over the South American mountains is so difficult that the coal imported into Bolivia for the railways' own use costs about $30 a ton. Abundant timber grows in the mountains within fifty miles of La Paz, but transportation is so difficult that trolley poles and lumber for building operations are brought from Oregon, a distance of thousands of miles.

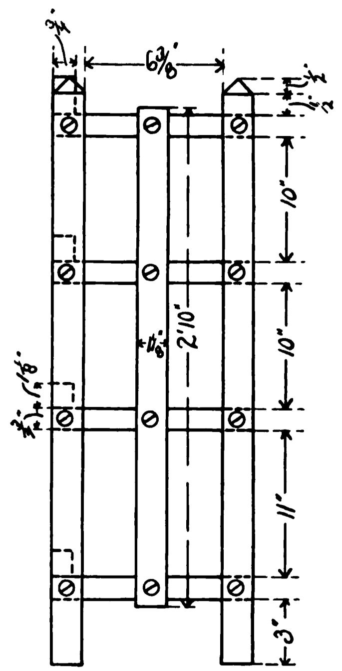
With an outfit consisting of an electric stove, an electric chafing dish and an electric coffee percolator or a teakettle, a family of two or three can keep house with comfort and reasonable economy.

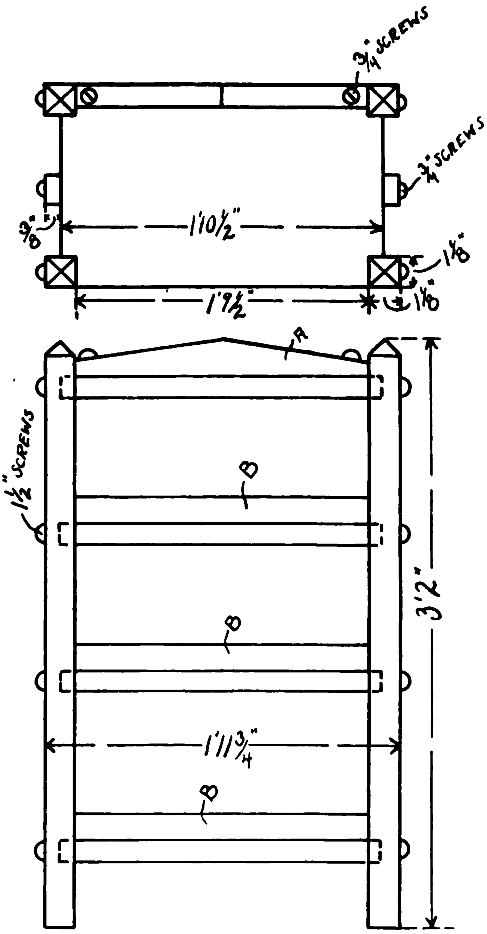
How to Construct a Bookcase

RALPH F. WINDOES

The book case shown in the following figures is one of very simple construction. It is made of quarter sawed oak, and any man or boy at all familiar with tools can very easily produce one. In selecting the wood, be very careful to see that it is entirely free from cracks, and that the wood is not the least bit warped. The lumber should be ordered as follows:

4 pieces 3′ 2¼″ x 1¼″ x 1¼″
2 pieces 2′ 10½″ x 1¼″ x ½″
3 pieces 1′ 9¾″ x 1¼″ x ¾″
4 pieces 1′ 10¾″ x 8¾″ x ¾″
1 piece 1′ 9¾″ x 1½″ x ¾″





Saw and plane it to the dimensions given in the figures, and it is ready to put together. Be careful in putting the screws in, that you do not split the wood, as oak is very brittle. Use 1½″ round headed blue steel screws for the corner posts and ¾″ for the side strips and the top strip on the back, lettered A. The shelf cleats, B, can be nailed in place, as they will not show after the case is put in use.

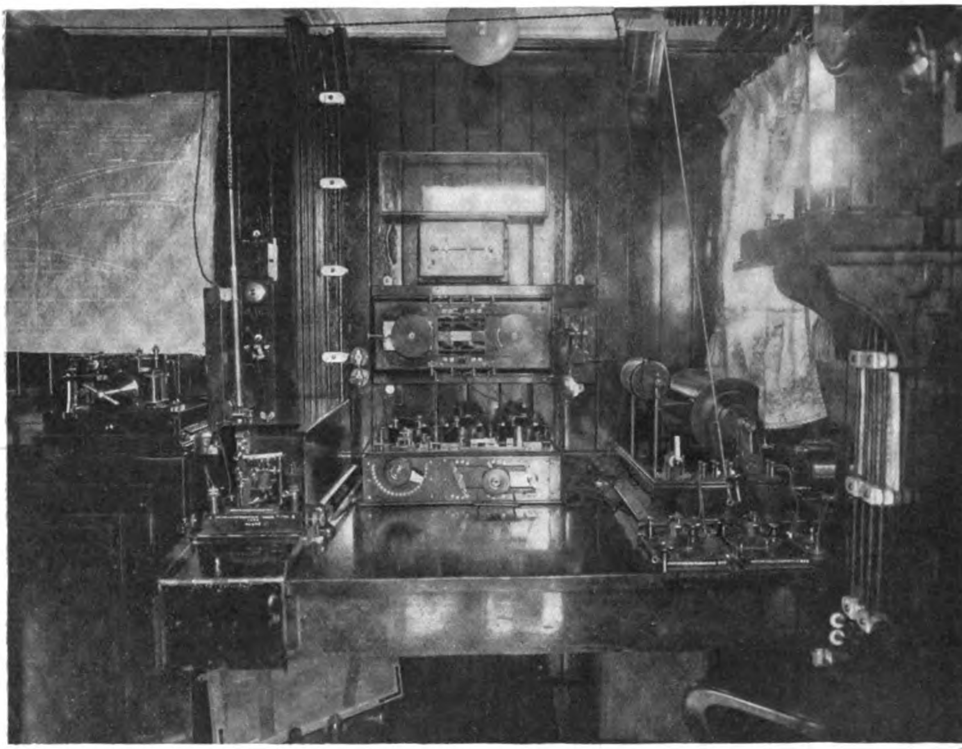
Stain the entire piece and varnish. Another good way to finish it is to stain and wax with some good prepared wax, a number of brands of which are now on the market. An excellent oak stain can be made by mixing lamp black and wood alcohol, and applying to the piece with a brush. After letting it stand a very short time, rub it with a dry cloth, and then apply the wax or varnish.

Louis Grouch (having trouble with the operator) — Hello! Hello! What's the matter! Is there some fool at the end of this wire?"

Operator — "Not at this end."

— *Operating Bulletin.*

The yearly production of aluminum is estimated at 10,000,000 lbs.



THE APPARATUS TABLE IN THE MARCONI CABIN

From left to right are seen: the printer, the coherer, the telephone, the bell alarm, the electromagnetic receiver, the tuner, induction coil, and key

The Wireless Telegraph on the Lusitania

HERBERT M. LOME

When the record-breaking Cunard liner Lusitania raced on her maiden voyage across the Atlantic ocean there were millions of eyes eager to read each morning and evening and at noon-time too, the wireless despatches from aboard the famous ship that told of her conquest of the seas.

But few, if any, had even a faint idea of the genius, the devotion, the hard work that made it possible to send those dispatches through space with such accuracy and precision.

The Marconi wireless "station," to use the technical term, on the Lusitania is the most complete of any to be found afloat, or ashore for that matter, and among the apparatus used are devices which have not yet been introduced anywhere else. With a less complete apparatus it would have been difficult to send and receive the scores of bulletins and messages, both public and private, that sped to and from the ship.

A floating station is manned by from one to three operators, the number depending upon the prospective flow of business. The Lusitania has probably the largest staff afloat, consisting of three persons, a chief and two subordinates. These take turns at the instrument and their "tricks" are divided, according to nautical fashion, into eight hours each. The most important part of the twenty-four hours, that in which the long-distance messages are sent and received—is of course, apportioned to the chief, and he, too, takes command whenever there is a rush of business or when interesting and important news is passing between some station and his own.

The Lusitania, when afloat, takes precedence of all other ships in the matter of obtaining or sending communications. She is in "wireless" as in other senses the Queen of the Ocean. If she desires to speak to any station, no matter if that station is already in touch with some other ship or land station, her wishes must be accepted. She can "cut in" or "cut out" at her own sweet will. If, too, a half dozen different ships or stations are endeavoring to talk to her, she can make her selection from among these, and assign the rest their order of precedence. In other words, she is the wireless autocrat from whose decision there is no appeal.

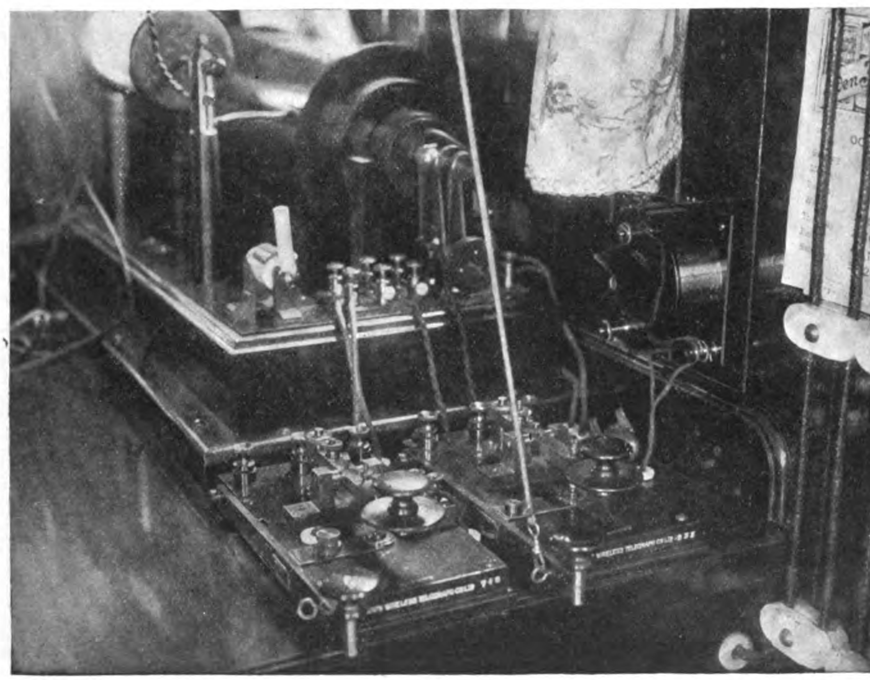
All space is supposed to be permeated by an immaterial fluid called the universal ether. This ether is found in the interior of solid bodies as well as where these bodies are not. Invisible as air, and infinitely more elusive, it has been a question among some whether or not ether is matter. Apparently it does not gravitate, and it does not directly appeal to any of our senses. Still, it is much easier to assume its presence everywhere than to deny its existence anywhere. The familiar experiment of the sealed glass tube which surrounds a vacuum as perfect as human ingenuity can obtain would seem to prove the actuality of ether. It has been shown experimentally that while sound cannot move across the interior of this tube by reason of lack of air, light passes through it and so, too, do radiant heat and gravitational force. If it is true that these last activities cannot be transmitted through absolutely empty space, then *something* must so transmit them. Furthermore, these activities are sent at definite speeds with the aid of the *something*, which is called the ether.

An electrical discharge, such as is brought about by certain of the Marconi instruments, causes undulations in the ether which are known as Hertzian waves and which have the property of promulgating themselves in all directions in accordance with recognized laws. When they come in contact with an appropriate receiver, a portion of them can be caught by the latter and made to record themselves on the human ear through the medium of the telephone, or on paper by an inking or printing device.

Some claim that there is no connection between the "splash" made in the ether by a Marconian discharge on the one hand, and a true electrical disturbance on the other, but that such discharge sets up an ethereal disturbance which results in waves being sent through the mysterious, all-prevading substance, but that these waves are totally distinct from an electrical manifestation proper. Yet for the purpose of both receiving and sending, a station must have an "earth wire," so as to permit of what is apparently the completion of the electric circuit. Hence it is that the antennas or elevated wires on the sending ship or land station throb their waves across space to the receiving antennas, from which they escape via the "earth" into the water and go back to the sending ship. This would seem to prove that the Hertzian waves are electrical impulses of a comparatively obscure form, and that they are not merely ether disturbances brought into existence by electrical bursts or discharges. However, like a good many other matters connected with "wireless," the question is still in dispute.

The devices that catch or send the "waves" are the elevated wires or antennas, which, with their supporting poles or masts, are the most striking features of a Marconi or other wireless station — that is, as far as outside appearances are concerned. There are more than half a dozen kinds of antennas, including the single wire, the multiple wire, the cylindrical, harp, fan and inverted cones, each one of which is named from the shape which it assumes. That on board the big liner is of a comparatively simple nature and is known as the "T-aerial," taking its name from two phosphor-bronze wires, each five hundred feet in length — one thousand feet in all. These wires go from mast to mast, of which the Lusitania has two, hollow and made of steel. The wire is one-quarter of an inch in diameter. It is taken down at the termination of each trip and carefully gone over by the naked hand of the chief operator for the purpose of ascertaining whether the elements have caused a break in the smooth surface that is essential in order to obtain perfect sending and receiving. Also, owing to the proximity of the funnels, there is always a possibility of a burn on the wire from drifting red-hot cinders. All of these may result in little specks or fragments of wire sticking up, which must be filed or otherwise smoothed down. The ends of the wires are fastened to stretchers made of ash wood and 11 feet long, and by means of these with pulleys and shackles the wires are stretched tightly. Each antenna throws forward a "leg" 100 feet long, ending in insulators. As the wires pass through these they are twisted into one single wire which ends in the Marconi quarters. The insulation must be perfect in order to keep the wires from "grounding" or coming in contact with anything which might let the incoming or outgoing "waves" escape.

only a theory and impractical. Both coherer and electromagnetic receiver are to be found on the Lusitania, though the first has been practically discarded as far as daylight use is concerned, for the reason that the receiver is much more rapid than the coherer. Furthermore, the receiver can also detect waves of too weak an electromagnetic force to be detected by the coherer. On the other hand, the electromagnetic receiver speaks to the ear only via the telephone; whereas the coherer not only uses the telephone, but also furnishes a written record of the message received through the medium of a "printer" or "inker" of the Morse type. Still, in wireless



THE 10-INCH INDUCTION COIL, FOR SENDING ORDINARY MESSAGES, AND THE KEYS

An impulse or an oscillation created by sending instruments is received by the antennas and passed into the operating room, where it is detected and registered by one of two instruments. These instruments, as far as the Marconi system is concerned, are either a "coherer" or an electromagnetic receiver. The former is an invention of Marconi himself, and it was chiefly through it that he became famous, as prior to its existence "wireless" was

telegraphy speed and distinctness are everything, and these are furnished with certainty by the new device. One of the coherer's good points is that it can be attached to an alarm bell, by which it can arouse a sleeping operator or give warning of an incoming message.

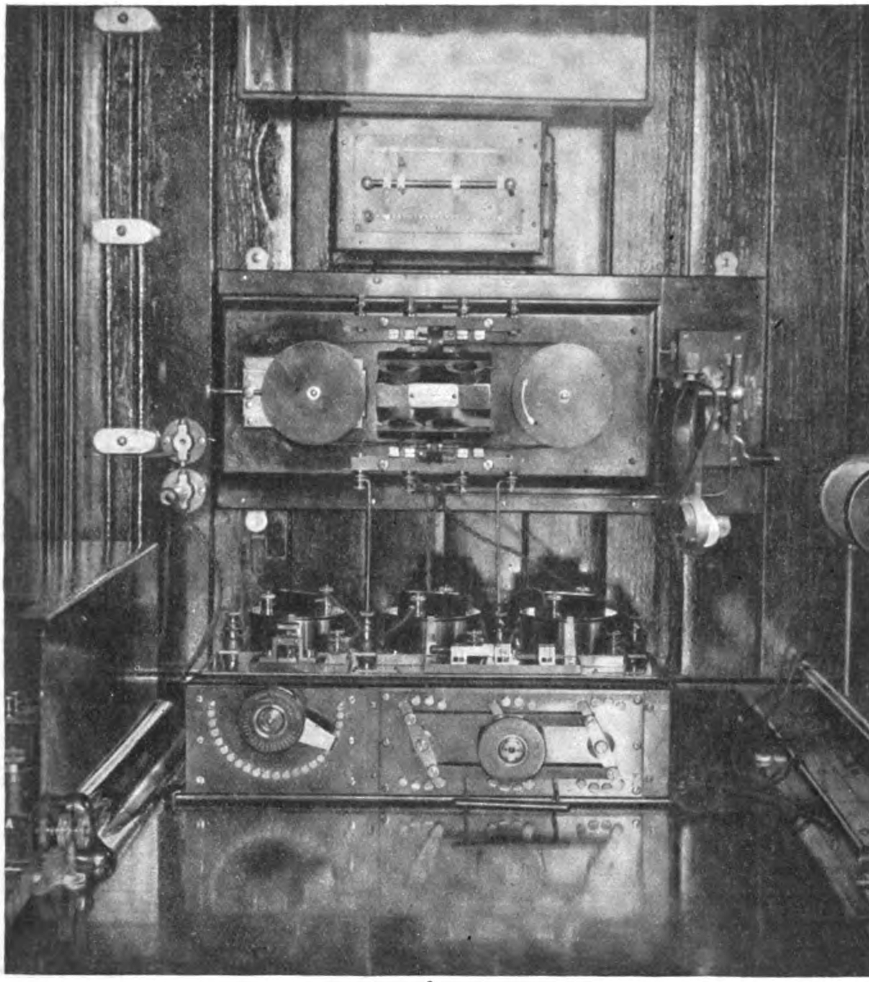
The Marconi coherer has a maximum speed of receiving or sending about 15 words a minute or one-half that obtainable by the electromagnetic receiver. In these days when speed in almost every affair of life seems to be an essential, it follows that the chances of survival on the part of the coherer are but poor. There are various types of electromagnetic receivers, but the one on the big steamer is the most sensitive. It is the result of the genius of Marconi and of some of his colleagues, and is totally different in both construction and principle from the coherer of older days. Instructions for making may be found in the ELECTRICIAN AND MECHANIC for July, 1907. It consists of a flexible, endless band of iron wires which is steadily and unceasingly driven by clock work over grooved ebonite wheels. Midway between, and on a line with the lower edges of these wheels, is a glass tube which is wound about with insulated wire, one end of which leads to the antennas and the other to "earth." Thus we have a little induction coil in which the moving band of iron is the core, the insulated wire just mentioned the "primary," while a "secondary" winding is made perpendicularly over the tube, the ends of which winding are connected to a telephone receiver.

Above the tube and on either side of the "secondary" are two fixed, permanent but adjustable horseshoe magnets. These are so arranged with regard to strength and direction of polarity that the band of iron emerges from the tube with its internal magnetism reversed in an opposite direction to that which it — the magnetism — occupied when it entered. The sensitiveness of the apparatus is increased by the aid of the constantly renewed magnetic instability in the iron band or core, under the action of the permanent magnets. Hence it is that the person using the telephone is able to detect sounds which would be otherwise almost lost to the auditory nerve. This means that the distance at which an operator can send or receive a message is vastly increased — a point of the utmost importance in the case of "wireless."

This receiver can be worked independently of the "tuner" if necessary. The "tuner" is a device which, of itself, would make the Lusitania's Marconi outfit unique and distinctive, inasmuch as it is not to be found in any other station afloat or ashore. The "tuner" plays an important part in the economy of "advanced wireless." The waves brought into force by the Marconi operator resemble those of sound, in that they will only cause a response in a body which is fitted to give off the same number of oscillations or vibrations per second which they themselves possess. Unless, therefore, a receiving station is "tuned to" or normally gives out the same number of waves per second as the sending station, a Babel of sound of an unintelligible nature results. More than that, if a receiving station is in "tune-accord" with two or half a dozen stations which are desirous of sending different messages, the receiving operator will be deluged with a flood of noises each of which confuses the others. In most cases, a ship to which two or more messages by different stations are being sent manages to shut off that one or those with which it is in tune to which it does not wish to speak. But this kind of thing has its manifest disadvantages, as for instance the inability to communicate with those other stations which are tuned up to, or down to, a given wave length.

But the apparatus on board the big liner does away with practically all the inconveniences alluded to. With the assistance of her "tuner," she can not only get into connection with *any* station on sea or land, but she can shut out those other stations that would communicate with her, no matter what the "tune" of these may be. In other words, she can isolate herself and, in a sense, the station with which she is desirous of communicating. A half dozen ships may be violently signaling their desire to speak with her, but these she can ignore, and after having obtained the "pitch" of the craft with which she wishes to converse, she can become entirely oblivious of all others.

The external appearance of the tuner is that of three cylindrical discs connected by a four-way switch. On the right hand side of the case which holds the apparatus, externally and in front, is an arrangement by means of which the lengths of the incoming waves can be ascertained. On the left hand side, and also externally, is an apparatus which informs the operator of the number of micro-henries or breadth of such waves. With the assistance of these two devices



THE ELECTROMAGNETIC RECEIVER AND TUNER
The Lusitania was the first, and is now perhaps the only wireless station equipped with the last named instrument

the length of the antennas of the receiving station can be made equal to that of the sending station, in which, by the way, lies much of the whole art and secret of this tuning business. The receiving operator can therefore "key up" or "key down," as the case may be, to his distant connection. The matter of shutting out other sending stations is also performed by a portion of the "tuner."

The telephones, without which "wireless" would be useless to humanity, are, it need hardly be said, of a most sensitive type. With the assistance of this telephone and the electro-magnetic receiver, messages may be heard at an incredible distance.

One of the features of the telephone is that it has an adjustable diaphragm; this for the purpose of approaching the same to the magnets if necessary. There is also an ingenious apparatus by which the diaphragm can be made thinner. Properly adjusted, the vibrations from the incoming current are rendered incredibly plain by the instrument.

The type of electricity used for producing the oscillations or Hertzian waves which underlie the workings of "wireless," is a form of dynamic-static or, to use the term generally employed, electromagnetic electricity. This is brought into existence by the transformation of ordinary electricity, such as that furnished by a dynamo, a storage battery or a series of primary cells, into the kind desired by means of an induction or Ruhmkorff coil, as it is usually called. The result of sending a current of "ordinary" electricity through the coil greatly increases its "potential." In other words there is a tremendous enlargement of the voltage of the current. Thus, for example, the Lusitania's dynamos yield a current of a comparatively few volts; but after it has been "intensified" by the induction coil or coils of her wireless apparatus, its potential may run up to anywhere from 90,000 to 100,000 volts. This high potential seems to be requisite in order to bring about the needed "splash" in the ether.

There is an enormous waste of energy involved in sending or receiving under current conditions. Thus it has been calculated that only one part in five million six hundred and fifty-five thousand of the power or electromotive force liberated by the sending antennas is picked up by the receiving apparatus.

The term "ordinary messages" is used when the station with which the Lusitania is conversing is distant, say a hundred and fifty miles. Beyond that space, however, "power" is brought into play. This "power" is supplied from a special apparatus which is hardly to be found at any station outside of the big steamer.

The machine room in which this "power" is obtained is simply crammed with the devices needed for producing the current. Within are a "converter," two ten-inch induction coils, a switchboard, condensers, oscillators and a whole array of apparatus which has to do with the "tuning" apparatus, with the aid of all of which it is possible to transmit with ease and certainty to the distances quoted.

Because of the intensity of the spark that emanates from the apparatus in the machine room, as well as in the case of the induction coil used for ordinary purposes, it has been found necessary to have a thick "casing" over the discharging rods of the coils, so as to minimize the noise and reduce the optical dangers which result from the flashes of light.

It is a curious thing that daylight, and bright sunny weather in particular, interfere greatly with the sending of wireless messages. The theory is that the sunlight forms a kind of invisible fog through which the oscillations have difficulty in passing. Dark, still nights are the ideal weather for "wireless," and it is at such times that phenomenal signaling has been chiefly done. The Lusitania with her high-power apparatus in action can converse from five hundred to a thousand miles, provided always that she attempts to do so at night. In the daytime, however, her sending, and for that matter, receiving area, is cut down.

While the Lusitania can isolate herself through the means of her "tuner" as far as any other "station" is concerned, yet she is not quite exempt from the annoyance that arises from atmospheric static electricity. It is this same electricity that is one of the chief troubles of the Marconi operator on sea and land—especially the former.

This form of electricity or "X," as it is known to the men whom it troubles, seems to be subject to no laws and makes its presence known at most inopportune moments. Especially is this true of those ships equipped with the older form of wireless apparatus, with which "X" appears to do very much as it pleases. Its "tone" or pitch is somewhat low. Beginning with a sort of whine, it gradually increases in force until it terminates with a "cough" or "sneeze." Sometimes it breaks right into a sentence that is being received, with the result that the operator loses a number of words equal to the length of the mysterious discharge. Because mainly of this atmospheric electricity, and because too of possible dangers from thunderstorms, every Marconi station is equipped with "a triple node stopper" by which all risks from the latter, and a good deal of annoyance from the former, are eliminated.

The electrical condition of the atmosphere is responsible for a good many freakish occurrences on the part of "wireless." Sometimes messages which are intended for a station comparatively close at hand go astray. For instance, an operator on the steamship Minneapolis sent a message to the captain of the steamship Etruria relative to the weather and so forth. The distance between the two ships was about seventy-five or eighty miles. But the message was received and read and printed on the steamship Carpathia — over one thousand miles away from the Minneapolis. What makes this matter peculiarly remarkable is the printing, for the inking arrangement works with the coherer and this instrument is not supposed to receive over very long distances, much less print that which it receives. Under other atmospheric conditions, one who has the telephone to his ear will not infrequently hear a few words from a far-distant station roll out like a drum-beat, only to die away as suddenly as they came into existence. It is also on record that sometimes the atmospheric electricity will shape itself into a word or parts of words, or even suggest a fragment of a sentence. But the seasoned operator ignores all this, for in the first stages of his work, he learns to differentiate true "wireless" sounds from those that are due to meteorological environment or temporary atmospheric conditions.

The fact that the Lusitania is comparatively free from such interference, marks an important advance in the perfecting of the system. Her apparatus, to the end of eliminating "X," and especially her "tuner," have worked admirably. The personal experiments of the chief Marconi officer on the liner have done much to solve the problem in question. By a re-arrangement of the "legs" of the antennas he has discovered that the interruptions of "X" may be reduced at least fifty per cent., and this, too, in the face of the current reduction of the noises by the other means cited.

After January 1, 1908, and in accordance with a recent edict promulgated by the International Wireless Convention, every wireless "station," no matter where or to whom belonging, must be in a position to communicate with every other "station" within its range. At the present, Marconi stations can communicate only with stations belonging to the same corporation. The new rule, however, will alter all this. In the future, the domain of the air, from an eletcrical standpoint, will not only be open to all, but in addition, there will be no such thing as a monopoly of it for the purpose of sending or receiving aerograms. Under that same rule, too, all stations must be equipped with apparatus which will enable the use of a "wave-length" of two thousand feet — neither more nor less. — *Van Norden Magazine.*

New Jersey Man's Orthopter

George H. Robbins of Newark, N.J., is building a flying machine on the plan of a tricycle. The ship will be operated by foot pedals. It will be thirty-five feet long and attached to it will be aluminum wings, arch shaped, each twelve feet wide and twenty-five feet long. One motion of the pedals, Robbins says, will give double action to each wing, and the flight of the machine will be controlled by wires leading from the handlebars to the ends of each wing, which will be flexible and act as steering propellers. There will be a strip of aluminum three feet wide on an arch over the centre of the machine, by which the operator may turn the machine into a parachute.

The electric transmission of energy is synonymous with electrical engineering, says Mr. B. A. Behrend, in "Cassier's Magazine." It received its first practical demonstration by the transmission of 50 h.p. over a distance of five miles to the town of Soleure, in Switzerland. The success of small plants has inspired electrical engineers with confidence. Long strides have been taken during these twenty years. The world beheld with wonder the transmission of 300 h.p. over a distance of 125 miles on the occasion of the Electric Exhibition at Frankfort-on-the-Main, in 1891. Shortly afterwards the water power of the Niagara River was turned to account, the power being transmitted from the falls to Buffalo and other towns in the vicinity. Now, the power of the falls has reached the heart of the State of New York, as far as the city of Syracuse. The power of Shawinigan Falls is transmitted over a distance of eighty miles to Montreal, and the country west of the Rocky Mountains to the Pacific coast is covered with high-potential transmission lines of far greater length than those of the East.

The Induction Motor as a Phase Converter

C. C. BATCHELDER

Converting from one polyphase system to another having a different number of phases is a problem which can always be solved by the use of transformers, since in the original system there must be two components of electromotive force in quadrature, and by varying the values of these components a resultant of any desired phase can be obtained; but a single phase system cannot be converted into a polyphase system by such simple apparatus, because the quadrature component must be supplied by some auxiliary means.

Also since the energy flow is pulsating in a single phase and steady in a polyphase system, conversion from the former to the latter requires apparatus which can store energy while the single phase input exceeds the polyphase output, and give up this energy into the polyphase system during that part of the cycle when the input falls below the output. In phase splitting devices employing inductance or capacity, an electromotive force in quadrature with the impressed electromotive force is obtained from the reactive drop of the current flowing through an inductive winding, or into a condenser, as the case may be; and the necessary energy is stored as magnetic energy, $\frac{I^2L}{2}$, in the core of the winding, or as electrostatic energy, $\frac{E^2C}{2}$, in the dielectric of the condenser; but such devices are inefficient and costly and are used only for such intermittent work as starting single-phase motors. The requirements are more satisfactorily met by induction and synchronous motors, which, by means of their rotating magnetic fields, can supply the electromotive forces and currents displaced in phase from those of the primary system, and can receive kinetic energy into their rotating parts and return this to the system as electrical energy when needed. Such machines are known as phase converters.

The possible use of the induction motor as a phase converter depends upon the fact, that the magnetic conditions existing in the single phase induction motor when running near synchronism approach those of the polyphase motor; that is, the field of the single phase motor has two components approximately in quadrature as to time and space. So if a motor having a polyphase primary winding be run single phase, there will be induced in the "idle" windings electromotive forces which are dependent in phase upon the angular displacement of these windings from the primary phase; thus, a three phase motor when run single phase gives three phase electromotive force at its terminals; a two phase motor, two phase electromotive force, etc.

The induction motor when used in this manner presents an instance of double transformation, in which energy is first transformed from one primary phase of the motor to the secondary or armature, and from there transformed into the other primary windings, which are known as the tertiary windings. Since the induction motor has comparatively poor regulation as a transformer, due to the unavoidable leakage of magnetic flux in the airgap, it is apparent that this double transformation can be accomplished only at the cost of appreciable loss of voltage, so that the resulting polyphase system must necessarily be somewhat unsymmetrical; the inequality of the resulting voltages depending on the self induction and resistance of the field and armature windings.

Graphically the phenomena may be represented as in Figure 1. Let ϕ_1 be the magnetic flux interlinked with both primary and secondary, or rotor, circuits. Then E_1' is the electromotive force induced by the primary, which must be overcome by an equal and opposite component of primary impressed electromotive force E_1. The quadrature magnetic flux is represented by ϕ_2, nearly 90 degrees behind ϕ_1, and of somewhat lesser magnitude on account of the resistance and reactance of the rotor. The quadrature flux ϕ_2 interlinks with the secondary and tertiary circuits, inducing in the latter the electromotive force E_2. This electromotive force is impressed upon a circuit whose impedance is equal to the sum of the internal impedance of the winding and the impedance of the receiving circuit, and causes a current I_2 to flow. The electromotive force consumed in forcing this current through the inter-

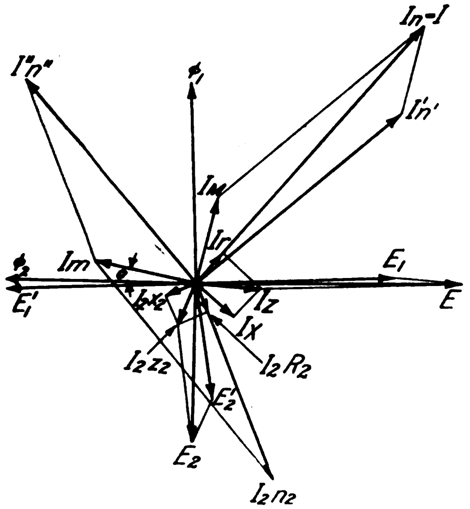


Fig. 1

nal impedance is the resultant of the electromotive force I_2R_2 required to overcome the resistance, and which is in phase with the current and the electromotive force I_2X_2 required to overcome the reactance, and which leads the current by 90 degrees. The resultant internal drop I_2Z_2 when subtracted from the induced electromotive force E_2 gives E_2', the electromotive force at the terminals of the receiving circuit.

The magnetomotive force required to produce the flux ϕ_2 is Im, which leads the flux by the angle *a*, the angle of hysteretic advance. The magnetomotive force of the tertiary winding is I_2n_2, n_2 being the number of turns in the winding. The magnetomotive force of the secondary will be of such magnitude and phase that when combined with the tertiary magnetomotive force, the resultant will be Im; this is therefore represented by I″n″. The effect of this magnetomotive force on the primary is that of an equal magnetomotive force I′n′ 90 degrees ahead of I″n″ in time and space. The phase of this magnetomotive force I′n′ has been determined from the standpoint of the machine acting as a generator; if, therefore, we reverse it, it will represent the magnetomotive force of the secondary as referred to the primary, as an input or motor phase. So reversing a second time to obtain the primary balancing magnetomotive force, we have I′n′ as the component of the primary magnetomotive force required to overcome that of the secondary. IM is the magnetomotive force required to produce the main flux ϕ_1, therefore the total primary magnetomotive force is In. Since, as shown in the diagram, the tertiary magnetomotive force I_2n_2 was drawn equal to I_2, and since in all practical motors the number of turns in the tertiary equals the number in the primary, In=I, the primary current. The primary resistance and reactance must be overcome in forcing this current through the primary winding, and this requires the components of impressed electromotive force IR in phase with, and IX 90 degrees ahead of the current. Adding the resultant of these, IZ, to the electromotive force required to overcome the primary induced electromotive force E_1, we obtain E as the primary impressed electromotive force. The electromotive forces of the quarter phase system are E′ and E″, in Figure 2, E′ being the reverse of E in Figure 1, since the latter was plotted when considering the machine as a motor.

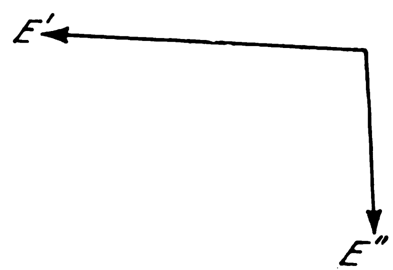


Fig. 2

The phase converter is the equivalent in its electrical and magnetic quantities to a divided circuit represented diagrammatically in Figure 3, where R_1 and X_1 are the primary resistance and reactance respectively, R_2 and X_2 the secondary resistance and reactance, and R_3 and X_3 the same quantities for the tertiary. Y_1 is the primary exciting admittance, Y_2 the quadrature exciting admittance, and Y_3 the admittance of the receiving circuit. Then if I_1, I_2 and I_3 are the currents in the respective branches, the total current input I is $I_1 + I_2 + I_3$ added vectorially.

Let E = voltage impressed on motor, E_1 = voltage across Y_1, E_2 across Y_2 and E_3 across Y_3.

Then, vectorially

$$I = I_1 + I_2 + I_3$$
$$= E_1Y_1 + E_2Y_2 + E_3Y_3$$
$$E_2 = E_3 + I_3Z_3$$
$$E_1 = E_2 + (I_2 + I_3)\ Z_2$$
$$E = E_1 + (I_1 + I_2 + I_3)\ Z_1 \qquad (1)$$

The value of the resultant voltages in the case of a three phase motor is made

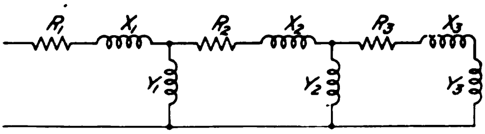


FIG. 3

clearer by a further study of the vector diagram of the quantities involved. Let a voltage E be impressed on the primary phase of such a phase converter (Figure 4). Then a magnetizing current I will flow in the winding. The impedance drop due to this current is IZ, so the voltage induced in the winding is represented by E′. Now the quadrature voltage is 90 degrees behind the *induced* voltage, therefore it is somewhat less than 90 degrees behind the impressed voltage, and the voltage triangle will be somewhat distorted, as shown in Figure 5, even with no load on the tertiary phases. Now as the machine is loaded the current I shifts more and more toward the induced voltage E′, and this throws the impressed voltage ahead of E. This is equivalent to increasing the angle *a*, and it is evident that at some value of the current,

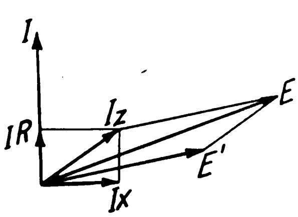


FIG. 4

a, will pass through 90 degrees and the voltage triangle will be distorted in the opposite direction. If the load on the machine be inductive, the current required to make $a = 90$ degrees will evidently be larger than that required if the load be non-inductive, and the opposite is true if a leading current is taken from the machine. Moreover, in the case of large machines with small air gaps requiring relatively small magnetizing currents, with a large angle of hysteretic advance, it is improbable that the impressed voltage E would ever lag behind the induced voltage E′; so that the distortion of the voltage triangle would always be in the same direction, except when a large inductive load was drawn from the tertiary windings. In the case of most small machines, however, this change of direction of distortion is very likely to occur.

The impedance of the tertiary phases results in a further distortion of the electromotive force triangle. Let the voltages induced in the tertiary windings and the voltages impressed on the primary be as shown in Figure 6; this will represent the no-load terminal voltage of the phase converter. As the machine is loaded up the reactance of the tertiary will cause the terminal voltage to lag be-

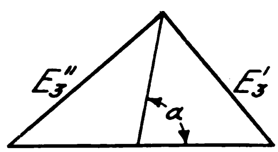


FIG. 5

hind E_3' and E_3'', tending to assume the values and phases indicated by the dotted lines. Since, however, the terminals of the two tertiary phases are connected, and therefore at the same potential, the terminal voltages coincide and give a resultant triangle as shown in Figure 7; where the dotted lines represent the no-load voltage of Figure 6, and the full lines the voltage with load on the machine. This unbalancing can be produced only by unequal division of the current between the two phases, so that in a phase converter with load the current is unequally divided between the two tertiary phases.

For the purpose of calculation, however, it can be assumed without introducing serious inaccuracy that the current divides equally between the two tertiary legs. Under these conditions the resultant impedance drop in the windings, due to the current flowing in the third line, is equal to the product of this current and half the impedance of one winding of the machine, since the current in one leg equals the current in the third line divided by the $\sqrt{3}$, and the drop in one leg must be multiplied by $\frac{\sqrt{3}}{2}$ to give the resultant drop at right angles to the impressed primary voltage: that is, if I= current in third line. $\frac{I}{\sqrt{3}}$ = current in each leg of winding, and $\frac{I}{\sqrt{3}} \times$ (impedance of one phase) $\times \frac{\sqrt{3}}{2}$ = resultant quarterphase drop $= \frac{IZ}{2}$

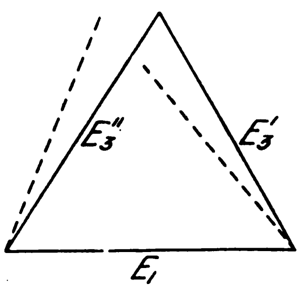


FIG. 6

This expression is slightly inaccurate since it assumes a balanced electromotive force triangle; i.e., an angle of 120 degrees between the currents in the two legs; but since the error is proportional to the cosine of the angle of variation, and not to the angle itself, it is not of very great magnitude.

Therefore, to calculate the resultant terminal voltages under varying conditions of load in the case of a three phase machine, we can proceed as indicated in equation (1) by using for Z, the primary impedance, $\frac{2}{3}$ the impedance of one phase of the winding, and for Z_3, the tertiary impedance, $\frac{1}{3}$ the impedance of one coil; and in the case of a two phase motor, by using the actual impedance of one phase for both Z_1 and Z_3. The angle between the primary impressed and the resultant displaced electromotive forces will be 90 degrees $\pm$ the angle between the primary impressed and primary induced electromotive forces $\pm \sin^{-1}$ (tertiary reactive drop divided by resultant terminal electromotive forces), the latter quantity being represented vectorially by a line from the centre of the primary impressed electromotive force, or base line, to the apex of the electromotive force triangle. In the three phase electromotive force triangle the actual quadrature voltage plotted must be the calculated quadrature voltage multiplied by .866.

In the foregoing analysis the motor slip has been neglected, but its effect on the results is insignificant, as in any practical case it is very small. It acts to reduce the effective quadrature electromotive force in proportion to the cosine of the slip, expressed in electrical degrees; and even for a slip of one tenth this would only reduce the voltage by about one per cent. The slip of a phase converter is not dependent directly on the power output, but upon the power factor as well, as the slip is proportional to the current in the rotor. Thus for small outputs at low power factors, the slip may be as large as for high outputs at high power factors, since the copper loss in the rotor may be as high in the first case as in the second.

The phase converter does not "fall out of step" as an induction motor does, when it passes beyond its point of maximum torque, but it has the same power characteristics as other induction machines, limiting it to a definite maximum

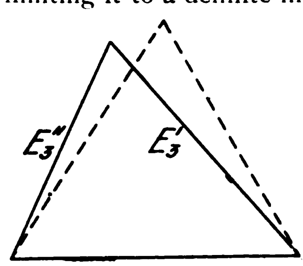


FIG. 7

output. However, when running from a single phase system of large capacity, this limit to the output of the phase converter does not limit the input to the receiving system, as after the maximum output of the converter is exceeded, the apparatus running from it will merely draw more heavily upon the single-phase supply system, and continue running, although under conditions of greatly distorted impressed electromotive force.

The curve Figure 8 shows the results of the above calculations applied to a 600 h.p. 1150 volt quarter phase motor run as a phase converter, and gives a good idea of what can be expected from commer

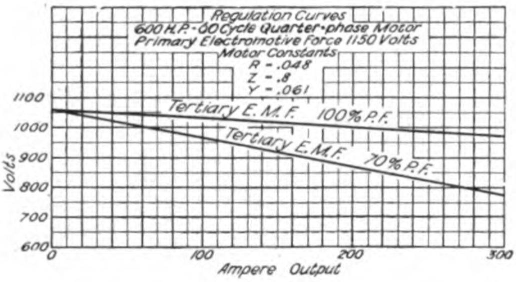


FIG. 8

cial induction motors used in this way. It will be seen that with the machine running light (no load on the polyphase system), the tertiary electromotive force is about 92 per cent. of the primary, and that with 200 amperes output, representing about 400 kilowatts input to the polyphase receiving circuit, the tertiary voltage has fallen to about 87 per cent. of the primary. With 200 amperes output at 70 per cent. power factor, the regulation is, of course, somewhat worse, the tertiary voltage having fallen to about 70 per cent. of the primary. The motor upon which these results were obtained was above the average in size, and on small machines such good results cannot be expected; in the case of a 50 h.p. motor operating as a phase converter, with the polyphase system drawing about the rated power of the motor, the tertiary electromotive force would be about 80 per cent. of the primary electromotive force at unity power factor, and about 60 per cent. of the primary electromotive force at 70 per cent. power factor.

The practical uses of the induction phase converter are necessarily limited on account of this voltage distortion, and in fact, it is little more than an emergency machine. In case of an urgent demand for machinery to supply power to three phase motors from single phase mains, it offers the cheapest and most easily available solution of the problem, and in case a permanent installation is desired, will serve the purpose very well while the requisite motor-generators are being manufactured.

In installations of several single phase motors it has also been proposed to eliminate the use of phase splitting devices for all motors except one, by starting this one with the usual resistance-reactance phase splitter, and then utilizing it as a phase converter for starting the rest of the motors as polyphase machines. One interesting and important feature of such a system has, however, been generally overlooked. If, after being started from the first motor, the others are left connected to it so that all are running in

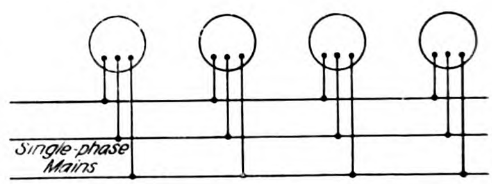


FIG. 9

multiple from the single phase mains, and also have their third terminal connected, as in Figure 9, both the continuous and maximum capacity of the motors will be materially increased, provided the motors are not all loaded at the same time. If part are heavily loaded and the rest are running light or underloaded, the latter will supply power to the loaded machines, enabling them to run as polyphase instead of single phase motors. Such a connection allows the use of smaller motors than would be necessary for handling the load peaks if the straight single phase system were used. — *General Electric Review.*

Airship Harbors in England

The gale which brought disaster to the Nulli Secundus, the first British military airship, taught the officers of the balloon corps at Aldershot a lesson from which they have already profited by recognizing that a mishap during an extended cruise may necessitate a sudden descent some distance from Aldershot, and they have set to work to discover suitable natural shelters, or "aerial harbors," in various parts of the country. A special map has been completed upon which is defined, in red, places which have been specially chosen, such as hollows in woods, shelters at the foot of hillsides and deep gravel pits, where an airship may descend in case of emergency and lie sheltered against a gale. Aeronauts in future cruises will be equipped with this map and should a quick descent be necessary will steer rapidly toward the nearest harbor.

Making and Fixing Electric Bells and Batteries—Concluded

BY M. COLE

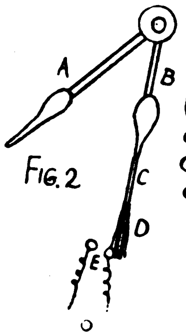
Fixing Push to Wall. Where there is woodwork or lath and plaster there is no difficulty, as it merely requires screwing on, but fixing to a plastered brick wall will be found more difficult, as the nails or screws do not hold well. If there is any wall paper to match that upon the wall the job is much easier, but when the push has to cover all the fitting, greater care must be used, and a large sized push will be required. To fit, cut away the plaster with an old chisel till the bricks are reached. The hole need not be more than two inches square, and should be larger at the bottom than the surface. Provide a piece of wood smaller than the hole, and of the thickness of the plaster, which should also be bevelled to hold better. After removing any loose plaster from the hole, wet the plaster, and having inserted the piece of wood, fill up with plaster of paris mixed with water to a paste. If the plaster of the wall is not wetted, the plaster of paris will not set properly. When the job is dry, the push can be screwed to the inserted wood. This method is both easier and better than the usual way of plugging the wall.

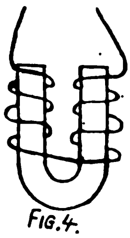
Several Pushes to One Bell. There is no difficulty in doing this. The bell and battery should be placed close together, and *no push between them*. The two conductors, one from the bell, the other from the battery, are joined to a push at the most *distant* part, forming the main circuit. Any number of branch circuits can be made by connecting one wire of the branch to each of the main conductors (of course without cutting the main conductor) at any place, and carrying the two branch wires to the desired point where they are united to a push. These branch circuits may also be tapped, and other branches taken from them. Always fix the most distant part first to form the main circuit, and see how the bell rings through that length of wire. When making branches, complete one branch before starting another, there can then be no confusion.

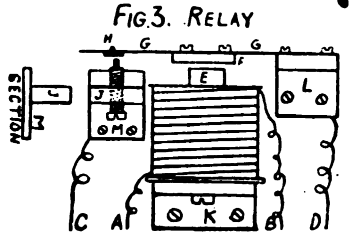
Hole in Wall. When a wire is to be taken through an inner brick wall of a house, there is much less difficulty than with an outer wall. With a long thin bradawl or sprig-bit, try the wall by driving the bit in with a hammer with gentle taps, till the sound and resistance shows that a brick is in the way. Then try again ⅜ of an inch below that, and continue till the layer of mortar between the bricks is met with. This cannot be more than three inches, and if the blade of the bit is thin, the trial holes are not noticeable. Having found the joint, the mortar can be pierced by twisting a screwdriver to and fro, till the crumbling of the mortar before the end of the blade allows the screwdriver to pass the whole of its length through the wall. The screwdriver must be one having a thin round shaft, and larger at the tip than the shaft. A bit of metal suitable for the job is easily made.

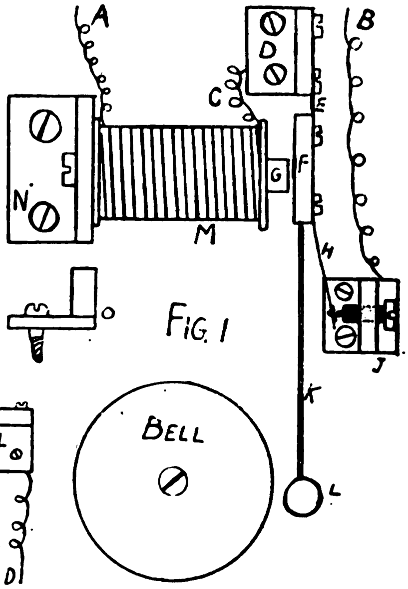
Hanger for Battery. A board ¾ in. thick, 12 inches long, and 8 inches wide is the proper size for this. Cut off the two top corners and make a ½-inch hole about 1¼ inches from the top, to hang the board by. To the bottom edge nail a strip of wood 1½ in. square, or fix a board 4 inches wide by two small brackets, to form a shelf to hold the two cells. If only the wood strip is used, the two cells are tied on with stout copper wire. The bell and battery may be hung close together on a dry wall; they are then both out of the way, yet easy to get at. This arrangement has the disadvantage of allowing the fluid to evaporate quickly, but it is an easy matter to pour in water to replace the loss from a small jug.

Testing for Faults. If a bell has been fitted some time and stops ringing, the cause is probably that the battery has run down. If of more than one cell, take each cell and connect separately to the bell, which it should ring through short circuit, or test the cell by taking a wire from each terminal and placing the ends on the tongue; if any current passes a peculiar taste will be experienced. If the zincs are corroded it is best to replace by new ones. If bell hammer trembles but does not sound, try adjusting the screw, and clean the end of the platinum wire tip of the screw,









also the bit on the spring. If both bell and battery are right, try the push, see that the surfaces that touch when pressed are clean, and if not scrape them. If none of these, the fault will probably be found in the line wire between the push and the bell; see if a staple has been driven in too far so as to cut the insulation. Short circuit the bell at some point between the push and the bell by scraping the insulation off the two wires for $\frac{1}{8}$ inch, and connecting the two with a bit of copper or brass. If this rings the bell, the fault is further away, if it does not the fault is between the test place and the bell. Scrape the ends of the wires where they are connected to the bell, also the surfaces of the binding screws they touch, and screw up again. See if the line wire is in a damp place in any part of the circuit.

How to Make a Bell and Battery. The following instructions show the easiest way of making a bell and battery. The bell is shown in Fig. 1. The parts N, D and J may be made of brass, the thick parts soldered to the thin ones, as shown in section at O. N is a bracket to carry the electromagnet M, the end of the core of which projects at G. It is shown screwed to the bracket, but will do if riveted. The wire for the coil is 20 or 22 B.W.G., silk covered, using about $1\frac{1}{2}$ oz. for coil $1\frac{1}{2}$ long by $1\frac{1}{8}$ outside measure. It is usually wound on a wood bobbin, the stem of which is very thin so as to get the wire as near as possible to the core G. The winding must be very even. In some bells the bobbin is omitted and the wire wound on the core. The armature F is of soft iron; this and the core should be made red-hot, and allowed to cool slowly by burying them in hot ashes. A piece of steel spring, E H, reaches from the bracket D to the contact screw J, and the armature F is screwed or riveted to it. The end opposite to the screw, and the screw itself, are tipped with platinum. This is done by drilling a hole in the screw-end and inserting the wire; the tip for the spring must be riveted to it. The screw J must be so adjusted that when F touches G there is a small space between the two platinum tips. The spring may be made from steel ribbon $\frac{1}{4}$ in. wide, or an old watch spring, which any jeweler will sell for a few cents. The bell may be either screwed down by a short screw — the hollow side being outwards — or screwed by a long screw, using the stem of an empty spool to raise it above the baseboard. The current enters the bell at A, travels through the coil M, the wire C to D, thence along the spring E H through contact screw J to the other terminal B. Binding screws should be fixed to base and the wires soldered to them.

The core of coil is ⅜ inches thick and 1¾ inches long, this allows ¼ inch to project through the reel. Most bells are made with two coils side by side; in this case the two ends of wires from inside the coils are soldered together, and the two outer ones treated as if they were one coil, the coils being placed so that the soldered ends are next to base-bracket. Fig. 4 shows how the wires are lapped when a horseshoe-shaped magnet is used.

Making a Battery. For a Leclanche cell, a flat carbon plate is required, long enough to project 1½ inches above the porous cup. A length of tinned wire should be twisted three or four times round the plate at the top end, and some lead cast on to form a cap to the top end of the plate, which will also protect the wire. The lead must be well coated with black tar paint; the projecting wire will form one of the terminals. The porous cup must be steeped in melted paraffin wax for 1 in. at the top. The carbon plate being inserted in the jar, fill up with a mixture of equal parts of broken carbon (not smaller than peas) and manganese dioxide, then pour some melted pitch on the top to seal it, leaving two small air holes, or insert two bits of small glass tube for the purpose. A zinc rod must be cast for the other pole, a wire being introduced at the same time to form the other terminal. The mold can be made by winding several layers of brown paper on a rod of ½ inch wood, on withdrawing which a tube is left. This should be placed in a jar and surrounded by sand. The zinc can be melted in an iron ladle, and must be pure. After casting it must be amalgamated by dipping in dilute sulphuric acid, and while wet rubbing with quicksilver until the surface has a coating of it; a rag tied to a stick should be used for this purpose. A strip of ordinary sheet zinc can be used instead of the amalgamated rod, but the effect is not so good.

A form of cell easier to make, but not so effective as the Leclanche, is made by tying together with rubber bands some carbon rods as used for arc electric lamps. To one of these a wire is connected by a cast lead cap — the other pole is a strip of zinc, no porous cup being used. The fluid required is 2 oz. of sal-ammoniac dissolved in one pint of water. When a porous cell cannot be procured, a bag of fine canvas can be used in its place, but it is not so durable.

The simplest of all forms of cells is a plate of copper and one of zinc in a jar of water in which a few drops of sulphuric acid have been poured. *CAUTION:* In all cases where water and acid have to be mixed, the acid must be poured *slowly* into the water, *NOT the water into the acid*, or an explosion will occur.

The Relay. Fig. 3. This is most useful when the bell has to be rung through a great length of wire. The relay is an automatic push worked from a distance. The conductors from the distant battery are attached to the terminals A B. The magnet E attracts the armature F, which closes the circuit D L G H J to C and allows the current from a local battery to reach the bell. This is a much better method than using great battery power from a distance, as a very weak current will work a relay which would scarcely have any effect on a bell at the same distance.

Converting Ordinary Clock to Electric Alarm. The easiest way to do this is shown at Fig 2. The hour-hand has a strip of thin steel (painted white) soldered to it, at the end being a small brush of very fine brass wire. The wires from the bell and battery are led to the two small

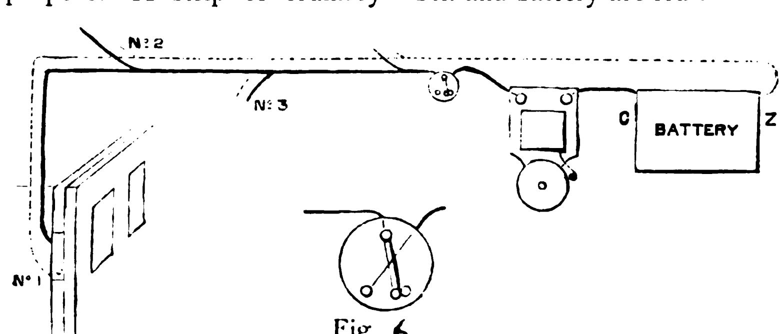


Fig. 6

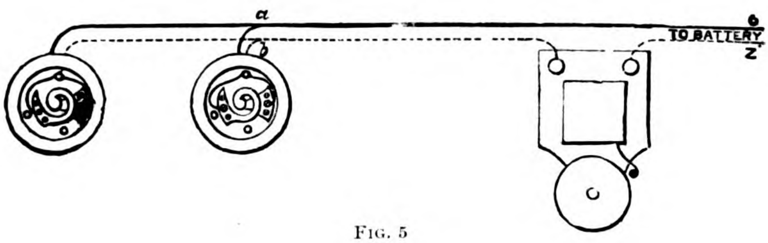


Fig. 5

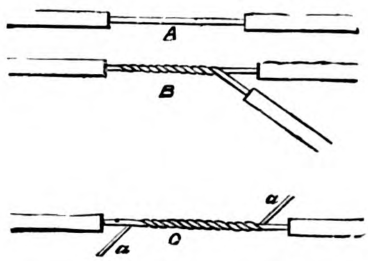


Fig. 7

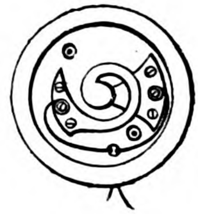


Fig. 9

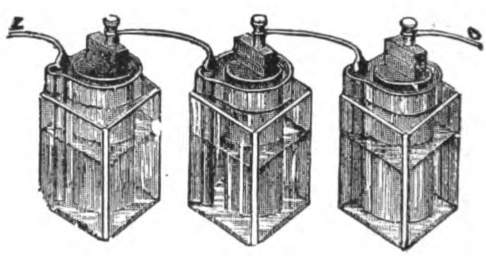


Fig. 8

brass knobs E. At the required time the brass touches the two knobs at the same time and closes the circuit.

Description of Diagrams. Fig. 5 shows the usual method of fitting a bell with its battery, pushes, etc. The battery is not shown in the diagram, as it is here supposed to be placed in a cupboard, or other place out of the way. The pushes are shown with their covers removed.

Fig. 6 shows another method. In this case the conductors are led to a door, in the frame of which is placed a special door contact, which rings the bell when the door is opened. Other shapes of contacts are made to cause the bell to ring as the door is closed. A switch is shown in the circuit near the bell (shown also in a larger size). This as placed, is to cut off all the pushes from the bell, so that it cannot be rung from any of the pushes when the switch is open. It could be placed near the door contact to cut off that one only, without interfering with the action of the other pushes.

Fig. 7 shows how the wires are joined up, A being the wire partly bared. B shows how a wire is branched from the main conductor, the two being well twisted together before soldering. C shows how the ends are to be twisted together in joining wires.

Fig. 8 shows three cells of the ordinary Leclanche shape joined in series, as they usually are for electric bell work.

Fig. 9 gives details of the push (the cover being removed). The two bits of shaped sheet metal form the contact pieces, and in pushes of good quality these are tipped with platinum. One of these lays flat on the base, the other one (the curved piece) is, when at rest, some distance above the straight one, but can be pushed down when required until it touches the flat one, and so completes the circuit The ends of the two conductor wires are seen brought through one hole, and then separating are screwed one to each of the sheet metal contact pieces. The other two holes are for screws for fixing the push to wall. The wires are stripped of their insulation for a little distance from the ends, and scraped clean, but great care must be used that the two wires are thoroughly insulated from each other where they go through the hole in the base. In some makes of pushes there is a special screw to hold each of the wire ends, in others the ends of the wires are placed under the contact piece and held down by screws. The conductors should be of copper 20 or 22 B.W.G., cotton-covered, and well soaked in paraffin wax for indoor work, but where exposed to the weather the insulator must be gutta percha. If for very damp places, the insulation must be indiarubber protected by tape well parafined. For indoor work twin-wires are much the easiest to fix.

Portable sets of bell and battery are very useful for sick-room use, or when travelling: for this purpose dry cells should be used. Two of them fitted in a box that fits them well, and the bell screwed on the outside. The conducting wires can be laid on the ground close to the wall, and under the door. A few staples will secure the wire sufficiently.

Photographic Tiles

Are a decorative use to which the blue print process may be put. Mr. W. H. Smith has demonstrated before the Croydon Camera club the making of imitation Dutch tiles by its aid. The process is cheap, and the paper can easily be prepared at home. The paper used should be freshly made, and should be developed in a suitable acid bath. The paper is first sized with gelatine in the form of cold jelly, which is rubbed into the paper with a pledget of muslin until the sheet of paper lies quite flat and damp. The sensitiser consists of two solutions : (*a*) a 20 per cent. solution of ferri-ammonium citrate, and (*b*) a 10 per cent. solution of potassium ferri cyanide. For use, mix together equal parts of each. Unmixed, the solutions keep well. A small quantity of the sensitiser (about 3 drams for a sheet 26 in. by 20 in.) is poured on the freshly sized paper, and spread evenly with a brush improvised from a piece of celluloid doubled in half with a piece of muslin stretched over it. When the surface moisture has disappeared, the paper may be hung up to dry, after which it is ready for printing. The sensitising must be done by artificial light, and the reason for doing it immediately after sizing when the paper is damp, is that it is much easier then to get an even coating than when the paper is dry. Printing is done in the usual way, and there is a visible image. When taken from the frame, the print is developed either in a 1 per cent. solution of hydrochloric acid, or in a bath of acetic acid of the same strength. The colors given by these two baths differ. Hydrochloric acid gives more half-tone, and so is very suitable for prints from hard negatives. If the paper has been over-printed, it may be dipped into plain water before putting it into the acid bath. Development is complete in a very short time, and then the print may be hung up to dry. For making tiles the prints should be 6 in. square, and great care should be exercised in choosing suitable subjects. The main picture need not occupy the whole tile. Mr. Smith showed many with the main subject occupying the centre 4 in. square, and the inch margin with a geometric design printed from a negative cut out of black paper, and others with the margins merely sunned down in various ways. The print is mounted in the ordinary manner on a 6 in. square of card-board, and this is glued on to a square of wood ¼ in. thick. To complete the tile, it is varnished with an ordinary white paper varnish. The tiles may be made up into panels by having a frame made to fit the number required from a narrow oak picture-frame moulding of a perfectly plain design. The tiles are put into this as a picture would be, and secured in their places with the usual thin backing of wood. For trays, the frame should be furnished with a glass front to protect the face of the tiles, which would otherwise be stained by hot liquids.

A firm in Paris is building twelve flying machines for sale at $6,000 each. They will be floating over our big cities next summer, and will soon be more fashionable than automobiles.

Mission Furniture Construction

I. Easy Chair

WILL B. HUNT, 2D

The art of making his own odd bits of furniture is an accomplishment of which any man or boy may well be proud, and one that at some time will surely stand him in good stead.

To those who have never done work of this kind, or have never been taught, it often seems a herculean task, and rather than spoil good material by attempting to build for themselves, they buy at the furniture stores, thus doubling the cost. But in this great age of ours, when progress is being made by leaps and bounds, many hitherto difficult things have been simplified, and so it is with furniture.

A wonderful stride toward simplicity was made upon the advent of Mission furniture, plans of which will appear in the coming numbers of the ELECTRICIAN AND MECHANIC.

These plans will enable the most inexperienced to follow out his own ideas, or those presented here, for when he studies the details carefully, he will know instantly "which is which," as outline drawings are shown, each accompanied by a number. This is not all, for even though numbered, it might be difficult to know which pieces join and so there is shown an illustration of the made up object with each numbered piece in its proper place.

Could sunlight be clearer?

Now let us make the chair as depicted.

First, buy thirty-five running feet of twelve-inch white wood or cypress (kiln dried). Then lay out your parts on brown paper, actual size, after which place your pattern on your boards and make your outline.

Next, with a saw begin to shape your object. In some cases a key-hole saw will be necessary. After having sawed all your parts, begin the construction, which should be done according to the accompanying numbers. First take No. 1 and fit it into No. 2. Take No. 3 and fit it into Nos. 1 and 2. Then put No. 4 into place and insert No. 5 No. 6 is the arm. This completes one side. When both sides are finished insert No. 7 and No. 8. Screw parts together as indicated by crosses and reinforce with plenty of glue to insure permanency. Glue wedges into place. Where screw heads show, sink the screws deep enough that they may be covered by wooden plug. The back may be of heavy carpeting or burlap, or you may use three boards, as shown by Nos. 10, 11 and 12, set at equal distances from each other, using Morris chair cushion for comfort and beauty. These may be purchased at any furniture or carpet department store and add much to the appearance of the chair, as they may be had in colors to match or harmonize with the other accessories of the room.

If burlap is used, tack it from the back of No. 10 to the front of No. 7, using brass headed tacks and allowing sufficient length of goods for a comfortable seat.

If cushions are used, place slats lengthwise of the seat of the chair to form a support for them.

The woodwork may be stained any decided shade with one of the many excellent wood finishes on sale in paint and hardware stores.

This will be found a pretty and comfortable bit of furniture and has the advantage of being both useful and artistic.

Any question concerning construction the reader may ask will be gladly answered by the writer.

Effect of Different Explosives

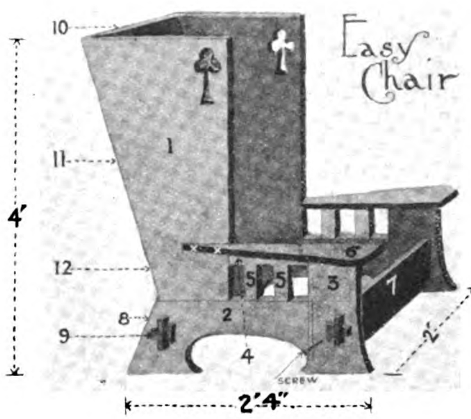
Whether a high-power or a low-power explosive is to be used in blasting, is dependent largely upon the use to which the rock is to be put, as well as upon the strength of the rock itself. Black powder, with its comparatively slow, heaving action, is used where the material is quite friable, as in mining coal or galena, or in excavating shale, hardpan, and similar material. A high-power explosive like dynamite is invariably used in tunnel-driving, shaft-sinking, and open-cut work in tough rock. It cannot be used for quarrying dimension stone, as it shatters the rock.

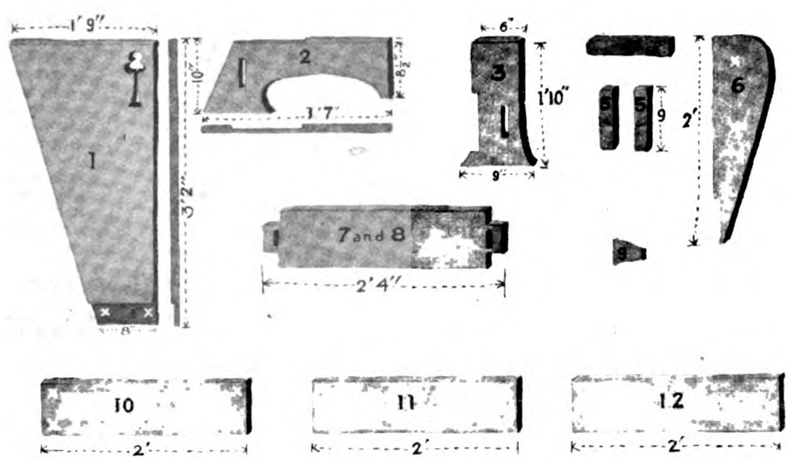
A · SERIES · OF

MISSION FURNITURE

WITH DRAWINGS & TEXT

BY WILL · B · HUNT 2nd





Number One

Wireless Troubles and How to Overcome Them

CHAS. OBEREM

Experimenting with home-made wireless telegraph apparatus possibly offers no greater difficulties to the amateur, than do the problems of chemistry or photography to the beginner; but inasmuch as the great experts who are developing systems of wireless signaling have still a number of important problems to solve, and in view of the fact that hundreds of boys throughout the country are experimenting with and constructing short-range outfits with various degrees of success, the present article (by one of them, 16 years old) will deal with some of the details of construction and operation of wireless apparatus, from the standpoint of boys who know very little of the theory of the art, and who have limited facilities for making the various devices employed.

As the construction of each new piece of apparatus is undertaken the amateur almost invariably fails to get the instrument to perform the required functions, or to act according to the requirements. There are coherer troubles, aerial troubles, ground troubles, battery troubles, and so on until everything is perfected. One of the first troubles an experimenter encounters is, after making a filings coherer, to so arrange and adjust the decoherer that the local circuit will make dashes as well as dots of the Morse telegraph code. In using a filings coherer with nickel filings, the first difficulty is often caused by employing a greasy file, or a file smeared with other foreign matter. It is well to see that the file used is thoroughly clean. If nickel filings are to be used, an ordinary nickel coin may be used. The filings required should be deposited upon a clean sheet of white paper, and then poured into the glass tube as required. In place of the metal filings, carbon particles may be used, and in fact where telephone receivers are used the latter are to be preferred, as they are self-decohering.

Referring to Fig. 1 which shows relay circuit. In adjusting the various parts the student should make sure that the magnets of the relay do not touch the movable armature. By pulling a piece

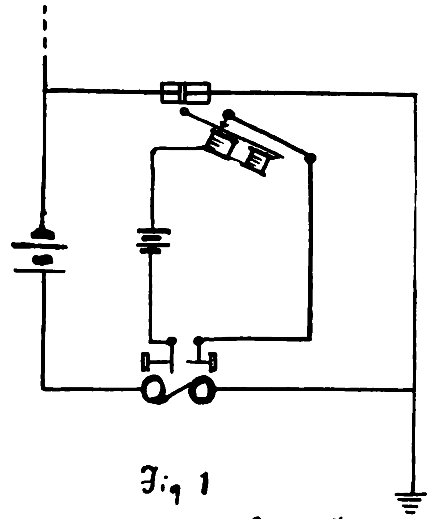
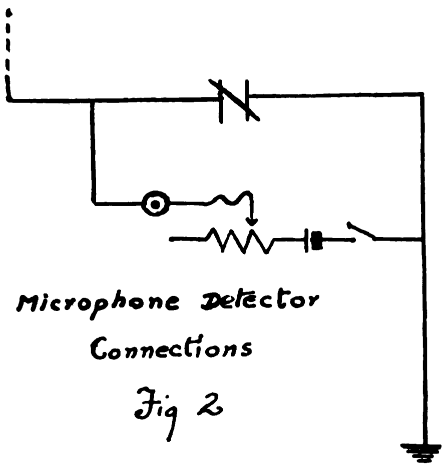


Fig. 1
Receiving Circuits
using Coherer

of paper between the magnets and the armature it may be determined whether the armature is as close as possible to the magnets without touching. The spring tension holding the armature back from the coils should be as light as possible. The platinum contact points controlling the local circuit should be perfectly clean, otherwise there will be an abnormal resistance interposed which the battery may not be able to overcome. In adjusting the tapper or decoherer, one must make sure that the play of the tapper arm is not great enough to allow the tapper to strike the glass tube hard enough to break it, and yet there must be movement enough to give a steady and rapid tapping. Two dry cells in good condition are sufficient to operate the local circuit, and the same amount of battery should be used in the main, or coherer circuit.

Most amateurs very early in their experiments discover that there are more satisfactory ways of detecting Hertz waves than by means of the filings coherer. Fig. 2 shows the theoretical wiring of microphone detectors, using a steel needle placed across two sharpened blocks of carbon, in circuit with a telephone receiver and battery. Care must



Microphone Detector Connections
Fig 2

be taken not to rub the fingers over the carbon edges, as very likely a film of moisture or perspiration will be deposited, which will interfere with the satisfactory operation of the detector. Lack of knowledge in this respect has caused many a lad to give up in disgust. A No. 5 steel needle, free from rust, has about the proper surface area. There are two methods of securing the needle in place and for providing for the correct pressure of same on the carbon edges. One is to use a small weight attached to a silk thread, the other is to employ a permanent magnet conveniently arranged underneath the needle and between the carbons. If the weight is used, a lead bullet about 32 calibre will serve the purpose, and if the magnet is employed make sure that the needle does not touch the magnet. Fig. 2 also shows a small rheostat in series with the telephone receiver, battery and detector, which may have about 50 ohms resistance in steps of 5 ohms each.

The ambitious student will naturally undertake the construction of an electrolytic detector. Fig. 3 shows the connections. Those boys who are constant readers of the boys' magazines and technical journals have seen instructions for making electrolytic detectors.

Generally it is found that after the detector has been made according to instructions and connected in circuit, the resulting signals are either inaudible or very indistinct. Although this is discouraging, it is true that going after the trouble will teach the student more points and give him more practical knowledge than any other instruction possibly could. It may be found that the acid solution used has not the proper proportion of acid; there may be too great a surface of platinum exposed to the action of the solution; there may be an insecure connection somewhere, or the telephone receiver employed may be defective. After every connection has been gone over carefully, and the above hints are observed, this detector will generally give excellent results.

Generally speaking, the transmitter gives very little trouble as compared with the receiver. When an ordinary induction coil is used which gives a half inch, one inch or longer spark, the radiation is satisfactory when a short fat spark is obtained between the secondary terminals, and when the aerial wire employed is of suitable height to cover the distance between the stations concerned.

It is especially essential that the amateur wireless telegraph experimenter become proficient with the Morse code, so that he can send plainly and receive 30 or 35 words per minute. The more expert one is, the easier it is to interpret signals which would otherwise be unintelligible. There are various details which require careful attention if wireless experiments are to be a success, among which might be mentioned the following:

Securely solder all wire joints and connections.

Make sure that aerial wires are well insulated from the ground.

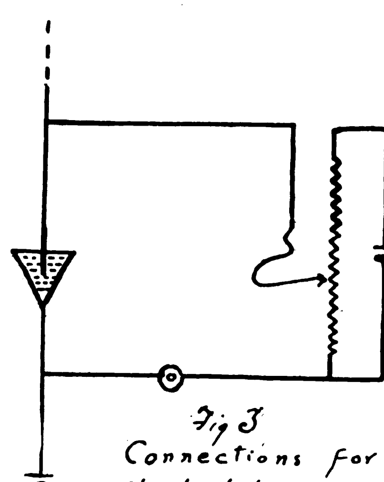


Fig 3
Connections for electrolytic Detectors

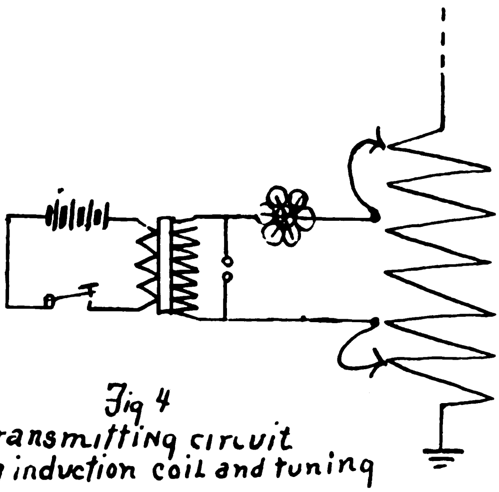


Fig 4
Transmitting circuit
sing induction coil and tuning

Make the best ground connections possible.

Keep all contact points clean and bright.

Keep the brass ball secondary terminals of transmitter well polished.

Do not use oil cloth coverings for work benches.

Use condensers across contact points to prevent sparking.

See that all screws and binding posts are tight.

When heavy currents are used for transmitter, have them properly fused.

Test all fuses to see that they are not open.

Keep your hands and your workshop as clean as possible.

Incandescent lamps make satisfactory non-inductive high resistances.

Inspect dry cells frequently and replace the worn-out ones.

It is hoped that the readers of this article will derive as much benefit from its perusal as the writer has from the notes made during two years of constant experimenting.

Don'ts for Pattern Makers,

Which, however, are good in any shop. They are from *Woodcraft:*

Don't start a job you don't see through, expecting to get an inspiration as you go along. This idea wears out the floor between your bench and the old man's desk.

Don't look as pleasant as a calf's father when the boss gives you a disagreeable job. Do it cheerfully. If you think he is rubbing it in, you can always quit; and if he really is, you had better.

Don't pick out all the snaps for yourself, when you have help on a job. However good you may be—

Don't forget there are others.

Don't despise the help of the apprentice on the job. He did not come in simply to learn to varnish, so let him do things. If he falls down, pick him up, and—

Don't forget you had your troubles, and when you are a has-been, he may help you.

Don't take time to lay out a job, then not use the lay-out; properly used, it will save time on the job.

Don't fail to study economy both of material and time; both cost your employer money.

Don't waste time setting bevels for standard cuts that are arranged for on the saw table or trimmer. A little mental calculation and the indicator is better.

Don't think that you know it all; there are other men who know a little.

Don't do by hand that which the machine should do, but you—

Don't have to wait your turn at the hand-saw to cut off a toothpick.

Don't fail to study your machines and how to get the most out of them, but—

Don't take liberties or long chances with the jointer, especially when the knives are dull; better a few shavings round your vise than a crippled mitt.

Railroad only 317 ft. Long

The shortest railroad in Louisiana—probably the shortest in the United States — runs from Burnside, on the Yazoo & Mississippi Valley Ry., to Houma's Landing, 317 ft. away. The rolling stock of the road consists of an old street car, formerly used in New Orleans. The motive power is a pale bay mule. Capt. P. T. Baden is owner, and the engineer is generally picked from the field hands of a big plantation close by. The line is used to convey passengers from the railroad station to the steamboat landing. The distance is merely a trifle over a block, and passengers never fail to quiz the road and its managment, from the president down to the driver of the mule. No fares are collected.

How to Build a Sixteen-foot Launch

CARL H. CLARK

III. Framing and Planking.

The next step in the building is the getting out and bending in of the frames. These frames are of oak and are ⅞ in. by ¾ in.; the stock should not be too well seasoned, as partly green stock bends much more readily, and is less brittle than perfectly dry stock. The frames should be of sufficient length to extend from the keel to the sheer in one piece; they may sawed to size at the mill, saving a large amount of labor. If a neat piece of work is wanted the frames may be planed and two corners on one of the wide edges bevelled. In order to make the frames limber they are steamed; a piece of iron pipe about 4 in. in diameter, and 4 feet long, with a cap on one end is obtained. A few frames are put into it; and it is filled about quarter full of water and the end put into a fire. The boiling water and steam will make them pliable and easily bent. The frames are to be bent in place 8 in. apart, centre to centre; there being three, equally spaced between each two mould points. The frames should be steamed until they are very limber; they may then be taken out and bent around inside the ribbands, each in its proper place. The end of the frame is to be notched or bevelled where it fits against the keel; at each ribband a heavy cord should be tied tightly around both frame and ribband, or a thin screw may be driven through the ribband into the frame. The ends of the pairs of frames extending above the top ribband should be drawn together with cords, sufficiently to preserve the same curve in the frame as below.

As soon as the frames have "set" in place the planking may be begun. The best stock for planking is probably cedar, as it is very light and durable. It is, however, rather expensive, and is hard to get in good clear stock. Cypress also is a very good stock for planking, as it is reasonable in price and easily obtainable in clear stock and long lengths. In some localities pine may be obtainable and is fairly satisfactory.

The planking, as already seen, is ⅝ in. thick. The stock should be ordered 17 ft. long and not less than 6 in. wide; it is well to have a few boards 8 or even 10 inches wide, as owing to the curvature of each plank a board considerably wider than the finished plank is necessary.

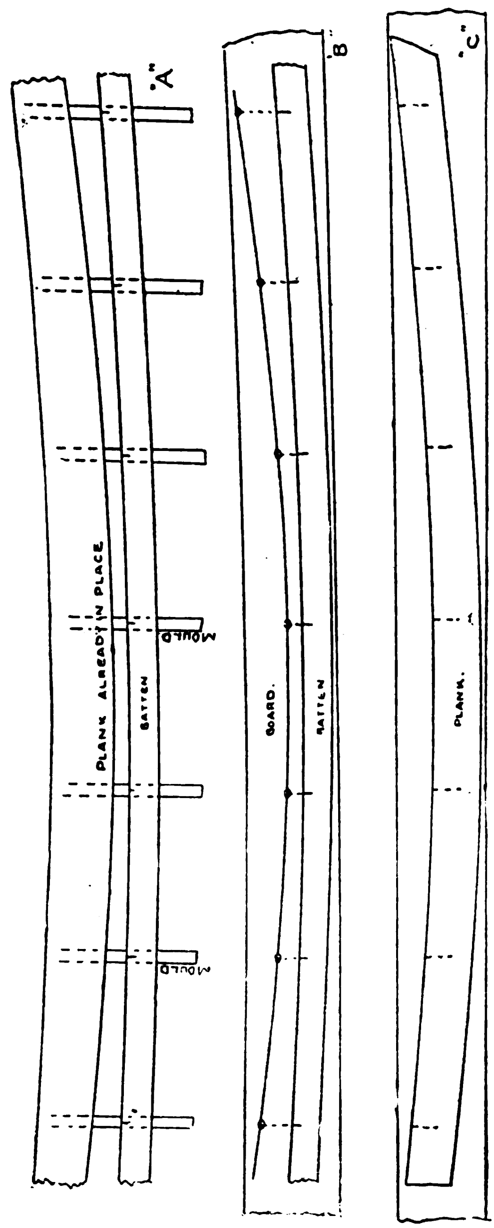


Fig. 8

In beginning the work of planking it should first be made sure that all frames bear evenly against the ribbands, and that the entire surface is "fair" and even; any irregularities should be corrected. The girth around each mould from the sheer to the keel should now be measured and divided into the same number of equal parts; those on the No. 3 mould being about 5 in. These divisions should be marked on each mould in pencil for help in planking.

The top strake may be put on first, as it is perhaps the easiest to fit, and will stiffen the boat somewhat. The top edge of this strake should be 5/8 in. below the sheer line as laid out on the brown paper, to allow for the thickness of the deck, as the deck laps out over the top strake. The easiest way to fit this top strake will be to clamp one of the boards around the boat in the proper position and mark on it at each mould the proper point. The board may then be taken down and a line run through the points with the batten. The curve is cut out and trimmed up; it may then be fitted in place again and any necessary alterations noted. Great care should be taken with the top edge of this plank, as it makes the sheer line of the boat and it must be fair and smooth. As soon as the upper edge is satisfactory the width of the plank on each mould may be laid off according to the widths marked on the moulds; this gives the outline of the lower edge, which may be run in and cut to shape. The forward end of the plank is now to be fitted into the rabbet on the stem and cut to the proper bevel; at the stern it may be allowed to run by, to be trimmed off later. This plank should be used as a pattern for the top strake on the other side, saving much fitting.

For holding planks or other pieces temporarily some iron screw clamps will be necessary — they should be 6 or 8 inches across the opening so as to allow them to be hooked around the moulds to draw the plank up into place. About a dozen should be provided.

The top strake can now be fastened in place, being held firmly in place by the clamps during the process. There are several styles of fastenings that can be used, according to the grade of boat it is desired to build. In some cheap boats nails are simply driven through the plank into the frame; while this will answer well enough for a heavy boat it is hardly suitable for a light boat such as this one. A very good fastening may be made with brass screws; they should be about 1 1/8 in. long and of rather heavy wire so as to be strong. In driving the screw a hole of the same size as the body of the screw is bored through the plank and countersunk on the outside for the head. Another hole the size at the root of the thread is then bored into the frame. The screw is then dipped into lead or soap and driven up tightly. Care must be taken not to twist off the screw while driving. When well done, this style of fastening is very durable and satisfactory and is much liked by some builders. The best form of fastening on the whole is of copper nails and burrs. A copper boat nail about 1 3/4 in. long is used. A hole is bored through plank and frame of such size that the nail may be driven home without danger of splitting the frame. A small washer or burr is then driven on the point of the nail; the point is then cut off leaving about 1/8 in. to be riveted over. A "rivet set," a sort of hollow punch, will be found handy for driving the burr down the nail. Some heavy piece of iron must be held against the head of the nail during this work and during the riveting over which follows. The projecting point of the nail is riveted down on to the burr, and not simply clinched. The parts must all be snugly together before riveting.

In planks of the usual width, about 5 in., a fastening should be driven about 3/4 in. from each edge and one in the middle. This is repeated on each frame. In narrower planks the middle rivet is omitted, and in unusually wide ones four rivets are used.

After the top strake is fastened in place, the strake below may be fitted. There may be considerable curvature to this plank and other means for getting its shape must be used. Fig. 8 shows the method of obtaining the curvature. A batten is prepared from a piece of 3/8 in. stock, 17 feet long and about 4 in. wide, and fairly straight on the edges. This batten, as shown in sketch "A" is laid around the frames just below the strake already in place, being allowed to bend naturally; it is then clamped lightly in place. The points where it crosses the moulds are now marked on the batten, and at each of these points the distance is measured from the upper edge of the batten to the lower edge of the plank above. The batten is now taken down and laid on the board from which the plank is to be cut. At each mould point marked on the batten, the distance just measured to the edge of plank above is now laid off, as in sketch "B." This series of points gives the outline of the upper edge of the plank, which is struck in and cut to shape. The relative widths of this plank at the several moulds may now be judged by reference to the spaces marked off on them; these widths are laid off and the shape of the plank is obtained as in sketch "C." This edge may then be cut out, allowing perhaps ¼ in. for fitting. The plank is now put into place on the frame work and fitted at the stem and wherever else necessary. The joints between the planks should be as close as possible all along on the inside, but on the outside should be a trifle open to admit the calking.

The garboard strakes should next be fitted. These strakes do not run up to the stern, but will taper off and stop somewhere near mould No. 5. As this plank has a considerable curve and twist, it may be well to fit a thin board first and use it as a pattern. The general process of fitting the garboard is the same as above described except that a considerable amount of fitting will be necessary. These garboards cannot be fastened to the frames at present, as the heels of the frames are loose; screws may be used and the plank fastened temporarily to the moulds. At the stem and stern all planks are fastened with brass screws.

It will be found convenient to fasten each plank temporarily to the moulds with slim screws, as it will stiffen the whole. The next plank above the garboard is now fitted, and the remaining planks may be fitted, working from the garboard upwards and from the sheer downwards, leaving a strake at the turn of the bilge to be fitted last. The several strakes should be left about the same width at the middle of the boat, and taper equally and evenly towards the ends.

There will be some planks which will not cut conveniently in one length. The joint or "butt" between the two parts of the plank should not be made on a frame, but midway between two frames. A piece of the plank somewhat wider than the strake is fitted between the two frames, and the ends of the two parts of the plank are brought together and fastened to it with screws or copper rivets. The edges of this butt block are bevelled on the inside. The butt in any plank should not come near the middle of the boat, but as near the ends as possible. When adjacent planks have butts, these should be placed at opposite ends of the boat and as far as possible from any other butt.

The heels of the frames may now be secured; pieces of frame about 15 inches long are steamed and bent in across the keel and on top of the two opposite frames. A long nail is driven through this "floor" into the keel, and it is fastened to the frames by long rivets driven up through plank and frame and riveted on top of the floor. These floors tie the two sides of the boat together and greatly stiffen it.

When all the fastening of the planks is completed, the moulds may be removed one by one, and frames and floors bent and fastened in their places. As fast as moulds are removed, braces must be fastened across the boat to hold her in shape.

The outside of the boat is now ready for rough jointing. A smoothing plane is used and the projecting edges of the planking planed down to a fairly smooth fair surface. The projecting ends at the stern are sawed off and planed down even with the surface of the stern board. The flat of the stem from the forefoot up should be bevelled off to follow the line of the plank, leaving a face about ¾ wide on the forward side for the stem band. The projecting square corner of the tail piece under the overhang also is rounded down to follow the contour of the boat.

If the boat is being built in a cellar or other warm place, the planking should be given a good coat of linseed oil to prevent its shrinking and opening the seams.

The boat is now ready for the deck and interior, which will be next described.

Build your boat now, while the weather keeps you indoors. Then you will have it ready for use next summer, when the shady pools and quiet streams invite.

Electrography, or Phototelegraphy

Sending Photographs by Wire

It is over thirty years ago now since Willoughby, Smith, and May discovered, more by accident than otherwise, the extraordinary power possessed by the metal selenium of varying in its electrical resistance, according to the amount of light which falls on it. These men were using it as a resistance in laying Atlantic cables, and its constant variability indicated before very long that its electrical properties must be subject to the influence of light.

Professor Korn, of the Munich University, conceived the idea of utilizing

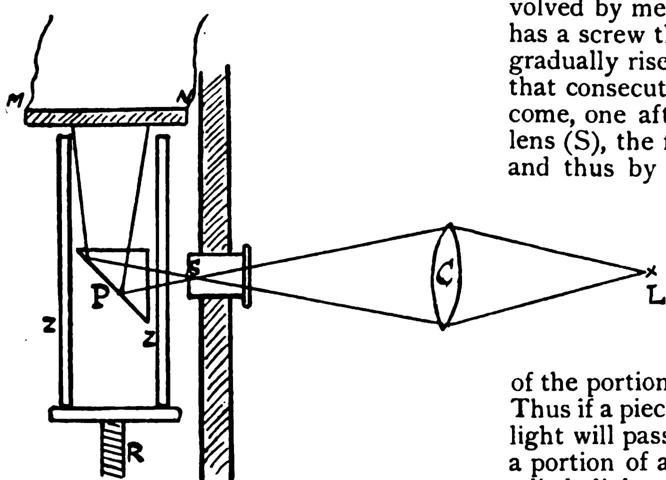


FIG. 1

this property for the transmission of photographs from one place to another some distance away, and after six or seven years of constant research and experimental work, he has succeeded to such an extent that photo-telegraphic stations have now been set up in Berlin, Munich, Paris, and London—the two latter cities being the very last to be fitted up with an installation.

It is, of course, quite impossible to transmit a photograph in its entirety from one place to another, and as this is the idea which always first presents itself to the mind, it must be discountenanced before we examine the actual method of transmission.

Two instruments are necessary for the sending of an "electrograph," — the transmitter and the receiver; and we shall now describe, in as simple language as is possible, the plan on which each is constructed.

The transmitter consists of a glass cylinder (ZZ, Fig. 1), round which the film-photograph to be sent to the receiving station is wound, and this is rotated by means of an electro-motor. It is enclosed inside a wooden box, through the front of which is an aperture containing a small lens (S), through which rays of light from a powerful Nernst lamp (L) are concentrated by means of the condensing lens (C). The cylinder is revolved by means of an axis (R), which has a screw thread, so that as it turns it gradually rises in height. The result is that consecutive tiny portions of the film come, one after another, in front of the lens (S), the film having a spiral motion, and thus by degrees the whole of the photograph passes behind the lens (S). The pencil of light, therefore, which meets the film and passes through it, is more or less diminished in so doing, according to the density of the portion of the film which it meets. Thus if a piece of white sky be at S, much light will pass through the film, whilst if a portion of a deep shadow be at S, only a little light will get through.

Now within the cylinder is fixed a prism (P), so arranged that all the light which passes through the film is reflected upwards on to MN. MN is nothing less than the metallic selenium "cell," through which the electric current is passing which is sent to the receiving apparatus. A special battery is used to supply a current of two hundred volts, and this current is first passed through the cell (MN) and then, via the telephone lines, is sent along to the receiving apparatus. The selenium cell offers a tremendous resistance to the current, but this resistance varies with every variation in the light which is being reflected on it by the prism (P). It is thus at once seen that what is *sent out* by the transmitting machine is a number of successive changes of electric current, and these travel along the telephone wires, a hundred, or even a thousand, miles—and these are all that is received at the receiving station.

Next let us consider the receiving machine. In this, a diagrammatic idea

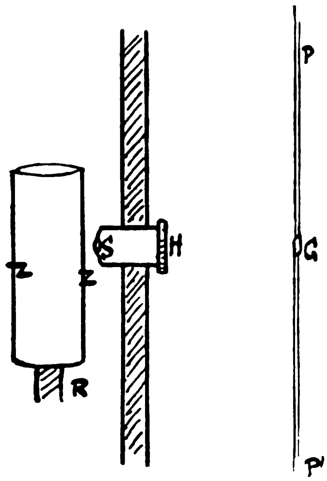


FIG. 2

of which is given in Fig. 2, we have a revolving ebonite drum (ZZ), enclosed in a light-tight box, through the front of which is a small lens (S). On the lens tube of S is concentrated a powerful beam of light from a Nernst lamp (L), by means of the condensing lens (C). But between the source of light and the revolving drum is placed a very delicate galvanometer, which consists of a powerful electro-magnet (not shown in the diagram), between the poles of which are two exceedingly fine silver wires (PP). In the centre of these is stuck a small square piece of magnesium foil (G), which just casts a deep shadow over the hole (H). An unexposed sensitive film is wrapped round the drum, which revolves with a spiral motion, in a similar manner to the transmitting drum. Now when the shadow of the magnesium foil (G) covers the hole (H), no light can fall upon the revolving film; but if G were removed to one side, the shadow would fall to one side of H, and a pencil of light would immediately fall upon the film, concentrated to a point by the small lens (S). And this is precisely what happens when an electric current flows through the galvanometer wires (PP').

The current which is sent from the transmitter is received by the receptive machine in these galvanometer wires, and as it varies, so the distance to which the foil (G) is shifted aside varies. Thus if a portion of a sky, or high light, be transmitted at a given moment, a strong current will be received in the galvanometer, and G will shift right to one side, and so allow the full light to fall upon H. But if a shadow is being transmitted at another moment, then the current sent to the receiver is weak, G is only slightly shifted, and the film only slightly exposed. Thus the shift of G corresponds precisely to the amount of current sent off each successive instant from the transmitting machine.

It will perhaps make matters still clearer if we add that should the foil (G) be shifted to one side throughout the whole time the film is exposed, on development we should merely get a series of parallel lines, which—if the developed film were once again affixed to the drum—would resolve themselves into a continuous spiral or helical line. In reality the lines are only a very small distance apart, and are barely noticeable if the film be examined from a distance.

The receptive film gives, on develop-

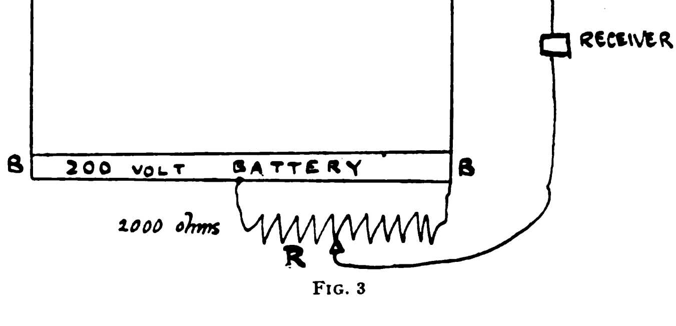
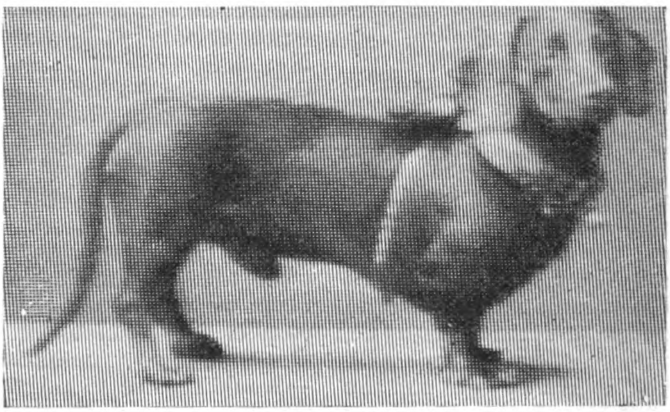


FIG. 3

ment, a negative if a positive has been transmitted, and *vice versa.* In order to minimize faults, it is made only one quarter of the size of the transparency used for transmission, and is $6\frac{1}{2}$ x 12 centimetres, the latter being 13 x 24 centimetres.

We have thus far merely got a general idea of the principle of transmission and reception of the tele-photographs, but it is in the many ingenious and delicate adjustments that the greatest interest will be felt. In order to get really good results it is necessary to, in the first place, compensate for the deficiencies of the selenium cell, as its changes in electrical resistance, with abrupt changes in the intensity of the light falling upon it, are not themselves abrupt enough; but the movement "lags," and this tardiness in response to the light changes would be fatal to the working of the instrument. A second "compensating" selenium cell therefore is used in conjunction with the first, and its resistance and inertia are the reciprocals of those of the first cell. The two are used in series, and for those of our readers who take an interest in the strictly scientific side of the matter we give a diagram — Fig. 3 — showing the exact arrangement. Here BB is the two-hundred-volt battery, half of which is put in shunt with the resistance (adjustable) R, and the other adjustable resistance (R′) is in shunt with the two selenium cells. By varying the two resistances, it is possible to get the most beautifully precise action in the movement of the cells with abrupt changes of light, and to this arrangement is due the real success of the instruments.

Secondly, the two revolving cylinders must turn synchronously. At the end of each revolution of the transmitting cylinder, an electric contact automatically arrests the movement of the receiving drum at the other station, just for an instant, the latter turning just a trifle more quickly, and thus arriving at the end of its revolution first. At the beginning of the next revolution a further contact on the transmitter once again releases the receiving drum, and once more the two revolve in unison. This is worked by means of an extremely sensitive electric relay, and is of primary importance in the working of the method.



A Korn Electrogram, Exact Size, as Telegraphed from Paris to London in Twelve Minutes

The speed of the motor is ascertained by means of a frequency meter, which works in conjunction with the electric motor which drives the cylinders, and each machine being provided with a similar instrument, it is quite a simple matter to ensure the rates of working being correct.

Professor Korn has now been six years working on his instrument, and it is now very different in design from the earliest ones. At first he used a vacuum tube in the receiver, whose amount of illumination was regulated by the currents received from the transmitting machine. The first experiments were carried out between Munich and Nuremberg, and the time of transmission was something like thirty-five minutes. At present the time is twelve minutes, but by using a special thread on the spiral axis of the

The Crown Prince of Prussia. Exact Size, as Telegraphed in Twelve Minutes by Prof. Korn's Process

cylinder it is possible to make it rise twice as high in each revolution, and thus the time is reduced to six minutes. The lines in the photograph are then twice as wide apart as they are ordinarily, but with photographs of heads this does not greatly matter.

Recently the first photographs were sent from Paris to Berlin, and from Berlin to Paris; and on November 7, in the presence of a large number of invited visitors, the first experiments through submarine cable were made at the office of the *Daily Mirror* in London. Seeing that the French authorities had only granted facilities for using the cable between Paris and London an hour or so before it was required, and therefore no complete test was possible previous to the public demonstration, it is perhaps hardly fair to criticise the results which, we venture to think, have been described with, to say the least of it, a little excess of enthusiasm in the *Daily Mirror* recently. We alone witnessed the development of the first result transmitted from Paris to Whitefriars Street, and this was shown to some three or four independent witnesses, and for the present it is obviously necessary to reserve one's opinion as to the practicability of Professor Korn's invention as now installed in London.—*The Amateur Photographer.*

Advice to Inventors

The old maxim that "A little learning is a dangerous thing" is especially applicable to inventors, as may be seen upon investigation of the patent office records in relation to almost any branch of industry. For example, the records of patents granted on "improvements in brakeshoes" show one case where a patent was for a brakeshoe provided with oilways on the face and with an oilcup mounted on the back of the shoe, the idea being to lubricate the rubbing surfaces in order to prevent rapid wear of the shoe. Another patented brakeshoe was designed to have a set of rollers on the face so that the anti-friction bearing thus provided would greatly reduce the wear of both shoe and wheel. Naturally the patentees of such devices would believe that failure to adopt them was due entirely to prejudice, and perhaps it will be found that the investigation which it was announced some weeks ago was to be undertaken by the block signal and train control board under the direction of the interstate commerce commission into the charges that an association of manufacturers had combined to suppress meritorious patents which would result in the improvement of operating conditions on railroads, was instigated by promoters of devices analogous to the brakeshoes cited. Those who have even the slightest acquaintance with the vast sums of money which the manufacturing concerns of America are spending on patents which promise well, but which turn out to be worthless, find absurd the suggestion that meritorious inventions are deliberately suppressed. — *Editorial in Railway Age.*

Remember, when you make a photograph, that almost any amount of over exposure can be cured in development, while if you under expose, no after treatment can ever produce anything but a chalk and soot effect.

How to Build a Small Model Undertype Engine and Boiler

HENRY GREENLY

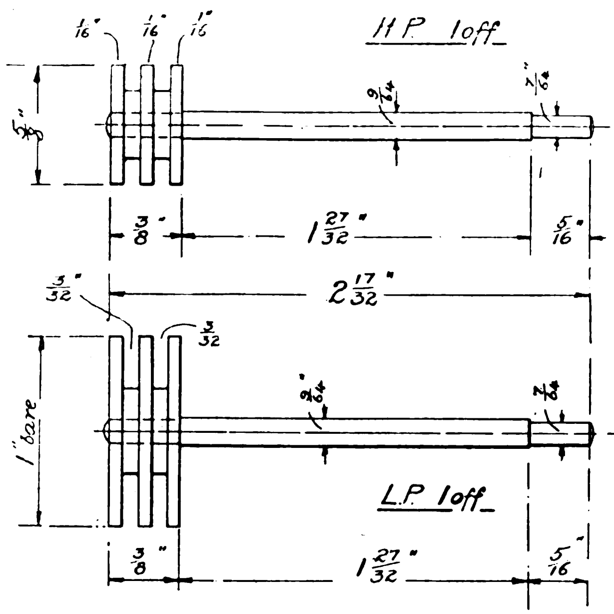


FIG. 21.—PISTONS AND PISTON-RODS.

V.—PISTONS AND PARTS OF MOTION.

The drawings with this instalment of the articles include pistons, piston-rods, cross-head, slide-bars, and connecting-rods.

Seeing that there is some difference of opinion in the matter of piston rings for model cylinders below ¾ in. diameter, the writer would advise those who do not care to experiment with rings for the high-pressure cylinder to fit a plain grooved piston to this cylinder. The packing may be asbestos or darning cotton, and where the device described by Mr. C. Blazdell of coiling a piece of clock-spring in the groove and wrapping the soft packing round it, is not adopted, two deep grooves may be employed, as shown in Fig. 21. As the end of such packing generally gives trouble, a darning needle with the fibrous material threaded in it may be used and at the last turn the end of the string may be "sewn" under the previous coils and trimmed flush with a pair of scissors. This done, it will be found that the piston will enter the cylinder without difficulty, and the end strand will not lap over the body of the piston and cause the latter to jam in the bore.

As the model is a compound engine, and leakage in the h.p. cylinder simply means increased forward pressure on the l.p. piston, a pair of piston rings may be fitted to the latter, the h.p. piston being simply packed with fibrous packing, in two grooves, as shown in the drawings.

As to materials. Cast iron being used for the cylinders, either steel, phosphor bronze, or brass rings may be employed. The latter is the easier material to work up. The rings are rather too slight to be successfully made in cast iron. In any case, the writer does not recommend a solid piston with rings sprung over it, as in a petrol engine, as trouble may ensue owing to the rings being unduly stretched in the process of springing them over.

It is always wise to make such a small piston in separate parts. One method is shown in the accompanying full-size drawing (Fig. 21). The piston may seem complicated, but being for the most part all lathe work, the model engineer should find it not an unpleasant task to make. The two halves may be made from castings, the pattern providing for the parting down the centre. The back ring should be made a driving fit in the piston-rod—that is, sufficiently tight to enable it to be skimmed up without recourse to soldering it to the rod. The other half should be tapped to take the thread on the rod and should be recessed for the locknut. Having marked the position of the two halves when screwed up tight, the front (that is, the tapped) part may be removed, after having taken a cut off the periphery and turning the groove for the solid ring shown in the drawing. The function of the solid ring is solely to form a distance piece for the Ramsbottom rings. This distance-piece should have no longitudinal shake when the parts are fitted together, but should not prevent the two halves of the piston from taking a bear-

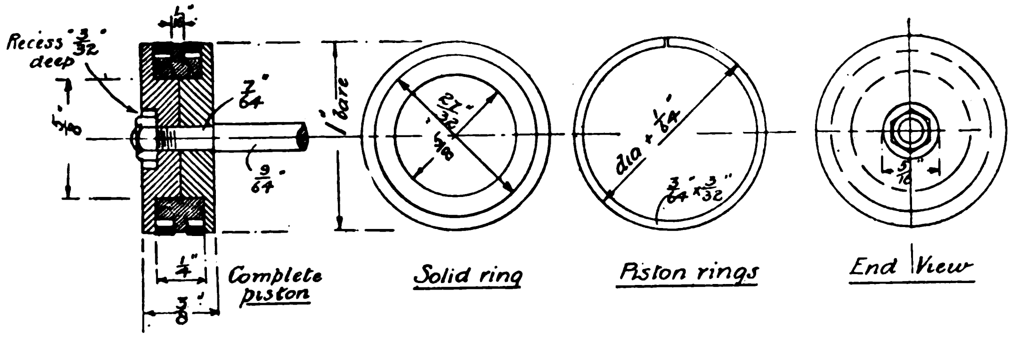


FIG. 22.—ALTERNATIVE DESIGN FOR LOW-PRESSURE PISTON, FITTED WITH TWO RINGS.

ing on each other. There would be no objection to a slight "floating" movement of the solid ring. That is, the bore of the solid ring may be made a "shade" larger than the spigots of the two halves of the piston body without detriment.

To make the piston rings, obtain a piece of thick solid-drawn brass tubing, about 1⅛ ins. outside diameter; bore the tube 3/32 less than the diameter of the cylinder and turn the outside down to about 11/16 in. diameter, parting the tube to make rings ⅛ in. wide. Split the rings at an acute angle, and with a soldering-iron solder the split portions together again, gently squeezing the ring so that the ends meet. Place the rings on a mandrel with a very slight taper, and with the keenest of tools turn the rings to finished width and to exactly the diameter of the cylinder. Unsweat the joint with an iron and carefully file the slit 1/32 wider than before with a small ward file. Although a few failures may occur, the ultimate result of this process should be two very satisfactory piston rings, which will be truly cylindrical when placed in the cylinder. When all the parts are made, a finishing cut may be given to the piston (the rings being removed), the two halves being screwed into position on the rod, the job being placed between centres or being held by the rod in a self-centring chuck.

Two "tommy" holes may be made in the front half of the piston body to facilitate the tightening up on the rod, and if a trial is desired, the same construction may be adopted for providing the h.p. piston with spring rings.

The cylinders having been made and fixed, the next item will be the slide-bars, cross-heads, and connecting-rods. These parts are identical for both the h.p and l.p. sides of the engine. No special process can be devised for making the crosshead, unless a milling spindle is available, but in any case the pattern-maker should provide a tenon or chucking-piece on the opposite end to the circular portion in which the piston-rod fits. Such a tenon-piece will enable the maker to hold the crosshead casting in the lathe and to turn and bore the neck for the shouldered end of the piston-rod. The hole should be bored deeply so that it in some degree forms a guide in filing away the space or the little end. The slides of the crosshead should be filed square with piston-rod,

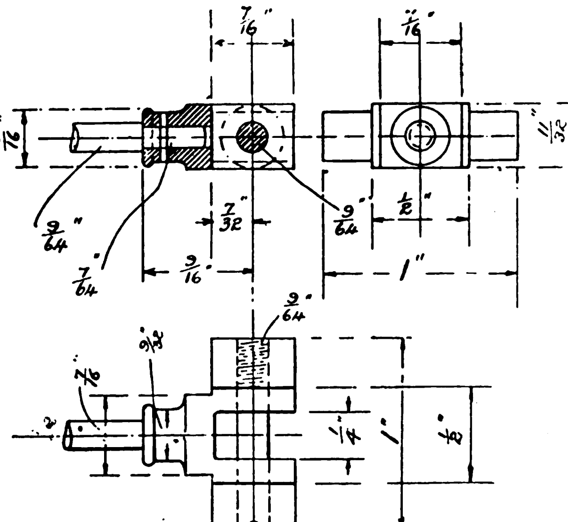


FIG. 23.—CROSSHEADS.

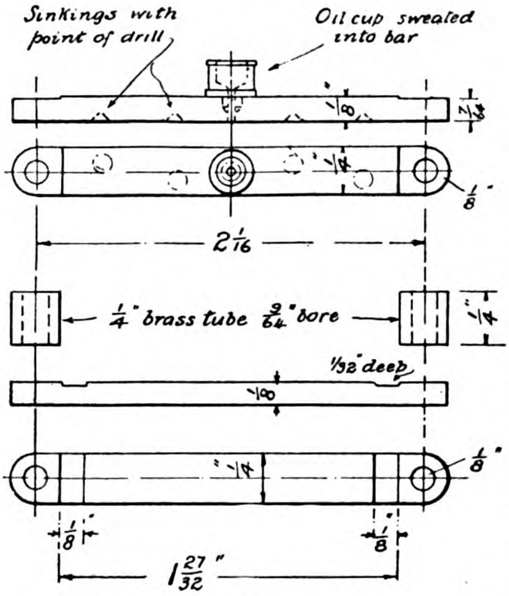


FIG. 24.—SLIDE-BARS.

and should be an easy fit laterally between the guides.

The little end pin may be made out of a piece of Stubb's steel rod to the nearest size to $\frac{9}{64}$ in. diameter obtainable. One slide block should be tapped to suit a thread cut on the end of the gudgeon-pin.

The slide-bars are arranged to be made of strip steel. Bright stuff is obtainable, but if the reader has only black rod of the required section available, recourse will have to be made to draw-filing to finish the bars for the slides. Distance-pieces for the slide-bars can be made out of brass tube, slices being cut off in the lathe to the required thickness. Of course, pieces of steel rod may be turned to size and bored for the studs if the appearance of steel is desired in preference to that of brass. The top bar may be provided with a small oil cup turned out of rod brass. This oil cup should be soldered in place, as the writer's experience has been that oil cups fitted by screwing into thin slide-bars are likely to become loose when the engine is working, unless the thread is a very tight fit.

The dimensions $1\frac{27}{32}$ ins., in Fig. 24 should be $1\frac{25}{32}$ ins. The difference is luckily unimportant, but we might as well be correct.

The connecting-rod may be made out of cast mild steel or bronze. If the former material is used, do not trouble about a brass liner. With regard to running condition, this refinement is not necessary to such a small model. Steel looks well, but if its rusting properties are deemed to be a disadvantage, phosphor-bronze or German silver may be employed. The rod is of round section with a plain-eyed little end and a marine pattern big end. The pattern should have centreing-pieces left on the ends and the big end should be cast solid with an allowance for the sawcut which is made to split the big ends after boring for the crank-pin.

It will be noticed that locknuts (reduced in thickness) are employed for securing the big end bolts. If desired, screws may be used driven from the back, the rod portion being tapped for screws. Or, the caps may be tapped and a bolt used as shown in the draw-

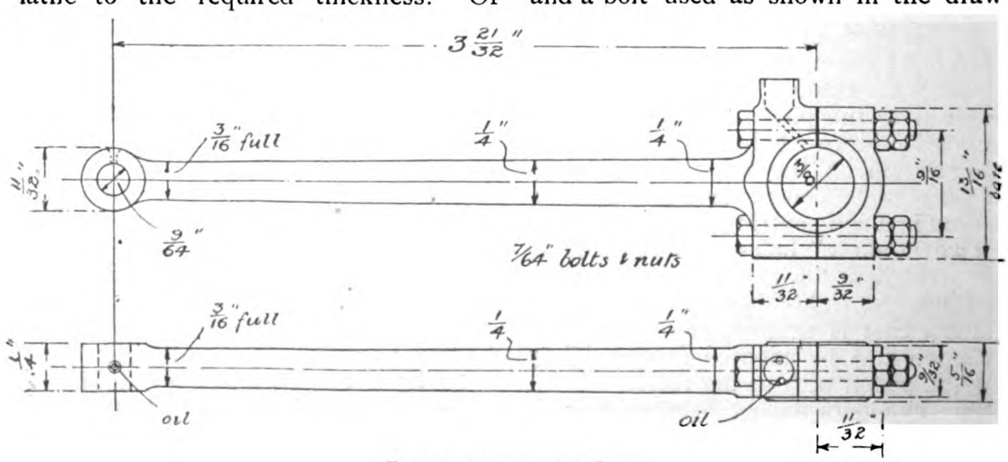


FIG. 25. CONNECTING RODS.

ings, only one nut being used in this instance. To ensure absolute parallelism, the connecting-rod may be mounted on the faceplate to drill for the crank and little end pins. Care must, however, be taken in bolting down, otherwise this method may prove less accurate than drilling the rods in the ordinary way. In any case, the sides, big end, will require to be faced, and the projecting collar formed in the lathe. To do this, however, the big end may be made to grip a mandrel, the rod being placed close up against a faceplate and made to act as its own driving carrier.—*Model Engineer.*

(*To be continued.*)

The Efficiency of Labor

The gravest evil from which this country is now suffering, graver by far than the exaggerated dangers from monopolies or from freight rebates, is the decline in the efficiency of labor. It finds expression in slouchy work on the part of those who know how to do better, and poor work on the part of those who have never been taught or are incapable of learning. To the more serious defect of lowered quality is added the troublesome feature of lessened quantity. It is a curious fact that the one question above all which is uppermost in the minds of manufacturers and other employers of labor, and which is privately discussed by them with helpless iteration, is so rarely touched upon in public utterances. The hope of developing some remedy is the only consolation to employers when they face the prospect of a decline in the volume of business.

There has been an extraordinary demand for labor of all kinds. So far as that has raised wages and directly increased the cost of production employers have had no grievance, although it is a troublesome and difficult matter to carry them back to the normal level. Manufacturers know that prices for their products usually decline more rapidly than the labor cost, and must be willing to face that contingency. The laws of supply and demand never operate so promptly in the one case as they do in the other.

As for the quantity of output of labor, that, too, responds fairly well, when the demand for labor declines. The process of weeding out the lazy and the inefficient begins promptly, and it may be accepted as a general fact that few managers have not thoroughly examined their rolls with a view toward making their selections. The percentage usually will be small, but the moral effect is quite out of proportion to the numbers. During the past two years the knowledge that a job was waiting for any man who was willing to take it has had a demoralizing effect upon all labor throughout the country. The fact will be firmly realized soon that steadiness, reasonable industry and acquiescence in necessary measures of discipline are primary conditions for employment, and that simple application for work is not the only qualification.—*Iron Age.*

Pile Sharpening Machine

An English contracting firm engaged upon the construction of harbor works in Rotterdam, Holland, has built a machine for the purpose of sharpening piles, which resembles a gigantic pencil sharpener. Piles of 28 in. in diameter are sharpened to a 5 in. point in 15 minutes.

The spherical balloon is now finding its true place in the world of sport and in the army. The dirigible balloon is finding an important place to fill in warfare. But the aeroplane, now just crossing the threshold of possibility, and rapidly advancing on the road to practicability, is the most interesting branch of aerial science. In a very few years we may expect to see this machine developed to the point where it will be used as a means of rapid transportation over long distances. Like all other aerial craft, it will find one of its first and most important uses in warfare, and we may expect to hear of specially trained troops which will mount aeroplanes, reconnoitre the enemy and drop explosives on his most strongly fortified positions from an altitude which will guarantee safety from his rifles and projectiles.

Steam and electricity have done wonderful things in the last century, both on and above the earth's surface. Now the aeroplane has come, the latest product of this scientific age, to give us new surprises.—*F. P. Lahm, U. S. A., in Outing.*

ELECTRICIAN AND MECHANIC

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EDITORIALS

We must remind some of our readers again of the necessity of notifying us in advance of change of address. Heretofore we have been able to supply back numbers, but now that the editions are becoming exhausted rapidly, we can hardly be expected to be responsible for magazines sent out by us and not delivered owing to change of address. If you should, for instance, miss three numbers and then suddenly remember you had not notified us of change of residence, you must not try to hold us responsible and ask for those missing copies gratis. We will, when it is possible, forward the current number on receipt of price, ten cents, previous issues at advanced price, as mentioned in an advertisement in this issue.

Our photographic contest is omitted this month, not from any lack of interest on the part of our contributors, but because the prints did not arrive early enough to insure insertion in this number. All prints should be in our hands the last day of the preceding month. Prints for March issue will not be considered after February 29th, but will go over for the next issue if received later.

You will all be pleased to note we are able to send your magazine earlier in the month. We hope to have our March number out even before the first day. Our Western friends will be particularly glad of this fact, as well as our news-stand dealers.

Ask your newsdealer if he carries ELECTRICIAN AND MECHANIC, and if not, get him to do so, so that it will be accessible to many who, when considering the purchase of a helpful magazine, will see it on the counter, and be only too glad to buy.

To those of our readers who are interested in flying machines of any kind, whether balloons, dirigibles, or aeroplanes, we would commend the two new magazines on this subject. *The American Aeronaut* is an excellently illustrated popular magazine, with a subscription price of $1.50 per year; and *The American Magazine of Aeronautics*, somewhat more scientific, costs $3.00 per year. We shall be very glad to take subscriptions to either journal from any reader interested in this coming topic of universal interest. No free sample copies of either.

M. Henri Farman won on Jan. 13 the Deutsch-Archdeacon prize of $10,000 for the first flight of a kilometre in a circle, returning to the starting point, with a machine heavier than air. Since that date he has made another flight of more than two kilometres, considerably more than a mile, circling about with the greatest ease and landing quietly at his starting point. Apparently riding an aeroplane is like riding a bicycle, largely a matter of practice.

QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but if he so requests, anything which may identify him will be withheld. **Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of letter, and only three questions may be sent in at one time.** No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for the reply, but is simply to cover clerical expenses, postage and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time. Neither do we guarantee that the answers will be satisfactory for any special use or purpose required.

If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will in every case be notified if such a charge must be made, and the work will not be done unless desired and paid for.

494. **Commutator Leads.** W. R. B., East Aurora, N.Y., asks if it is necessary to solder the connections into commutator segments, or will screws suffice? A Carlisle and Finch 40-watt dynamo gave considerable trouble by constant breaking off of the soldered wires, so holes were drilled in the segments and the wires pinched under set-screws. Now the dynamo refuses to generate. *Ans.* The screws should suffice, and your trouble is undoubtedly of some more serious nature. We should suspect that you have misarranged some of the wires, or that some one is broken back in the winding. Frequent loosening at the front ends would be likely to be accompanied with trouble further back. The leads to the commutator should be restrained from vibrating and breaking by interweaving them with cord. Do not use acid flux when soldering such joints.

495. **Non-Sparking Electro-Magnets.** T. W. H., East Oakland, Cal., refers to our answer No. 398 and asks (1) If the short-circuited coils produce any magnetism? (2) The two spools of the magnet have independent connections to the battery; why is this? Does a magnet lift more when unlike poles are operative than like ones? *Ans.* (1) No, it is quite inert in this respect. (2) The two spools are merely connected in parallel instead of in series with each other. Self-induction is the source of sparking at break of circuit, and this factor varies with the square of the number of turns. By this minimizing the number of turns in series the cause of sparking is reduced. Besides, you get more current through each coil by thus reducing the resistance of the circuit. Were the two coils in series, the resistance would be four times as great.

496. **Dynamo Design.** N. D., Bathgate, N. D., asks what should be the winding to give the maximum output in case of a dynamo with steel magnet and an armature 8″ in dia. and 2¼″ long? Where could the materials be obtained? *Ans.* To give an adequate answer in these columns would be impossible. An excellent machine of closely these dimensions is fully described in Watson's "How to Build a ¼ h.p. Dynamo."

497. **Electric Heater.** H. D. H., St. Louis, Mo., asks (1) What size and quantity of 18% German silver to use on a disc heater? (2) Can such wires be bought in plaster of paris covering? (3) Can a Parsell and Weed battery motor be operated in series with incandescent lamps on alternating currents? *Ans.* (1) We do not know what kind of a disc you mean, how large it is or how hot you want it. Do you mean the inking disc of a printing press? (2) Address the W. J. Barr Electric Heating Co., Cleveland, O. (3) You could for a few minutes at a time, but the solid iron would heat and the brushes spark badly.

498. **Gravity Batteries.** S. H. B., Huntington, Ind., asks (2) How many gravity cells would be needed to operate a ¼″ induction coil? (2) Why will not a toy motor run as a generator? What size of wire should be used on a 4-bar magneto to run a toy motor? *Ans.* (1) Gravity cells are not suitable; they have too high a resistance to allow enough current to flow. Use a few bichromate cells. (2) Such small machines are designed so uneconomically, that the entire output of armature is insufficient to energize the field magnet. You can get something by separately exciting the field. (3) See page 258 of the March, 1907, magazine.

499. **Electric Heater.** E. P., Somerset, Pa., asks how many feet of No. 18 German silver wire would be needed to make an electric heater to be operated on a 52-volt alternating current circuit? *Ans.* This is quite dependent upon the size, shape and radiating surface of your particular device. Experiment alone will reveal the entire conditions. If you wish a reliable device do not use German silver at all, but nickel wire. The zinc in the former seems to cause rapid deterioration.

500. **Vacuum Impregnating Process.** C. H. M., Bernharts, Pa., asks (1) What is meant by this in connection with preparation of coil winding? (2) Where can small commutators, or the segments for such be obtained? *Ans.* (1) The coils are immersed in water-proof paint, and the air exhausted from the containing vessel. Then when the atmospheric pressure is again admitted, the paint is forced into all the interstices of the coils, and therefore when dry are rendered proof against the entrance of moisture. (2) We think any of our advertisers of small machines would be able to supply what you want in this line.

501. **Electrician's Work and Wages.** C. S. J., Monroeville, Ind., asks (1) For information of its character and compensation. (2) What is "ball" lightning? *Ans.* (1) There is quite as much diversity along this line of employment as any other. Stringing wires for all sorts of circuits, setting up dynamos and tending them, or making some specialties having electrical applications might all be called the work of an elec-

trician. An electrical engineer has a higher grade of work, usually of the designing or supervising order. The pay of an electrician is comparable with that of a cabinet maker, say $2.50 to $3.50 per day. (2) This is sometimes known as St. Elmo's Fire, and is usually manifested as a stationary or slowly moving nebulous ball of fire on steeple, flag-staff or mast of a ship.

502. **Experimental Transformer.** S. J. McK., Highwood, N.J., asks (1) Where can a book be procured that describes the making of a transformer for use on a 116-volt alternating circuit, giving opportunities for several different secondary voltages? (1) Does Allsop's book on Induction Coils give directions for making 1" and 2" spark sizes? (3) Where can instructions be obtained for making an electromagnet that will lift 25 lbs. *Ans.* (1) We no not know of one that just fills your requirements, but a few simple directions will suffice to put you in the way to build a suitable coil. In the first place you do not need a secondary winding at all; have only one, with taps led off at as many points as you wish: attach the extreme terminals directly to the 116-volt source, and take the desired voltage from any appropriate taps. You can wind an iron core of tinsmith's annealed iron wire, like a ring armature of Gramme's original sort, but letting the section be circular rather than flat. Wind it on a wooden form, in halves, then remove the wood, bind the wires with twine and paper, then wind on the copper wire. The size of core and copper wire will depend upon how much current you wish to take. A construction that will allow for about 6 amperes can use No. 14 wire, wound in about 150 turns upon a core 3" in inside dia. and 2" dia. of section. (2) Yes, and numerous other sizes. (3) "Electromagnets," by Mansfield, price, 50 cents.

503. **Hand-driven Dynamo.** J. W. H., Cleveland, O., has forged wrought iron field magnets for a telephone-magneto armature, winding them with No. 16 wire and the latter with No. 18. When driven at a speed of 2500 rev. per minute, the machine generates well, and will run a 6-volt Porter motor, but not a slightly larger one. He asks what winding to use that will allow for about 12 volts and 3.5 amperes. *Ans.* A series machine is not very well adapted for general experimental work, but you can get somewhat better results than at present by use of No. 20 wire on armature, letting the field winding be unchanged. We should criticise your design of the field magnet as having too much iron in the pole pieces and too little in the cores. Also the legs on which the field stands, being continuations of the poles, contribute to unnecessary magnetic leakage.

504. **Toy Steam Engine.** M. W. S., Tuling, Tex., asks (1) Where can castings for such engines be obtained? (2) What is meant by a "constant cut-off at one-half stroke"? *Ans.* (1) See advertisement of The Sipp Electric and Machine Co., on page 5 of January issue. (2) The eccentric is fixed in a definite position on the shaft, such that the piston moves one-half the length of its stroke before the steam port is closed. Such an engine requires a "throttling" governor, and is wasteful of steam as compared with engines in which the point of cut-off is variable as determined by the operation of the governor in response to variations of the load. The Corliss engines were the first to embody the latter principle, and no large engines and few small ones are now built that do not include this method of governing.

505. **Small Induction Motor.** R. A. B., Fairport, N.Y., states that he regrets to find no article on this subject in the ELECTRICIAN AND MECHANIC. He is interested in the Electrical Engineering series, and is trying to make a ¼ h.p. motor for a 104-volt 60-cycle circuit, following, as well as may be, the principles explained in the October, 1907, number. He sends sketches of design and asks us to propose dimensions and winding. *Ans.* It is true that this is a vital subject, and one that we have by no means forgotten. If only it was possible for an amateur to procure the necessary sheet iron we would have published an article of this sort long ago. You will find some help in an article in the American Electrician for March, 1903, pages 148-150. This describes a ½ h.p. motor for a 125-cycle circuit, but you could use about the same dimensions with only 2" of laminations, and have the proportions good for the lower frequency. Use slots as you propose, with coils of No. 18 wire, 3 wide and 12 deep per slot. Your design of rotor is rather the better of the two. If you wish to include the self-starting feature, use an odd number of bars in this number, then there will be reduced opportunity for locking of these teeth with those on the stator.

506. **Crucible.** A. W., Wilburton, Okla., asks (1) Will plaster of Paris do for the material of a crucible for melting brass? (2) Will an electric spark ignite acetylene gas? (1) No, a sand or graphite crucible should be used. (2) Yes.

507. **Dynamo Operation.** A. D. S., Option, Pa., asks (1) If a direct-current compound-wound dynamo is rotated in the opposite direction from that ordinarily employed, what will be the effect when the load is applied? (2) How many amperes will 10 constant-potential 10-ampere 45-volt arc lamps require when run from a 110-volt dynamo? (3) Does the series coil of an arc lamp consume much energy? *Ans.* (1) Without any change in connections, the machine will not generate at all if run in the opposite direction. If you really wish to make a permanent change in the direction of rotation, you must exchange the cables that connect with the brush holders, or if it is a multipolar machine, you may be able to move the entire brush holder mechanism forward or backward by the amount of one polar space. No change in the exterior circuit will be experienced. (2) Such lamps ought to have both series and shunt regulating coils, and operated in pairs across the 110-volt circuit. There would need to be a resistance in each lamp to take up the remaining 10 volts each. The two of each pair of lamps would be in series, and five such pairs would of course require 50 amperes. If you were to operate the lamps singly, there would be the necessity of having a resistance in each lamp to waste 65 volts, and the total current would be 100 amperes. The modern enclosed arc lamps require about 80 volts and 4 to 6.5 amperes, and operate singly, therefore do not need the differential

winding. (3) Only about one volt, and with 10 amperes flowing the loss in this circuit is 10 watts, while the arc itself uses 450 watts.

508. **Alternating Fan Motor.** A. H., West Hoboken, N.J., has a "C. & C." fan motor rated at 1/8 h.p. when run on a 110-volt circuit. He asks what changes to make in the winding to make it a shunt generator and give a current of 8 amperes? *Ans.* Such motors are usually series-wound, and it is possible that the present wire on the field cores will answer for your shunt windings. If not self-exciting with these two spools in series, put them in parallel with each other, but still in shunt to the armature. Wind this latter member with No. 18 wire,—all you can get on.

509. **Sparking Transformer.** G. J., Ypsilanti, Mich., asks (1) How to make a transformer that can be operated on a 110-volt alternating current circuit, and give 2″ sparks? (2) How many square feet of tinfoil are there in a pound? *Ans.* (1) There is more to the required apparatus than a transformer. You are interested in high frequency phenomena, and should read Tesla's and Prof. Thomson's experiments in that field before attempting anything yourself. You will economize expense and be more likely to succeed. To make apparatus to produce the sparks directly from the alternating current supply would involve highly dangerous conditions. (2) Tinfoil is of various thicknesses. You can get definite information from Queen & Co., Philadelphia, Pa., or, for your vicinity, from the North Electric Co., Cleveland, O.

510. **Batteries.** C. E. R., Jonesboro, Ark., asks (1) How many volts will six bichromate of potash batteries give, and if they will run a 10-volt lamp? (2) Where can small balance wheels for experimental apparatus be procured? *Ans.* (1) Dependent upon strengths of solution, about 1.8 to 2 volts per cell. If you desire continuous operation, use the Fuller construction. Do not try to take more than a small current, or it will not be sufficiently constant. (2) From A. M. Clark, 90 John St., New York, or L. H. Wightman, 130 State St., Boston.

511. **Lightning.** E. E., West Webster, N.Y., asks if there is any danger from lightning striking a building that has a telegraph aerial, and if so how can switches or arresters be arranged as a safeguard? *Ans.* Yes, in the same sense that any structure is in danger of being struck. You might adopt the sort of protective devices adopted on telephone lines.

512. **Ground Detector.** R. B. L., Greenford, O., sends a sketch of the arrangement of two incandescent lamps in series, with intermediate ground connection, and asks how such can be used on a switchboard as a ground detector? *Ans.* The lamps are not always burning, but when it is desired to try the circuit for accidental grounds, as is a regular daily requirement in many stations, the circuit is closed. In consequence of the two lamps being in series, the normal potential between the mains sends less than half current through, and only a faint light is given. If however, one of the mains is grounded, one of the lamps, by reason of the regular ground connection, will be short-circuited, and the other lamp will jump to its full candle power. The accidental ground must then be looked for on the main to which the extinguished lamp was directly connected.

513. **Shellac.** R. W. H., Lavelle, Pa., asks (1) How to mix good shellac varnish? (2) Will Scotch glass tube be a suitable substitute for solid glass rods for a Wimshurst machine? (3) Should the governor of a plain slide valve steam engine be placed between the throttle and boiler, or between throttle and engine? *Ans.* (1) The flakes of dry shellac are to be dissolved in grain alcohol, and then thinned to any desired extent in denatured alcohol This latter grade may be used exclusively, but the dissolving is not quite so rapid. Ordinary wood alcohol does not make a good solvent, but may be employed for diluting. (2) Yes, but it is a good precaution to heat the glass to perfect dryness and shellac it inside and out. (3) Between throttle and engine, thereby allowing for repairing governor without having to interfere with other use of boilers.

514. **Small Spark Coil.** F. H., Fulton, Ill., asks (1) What size of spark coil can be made with ½ lb. of 17 and 1 lb. of No. 36 wire? (2) Will a 500-ohm telephone induction coil give visible sparks? (3) What is size of sample of wire sent? *Ans.* (1) About half an inch length of spark. (2) It will probably produce no jumping spark, but by momentarily touching the ends together in the dark something may be seen. (3) No. 32.

515. **Copper-Float.** W.B., Washington, Pa., asks (1) What is the present address of E. V. Church, who managed the Dollar Battery Co. at 368 Livingston street, Brooklyn, N.Y.? (2) Where can an electrolytically deposited copper-float capable of withstanding 100 lbs. pressure be obtained? (3) Are spark-plugs made with a diameter less than ½″ at the threads? *Ans.* (1) We do not know, but think you can find out by addressing the Postmaster at Brooklyn. (2) Perhaps from The Bunby Steam Specialty Co., New York. (3) We think not, for with proper insulation the metal would be so thin as easily to be twisted off in the hole, and to get such a piece out would be a difficult and annoying matter.

516. **1-4 H.P. Dynamo Design.** F.R., Kansas City, Mo., sends a sketch of a "Manchester" type dynamo, each of the field cores being 1 ft. long and 1″ dia. and wound to a total diameter of 2¼″ with No. 25 wire. Armature is wound in 18 sections of 54 turns each, with No. 22 wire; over all it is 3½″ in dia. Is this winding proper for 50 volts? *Ans.* The armature is good, but you have an insufficient amount of iron in the field cores. Your sketch does not show the axial length of polar face, but the cores ought to be nearly 2″ in dia. instead of 1″. You would not be likely to get more than 30 volts as at present constructed. You will need about 2¼ lbs. of wire on each core.

517. **Toy Dynamo.** W.V., Schenectady, N.Y., sends a sketch of a two-pole dynamo, of design somewhat imitating the standard Thomson-Houston upright form, but rather crude, as if the patterns were sawed from a 1″ board. Bore is 2¼″, and cores are 1″ in dia. and 3″ long. He asks what the output of such a machine would be, and what particular sizes of wire to use? *Ans.* The pole tips come too close together,— allow ¼″ space, and set the two field

cores 2″ apart, and have them round, and if of cast iron not less than 1½″ in dia. The outer parts of pole pieces are unnecessarily large. Put the iron where it will do more good, *i.e.* in the base. If you use a toothed armature wound with No. 20 wire and field with No. 23, you may be able to get 25 volts and 3 amperes.

518. **Bobbin Winder.** F.J., Howertons, Va., is trying to make a bobbin winder that will work with any size of fine wire, and asks how to proportion the threads of the leading screw. *Ans.* For fine sizes of wire very successful winders are made in which the wire guides itself, as it is pushed against the preceding turn with a meagre pressure as derived from the dragging action of a piece of sheet metal flatwise in a vessel of oil. By varying the size of the sheet and the consistency of the oil, almost any desired conditions may be obtained. Let the wire come vertically down to the bobbin, and pass through a hole in a horizontal arm of considerable length. On this arm is the retarding vane.

519. **Alternating to Direct Current.** V.A., Beaver City, Neb., asks what is the construction and degree of practicability of the aluminum current rectifier. *Ans.* Such a device is found to be far from satisfactory, both from the point of convenience and economy. The efficiency is less than 50%. The mercury arc rectifier is far superior.

520. **Induction Coil.** C.H., Roxbury, Mass., asks for directions for making an induction coil 10″ long. *Ans.* See magazine for July, 1907.

521. **Electrolytic Wireless Receiver.** W.H.W., Bluefield, W. Va., asks for directions for constructing one. *Ans.* See article in magazine for July, 1906.

522. **Shuttle Armature Motor.** J.G., Hope, Ind., has made such a one with the simple field magnet of a piece of iron pipe, but the armature seems to run very feebly, even when current from four dry cells is used. What is the reason? *Ans.* We think the motor does very well on such a meagre current. Such cells have a very small output. Try large bichromate cells, say with two zincs and three carbons in each, 3″x6″ size.

523. **Solar Thermopile.** H.E.B., Hillsboro, N.D., asks (1) Would a thermopile actuated by the sun's rays through a lens be practicable? (2) What precautions should be observed in erecting a wireless telegraph station? *Ans.* (1) The current from such a device is extremely meagre, and we do not know just what use it would be to you. With automatic appliances to close and open the circuit at proper times, you might utilize the energy to charge small storage batteries, and then use from them as occasion demanded. (2) We do not know except to have the antenna on as high an elevation as possible.

Book Reviews

ELEMENTARY TURNING FOR USE IN MANUAL TRAINING CLASSES, by Frank H. Selden. Fully illustrated. Chicago: Rand, McNally and Co., 1907. Price $1.00.

The series of exercises given in this book is the result of long experience on the author's part in teaching the subject. The work is planned so as to give correct instruction in the use of tools. The elementary principles are covered fully and in an orderly fashion, with numerous helpful illustrations. In the first part exercises are given varying in difficulty from a simple cylinder to a goblet with rings. The second part gives a large number of more complicated models of various degrees of complexity. The third part is devoted to a careful explanation of the necessary tools and fittings, with instructions for use. The book forms a most helpful manual for manual training teachers and pupils.

ELEMENTARY WOODWORK FOR USE IN MANUAL TRAINING CLASSES, by Frank H. Selden. Fully illustrated. Chicago: Rand, McNally and Co., 1906. Price $1.00.

This book is similar in plan to the one reviewed above, and merits the same commendation. The author's desire is to teach correct methods of using tools, and to impart instruction in graded steps. In the first part, the use of various tools, finishing surfaces, and the various common joints are treated. The second part goes on to more complex joints and exercises, and the third is devoted to tools and their uses. This book should be in the hands of every would-be woodworker, not yet thoroughly skilled in the art.

PLAIN GAS ENGINE SENSE, by E. L. Osborne. 2d edition. Gas Power Publishing Co., St. Joseph, Mich., 1906. Price 50 cents.

This is a book of instruction for every one who desires to learn the principles of operation of these useful sources of power. It takes up each point in the working of the engine in proper order and explains it in simple and easily understood language. Every user of a gas engine should spend fifty cents for this handy little volume.

THE GAS ENGINE IN PRINCIPLE AND PRACTICE. Including comparison of the two-cycle and four-cycle types of internal combustion engines, with description of the various designs, together with notes on suction and pressure type gas producers, crude oil vaporizers, etc. Written and compiled by A. H. Goldingham. Gas Power Publishing Co., St. Joseph, Mich., 1907. Price $1.50.

This book is much more comprehensive and technical than that reviewed above, though still easily understandable and free from mathematics except of the simplest kind. The scope of the book is well indicated by the title, and it forms a valuable supplement to the more simple treatise. It is indispensable to every user of a gas engine for power purposes, and a thorough study of it will save him many dollars.

FLYING MACHINES, Past, Present and Future. A popular account of flying machines, dirigibles, balloons and aeroplanes, by A. W. Marshall and Henry Greenly. Fully illustrated. New York: Spon and Chamberlain. Price 50 cents.

An interesting and well illustrated account of many of the historic flying machines, with some predictions. As nearly up-to-date as a book can hope to be in this rapidly advancing art.

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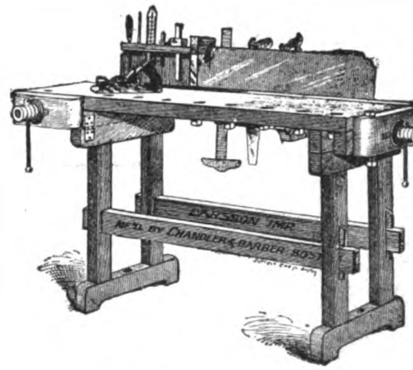

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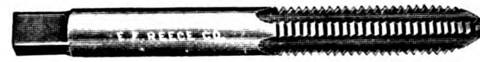

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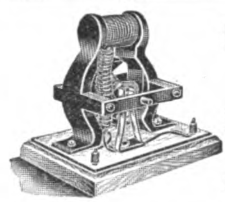

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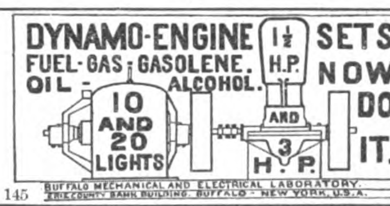

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