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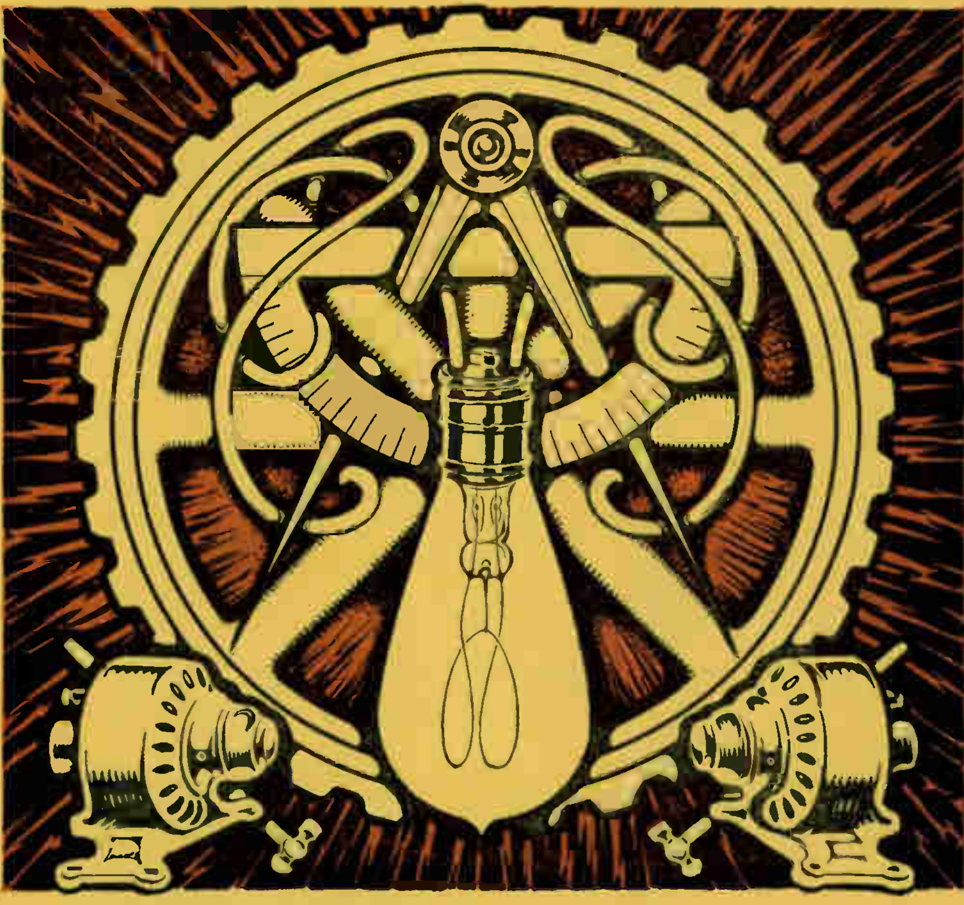
ELECTRICIAN & MECHANIC



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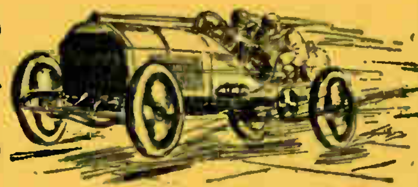
Do YOU want to Learn to Drive an Automobile



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"I am working in a repair shop. Have increased my income $20 more per month so far and expect to get as high as $50 more per month."—Jno. C. DeKoster, Lynden, Wash.

"I am now working in the American Auto Co., was formerly in the jewelry business."—James Tronto, Providence, R.I.

"I am now driving a Packard 30. Your Course helped me wonderfully."—Edw. Hauler, New Orleans, La.

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"Your Course enabled me to get a good position which has increased my income."—Geo. E. Davelarr, Prosser, Wash

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The illustration shows a picture of a repair shop opened by one of our students and his bank book with his first deposit—this, not so long ago—today he employs several men and has the agency for a car and is MAKING MONEY—his name is A. C. WALKER, Vandalia, Ills.

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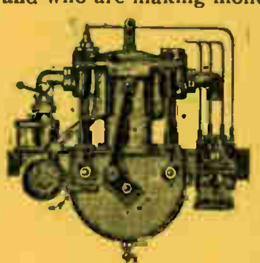

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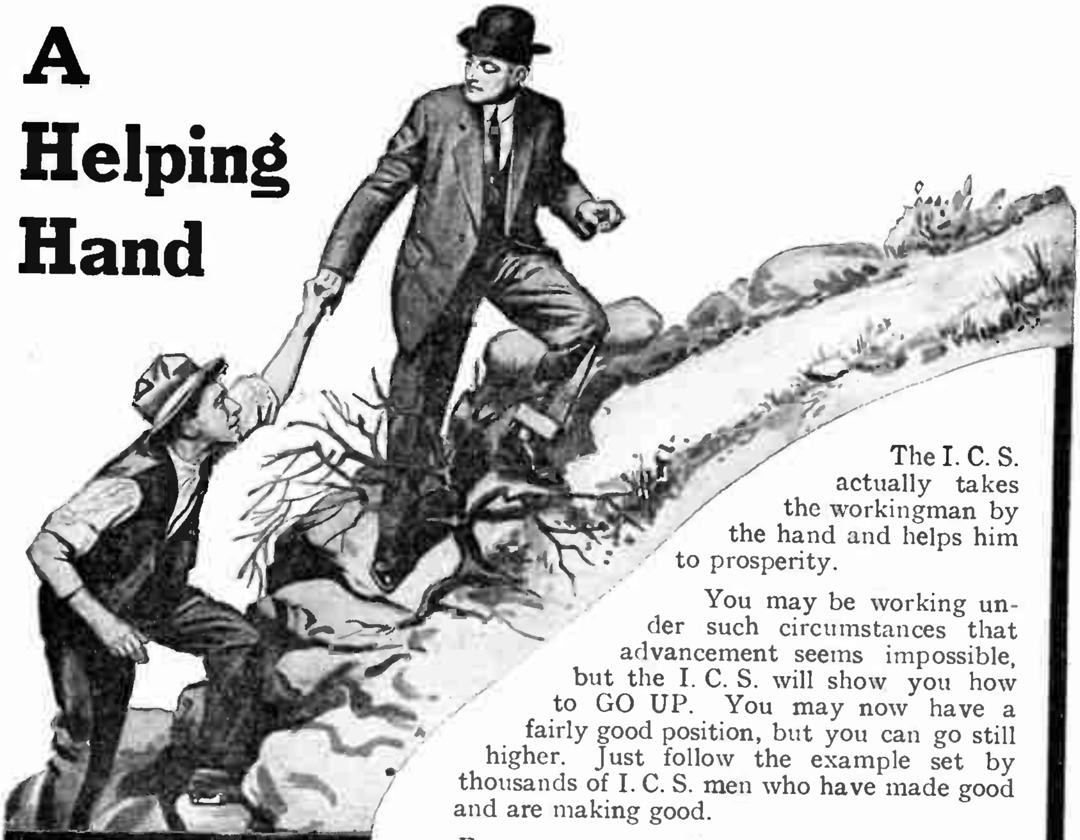

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A LABORATORY ELECTRIC FURNACE—Part I

How It Can be Made by the Amateur

GEORGE F. HALLER

No amateur's laboratory can be considered complete without some sort of a high-temperature furnace, in which experiments can be carried on in reducing the metallic oxides, forming small quantities of calcium carbide, and making aluminum. The furnace described in the present article can be put to the above uses, and in addition can be used for making solder or spelter, and even for melting brass or iron for small castings. In fact, the uses to which this furnace may be put are innumerable. To the metallurgist a furnace of this type ought to prove of practical value, since it will produce a higher temperature in a shorter period of time than any gas furnace obtainable.

The furnace is of the well-known resistor type, which is undoubtedly better suited for general laboratory work than an arc furnace, in that there is no danger of carbon contamination. It is particularly well suited for reduction work, since the resistor material gives off sufficient CO to maintain a rich atmosphere of this gas within the furnace without the addition of any coke to the material which is being reduced.

A temperature of 1800°C is easily maintained. This is sufficient to melt steel, nickel and gold. Under extreme conditions a temperature of 2200°C. may be obtained. The power used to produce a temperature sufficient to melt nickel is about 1200 watts; so that the furnace can be run continuously for from ten to fifteen cents per hour. The heat is produced in a mass of coke or carbon granules through which the current passes. The resistance offered by this resistor material is sufficient to cause it to become white hot. The melting crucible is located in the center of this mass of glowing carbon, so that it is heated to the highest temperature in the furnace.

This furnace is very simple to construct—well within the ability of the average experimenter. The cost of materials for making the furnace proper should not exceed $3.50.

The present article also takes up the construction of a step-down transformer for use with the furnace on alternating current. It is advisable to construct this transformer, but it is not essential, as a water rheostat can be used in its stead. The use of a water rheostat, however, necessitates drawing 75 amperes from the service, which would not be practical in all places. With the transformer the maximum current drawn from the line should not exceed 20 amperes. The power lost in a water rheostat would soon pay for the cost of construction of a transformer or an inductive impedance.

Fig. 1 shows a sectional view of the furnace through the center. The outer walls and the bottom *B* are composed of fire brick slabs. They are held in place by a sheet iron shell entirely surrounding the furnace. Within the firebrick shell is a heat insulating wall, composed of magnesia oxide and asbestos, represented by the section marked *C* in the drawing. *D* is a refractory lining, consisting of molded fire-clay made cohesive by the addition of Portland cement. *A* represents the resistor material. *E* is a graphite crucible setting on a fire-clay block *F*. *H* and *I* are turned graphite rings which serve as electrodes to distribute the current around the whole area of the resistor material. *J* is a movable fire-clay ring which serves to concentrate the heat along the sides of the crucible. If it were not for this ring the current would not flow in the resistor material near the crucible, because the carbon near the crucible, being colder, has a higher resistance than the more heated portions in the interior of the mass. The ring concentrates the flow of current along the sides of the crucible where it is needed. The ring also serves as a means of regulating the amount of current which the furnace uses. If the ring is set lower down, or the crucible higher up, there is less constriction in the area of the resistor material, and more power is used, resulting in a higher temperature. On the other hand, if the ring is moved up or the crucible lowered, thereby reducing the area of the resistor material, the current is materially lessened. For ordinary use the position of the ring and crucible shown in Fig. 1 will give the best results.

The sheet iron outer shell should first be made by bending a piece of No. 20 gauge sheet iron 40½ in. long and 8 in. wide into a box 10 in. square. The overlapping edges are drilled and the sheet is riveted. Procure five fire-clay slabs. They vary considerably in size, but it will generally be possible to procure them about 10 in. long, 8 in. wide and 2 in. thick. If slabs of this size are not obtainable, the outside dimensions of the furnace can be modified to suit the size of the slabs that are obtainable. Two of the five slabs should be cut across, making them 6 in. long by 8 in. wide, with a cold chisel and a hammer, working slowly and cutting uniformly all around the slab. These two pieces form the ends of the lining, and a third piece, cut 6 in. square, constitutes the bottom. The two sides are made from 10 x 8 in. slabs (see Fig. 2).

A shallow wooden box or tray, as shown, forms the base of the furnace. The iron shell, with the fire-clay slabs,

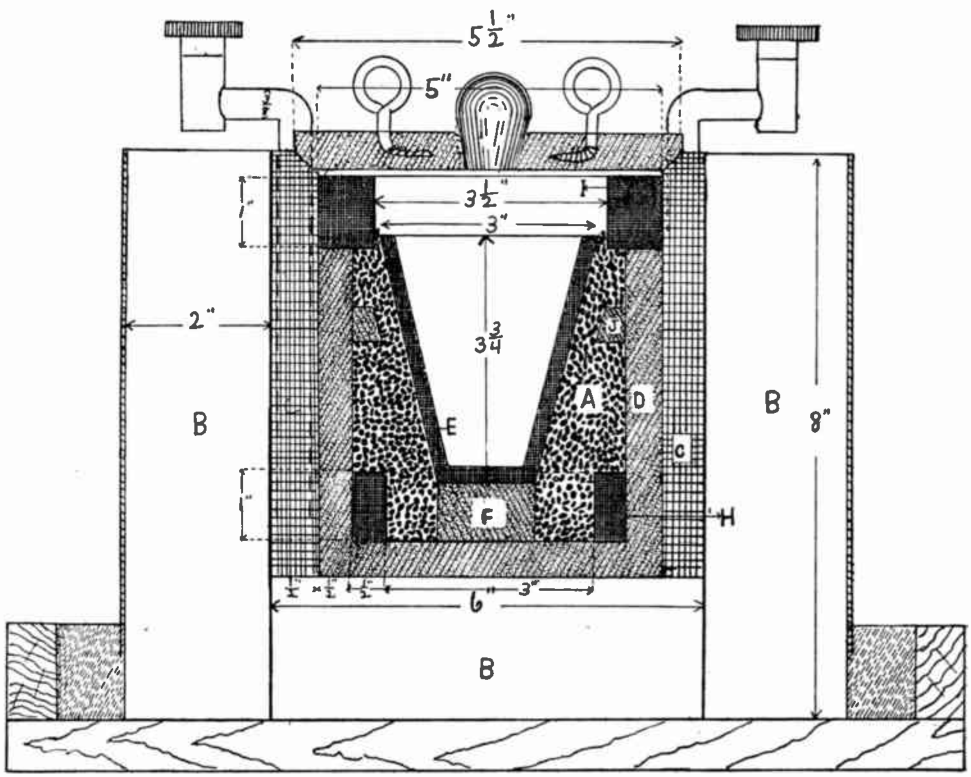


Fig. 1. Section of Furnace

is set up in the center of the tray, and a mixture of 1 part Portland cement and 3 parts sand with sufficient water to form a moderately thick mortar is poured around the shell so as completely to fill the tray. The lower edges of the sheet iron can be cut with shears and lips bent out at right angles so as to hold firmly to the cement. A number of nails can be driven through the sides of the tray before the cement is poured in.

While the cement is drying, the two pieces shown in Fig. 3 are turned and sawed to shape. They are cut from graphite blocks and must be machined true to size in order that the graphite current distributing rings, *H—I*, may make good electrical contact. The brass terminals are made as shown, of ⅜ in. rod, and are pressed into the graphite pieces so as to make good electrical contact.

Next, a circular wooden core must be made in order to cast the insulating lining. It is best done by turning up a circular block 5 in. in diameter, 6 in. long, with a bevel flange at the upper end, in order to form the beveled seat for the cover, as shown in Fig. 1. A recess 1 in. wide, extending 1½ in. from the bottom is cut in the core as shown in Fig. 4. The graphite electrode with the long brass terminal is inserted in the recess so that it goes into the core just ½ in. A wooden block is cut to fit into the recess in the core below the electrode so as to hold the latter ½ in. above the fire-brick bottom of the furnace. This block should make a loose fit so that the core can be removed when the cast has set. The brass terminal sets in the back corner of the fire-clay slab, as shown in Fig. 2.

The space between the core and the slab is filled with a mortar composed of 2 parts of magnesia oxide, 2 parts asbestos, and 1 part Portland cement, moistened with sufficient water to make a thick paste. It should be tamped down during the pouring, being careful, however, not to disturb the electrode or the brass terminal. The latter can be held perpendicularly in its place by laying a piece of wood under the bent portion across the corner of the fire-brick slab, and driving several nails on either side of the bricks through the

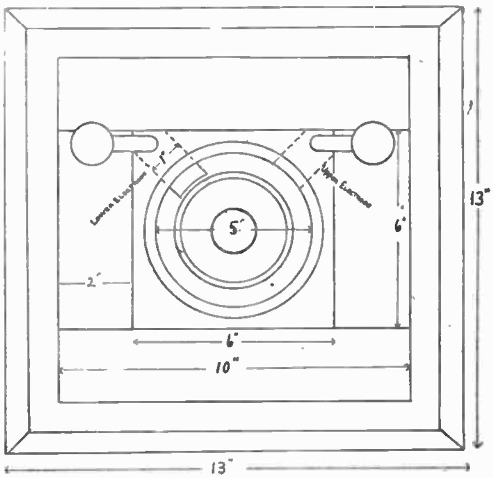


Fig. 2. Plan of Furnace

wood to prevent side motion. The other graphite electrode must be held in place in the opposite back corner 1¼ in. from the top of the furnace, by a similar piece of wood laid under the curved portion of the terminal and resting on the fire-clay in such a way as to hold the curved arc firmly against the core during the pouring. It is essential that the upper graphite electrode press against the core in order that the distributing ring will make good contact when the furnace is in operation.

When the insulating lining has set, the wooden core should be carefully removed by lifting straight upward by means of two screw-eyes which can be screwed in the upper end of the core. Avoid twisting the core, in order to avoid disturbing the lower graphite electrode which projects into the core. The piece of wood under the electrode should be removed.

Everything is now ready for casting the refractory lining. The wooden core previously used should be turned down to 4 in. in diameter and cut off to 4¼ in. in length. The lining is cast from a mixture of 6 parts carborundum sand and 1 part Portland cement, mixed with enough water to make a thick paste. A sufficient quantity of this is poured in the bottom of the furnace to make a layer ½ in. thick. The core is then carefully centered so as to press against the projecting lower graphite electrode, and the side walls are cast. When this lining has set the core can be removed.

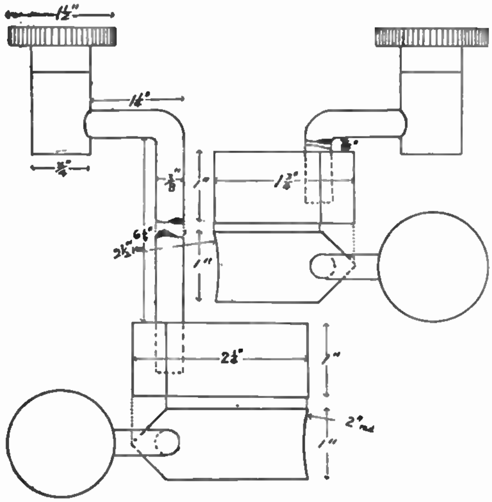


Fig. 3
Graphite Electrodes and Terminals

The inside should be smooth, with the lower graphite electrode just flush with the surface. The refractory lining should extend to the bottom of the upper electrode, the latter is just flush with the magnesia lining.

The two graphite distributing rings should next be turned to the dimensions shown in Fig. 1. The smaller rings should fit into the bottom of the furnace and make good electrical contact with the electrode. If the contact is not good, the space between the two can be filled with powdered flake graphite wet with a thin solution of molasses and water. This paste should be tamped into the joint as firmly as possible. The larger ring rests on the upper edge of the refractory lining, and must make good electrical contact with the upper electrode in the same manner as the lower ring.

The fire-clay block *F*, upon which the crucible sets, is cast separately out of the same material as the refractory lining. A small mold can be made of light wood 1½ in. square and 1 in. deep. It is well to cast several blocks of different heights by not filling the mold full, so that the crucible can be raised or lowered at will.

A wooden mold must also be made to cast a number of the insulating rings *J*. It can be turned in the face of an inch board. The outer diameter should be 4 in. and the inner diameter should be such that a space of about ⅜ in. will be left between the crucible and the ring when set in the position shown in the drawing. The rings are ½ in. thick. As the rings do not last long, since they are subjected to the most intense heat of the furnace, it is well to make a generous supply and to keep the mold for future use. The same mixture as was used for making the refractory lining is satisfactory for casting the rings.

The cover is also cast separately in a turned wooden mold from the same material. The screw-eyes shown in the figure can be set in while the mixture is still soft. They will be found very useful in lifting off the cover of the furnace. The taper plug in the center of the cover is turned from a graphite rod, and serves to close the hole left in the cover through which the progress of the melt can be watched through a smoked glass while the furnace is in operation.

The resistor material is made by grinding up old electric light carbons and coke. The grinding should be continued until there are no lumps more than ¼ in. in diameter; then the mass can be sifted, and the dust rejected.

The crucible is a standard graphite crucible, holding about 120 grams. If possible one of the new alundum lined graphite crucibles, on sale by the Norton Co., at Worcester, Mass., should be used, as it will be found more satisfactory than the standard graphite crucible.

(*Continued on page* 293)

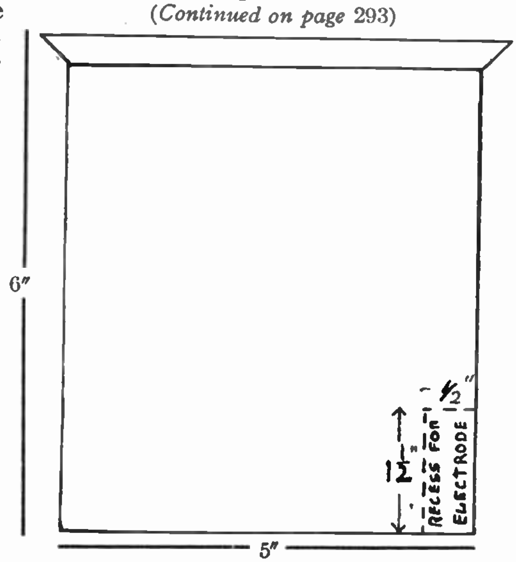


Fig. 4
Core for Casting Magnesia Lining

THE ELECTRICAL TREATMENT OF HIGH BLOOD PRESSURE AND HARDENING OF THE ARTERIES

JOHN H. BURCH, M.D.

(Electro Therapist to St. Joseph's Hospital and The Hospital for Women and Children)

That a man is as old as his arteries, is a trite but true medical aphorism. Arterial degenerations are the most frequent cause of death. In fact, it is estimated that over 50 per cent of the mortalities after fifty years of age result from diseased conditions involving the blood vessels.

Old age and premature decay is, in the great majority of cases, preceded by hard inelastic arteries. The walls of the blood vessels become thickened and brittle, the circulation of the blood is interfered with, the tissues of the body not being properly nourished shrink and degenerate, the store of energy lessens and the mental faculties deteriorate.

Most of the sudden deaths reported result from diseased arteries. The membranes lining the blood vessels become inflamed and at times ulcerate, their walls become inelastic and brittle, so that any sudden shock or emotion that unduly stimulates the heart may be sufficient to rupture the smaller vessels in the brain causing paralysis or death from apoplexy.

The great problem, then, in preventing premature old age and senile decay is to keep the arteries soft and elastic and free from disease. To accomplish this would mean the discovery of the true elixir of life. Normal old age cannot be prevented, as man was born to grow old and die. The present generation, however, become aged and decrepit long before their allotted time, and it is the duty of the physician to warn his patients of the cause and insidious nature of arterial disease, that methods of prevention and treatment may be instituted to prevent it.

To prevent or arrest the onspread of these degenerative processes within the walls of the blood vessels it is necessary to study their cause. Gout, alcoholism, excessive use of tobacco, overindulgence in eating, too little exercise and excesses of all kinds have always been considered the chief cause of hardening of the arteries. A careful analysis of these

Method of Measuring the Blood Pressure

cases, however, will disclose the fact that mental anxiety, worry, the strenuous life, the monotonous tread mill existence, associated with excess in eating and too little exercise and recreation are responsible for the great majority of these cases. Most of my cases have been successful business men of the most exemplary habits who have achieved financial success by strenuous effort and constant application.

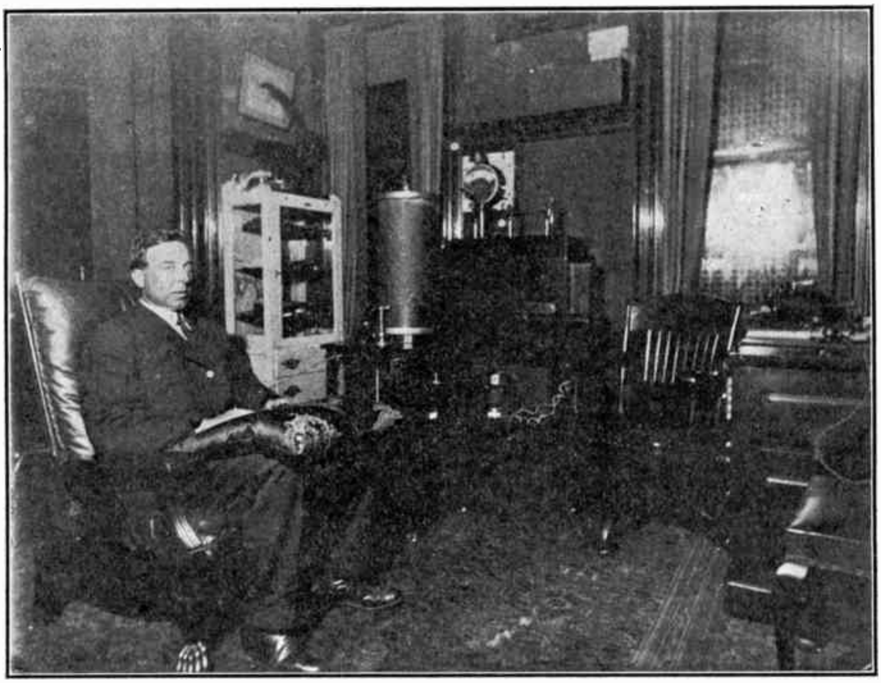
Recently an instrument has been devised called the blood pressure apparatus, or sphygmometer, that makes it possible to determine the approach or existence of arterial disease. Nearly every case of hardening of the arteries is accompanied or preceded by a high arterial tension. That is, the artery becomes hard, inelastic and incompressible beneath the examiner's finger, or the blood pressure apparatus instead of registering from 120 to 135 mm., as it should in a healthy adult, will be found to be much higher. This instrument is of inestimable value, as it enables the physician not only to determine the true condition of the arteries but at the same time, by its use, he is able to observe the effect of his treatment.

The treatment of this dreaded disease has been, until recently, very unsatisfactory. The drugs that were employed produced but temporary effects and had but little influence in arresting the degenerative changes within the walls of the arteries. Dietetic and hygienic measures have arrested the progress in some few cases, but the results as a rule have been far from satisfactory.

Several years ago d'Arsonval, while experimenting with the effects of electrical currents of very high voltage and frequency, upon the human body, found that by employing a special apparatus and technique, that it was possible safely to employ from 10,000 to 100,000 volts of electrical energy with a frequency of from 100,000 to 100,000,000 vibrations per second. A person subjected to this tremendous voltage experiences no sensation whatever; yet sufficient current is passing through his body to light an incandescent lamp and cause vacuum tubes to fluoresce held at some distance from his body. D'Arsonval found that, when properly applied, these electrical currents of high voltage and frequency caused a distinct lowering of the arterial tension that persisted for a considerable period of time after the application. This has been verified by many subsequent observers. D'Arsonval's method of auto-condensation has a most appreciable effect upon the interchange of waste and repair taking place within the body. The amount of waste material excreted from the body is greatly increased, more oxygen is absorbed and utilized in the construction of healthy tissues, while a larger volume of poisonous carbonic acid is liberated. By increasing the elimination of waste products the blood stream is freed from irritating poisons that cause inflammation and finally degeneration and thickening of the walls of the blood vessels.

In applying this method the patient sits or reclines upon a suitable chair protected by properly insulated cushions. Beneath the cushion is a large condensing plate of metal that is connected with the extremity of a small spiral of thick copper wire. The patient holds in his hands metallic electrodes that are also connected to one of the spirals of this small solenoid. The two extremities of this small spiral, or solenoid, are connected with the outer coating of condensers that are attached by their inner coatings to the secondary terminals of a powerful high voltage transformer. The patient receives, therefore, what is known as a shunt current from the condensers, that is further augmented by the self-inductance of the small solenoid. The patient may receive from 100 to 1,000 milliamperes of current with perfect safety, and many times this amount of energy is necessary to overcome high blood pressure. As a rule, the arterial tension will drop from 10 to 30 mm. after a séance of from ten to fifteen minutes. In simple high arterial tension the lowering of the blood pressure will be marked, while in true arterial disease it will be less after each treatment. During the interval between the treatments the blood pressure will again rise, but not to its original height. Each treatment will cause an appreciable lowering of the arterial tension until a point will be reached below which it cannot be lowered. When this point is reached, the index of the patient's blood vessels is determined.

One of my patients, a man sixty-five years of age, came to me complaining



Method of Treating Hardening of the Arteries by means of Electricity

of pain and numbness in his extremities. His memory that had previously been excellent became impaired. His face was flabby, the lower eyelids were swollen and the veins of the forehead distended. He suffered from insomnia, became very nervous and irritable and was prone to worry over trifles. He was a very successful business man who had led a strenuous life. His habits were most exemplary, and until recently his health had been apparently perfect. His arteries were hard and inelastic and the blood pressure apparatus registered 220 mm. After the first treatment by means of auto-condensation the arterial tension was reduced to 200 mm. At the expiration of two months he had received twenty treatments. His blood pressure at that time registered 160 mm. His condition was in every respect greatly improved. He discontinued his treatments for a month, at the end of which time his arterial tension was again taken and found to be but 165 mm. Several months later it remained about the same. This is a typical example of what can usually be accomplished by means of electrical treatment in these conditions.

Another patient had been told by her physician that she had organic heart disease and hardening of the arteries. The effect of this opinion was most disastrous. She became greatly alarmed and rapidly developed a morbid fear of impending danger. She dared not walk any distance, as she feared that her arteries would break; and she did not allow herself the requisite amount of sleep, as she feared that her heart would stop beating. An examination of this patient confirmed the statement of her physician. There was a valvular lesion of the heart, but nature had compensated for it by an over-development of the heart muscle, and it would possibly never cause her trouble. Her arterial tension was, however, very high. It registered 210 mm. After the first treatment the blood pressure registered 160 mm.: a reduction of 50 mm. This proved that the high arterial tension was of nervous origin. It required but a few treatments to re-establish a normal blood pressure and successfully relieve the patient of her morbid fear. This case demonstrates the value of exact methods for the determination of the arterial tension and the value of electrical currents of high voltage and frequency in lowering high blood pressure.

A MULTIPLYING AND DIVIDING INSTRUMENT

FREDERICK B. GILBERT

An instrument which will mechanically perform the processes of multiplying and dividing can be easily made for a few cents, and will not only be an interesting but a useful piece of apparatus. It is in reality a simplified slide rule, which is a tool used by engineers and merchants (chiefly in foreign countries), for doing rapid calculations in arithmetic and trigonometry by means of divided scales which can move back and forth across each other on sliding parts. This instrument will merely have *two* identical scales, one of which may move across the other.

The construction is exceedingly simple. Procure a piece of logarithmic cross-section paper which may be had from any dealer in draftsman's supplies. This sheet will be observed to be a square divided into different sized little rectangles. Heavy lines divide the square into large rectangles and these lines are numbered from 1 to 10 along each side of the square. Hold the sheet so that the numbers read right side up and cut off the margin on the edge nearest you just below the numbers. Now cut off a strip equal in width to one of the small divisions made by the lines running from left to right. Then cut off a strip equal in width to *two* of the next small divisions. You will now have two strips of paper about 9¾ in. long and ⅜ in. wide, both divided by a scale. These two strips comprise our sliding scales. The next thing is to make the sliding arrangement. Its construction with the proper dimensions will readily be seen from the figure. The easiest way to make it is to procure two slips of hard wood, 11 x 1 x ⅜ in. Saw out the slide from the middle of one of these by a bias cut so that when the two outside pieces are screwed to the other piece of wood the slide will work closely but freely between them. The paper strips are next glued on; the numbered one to the base, so that the numbers read from left to right, and the other one to the slide, so that its graduations can be made to coincide exactly with those on the numbered strip. Now, with india ink number the upper strip exactly like the lower one. Then number the other strip between the numbers 1 and 2 from 1 to 9, that is divide the space between 1 and 2 into 10 parts, as in the figure. It will greatly aid in reading the rule if the half-way divisions between all the numbers are slightly produced so as easily to distinguish them (see figure). For reference, letter the sliding scale *A* and the stationary scale *B*. The rule is now complete.

The operation of the instrument is based upon the principles of logarithms, *i.e.*, to multiply numbers add their logarithms, and to divide numbers subtract their logarithms. A knowledge of logarithms, however, is not necessary for a successful operation of the rule.

Let us first examine a scale and learn how to read numbers on it. We see that the whole scale is divided into 10 parts, and these parts into 10 other parts. We have numbered the large divisions with the numerals 1, 2, 3, 4, 5, etc. This marking, however, is purely arbitrary, for each number can just as well represent a decimal part or multiple of itself. Thus 5 can be called .005, .05, .5, 5, 50, 500, etc. The small divisions give the numbers between any two successive powers of 10. Thus 3.5 or 35 or 350 is represented by the long mark between the 3 and the 4 on the scale, 2.5, 25, 250, by the long mark between the 2 and the 3 on the scale and 1.3, 13, 130, is represented by the third graduation just following the 1 at the extreme left of the scale. In numbers like 455 the third figure can readily be estimated by the eye as half way between the 450 and 460 marks. The reading of the rule requires a little practice, but it soon becomes as easy as reading numbers that are written out in figures.

Multiplication.—The left-hand 1's on both scales are called the "left indices," and the right-hand 1's the "right indices." Without going into the theory, the following rule may be followed for multiplying two numbers together. Place the left index of the *A* scale over one of the numbers read on the *B* scale, then on the *B* scale, just under the other number read on the *A* scale, find the product. If the other number falls off the scale (*i.e.*, lies on the part of the slide projecting out), place the *right* index over the first number and proceed as before.

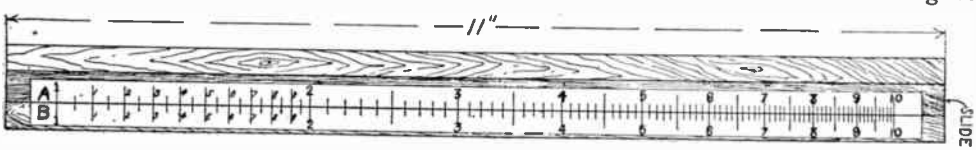
Example. 23 x 30 = 690.

Place the left index of the *A* scale over 23 on the *B* scale, and on the *B* scale, just below 30 on the *A* scale, read the answer, 690.

Example. 45 x 50 = 2250.

In this example it will be discovered that by placing either 45 or 50 on the *B* scale under the left index on the *A* scale causes the other number to fall off the scale. Hence, place the right index of the *A* scale over say 45 on the *B* scale, and on the *B* scale under 50 on the *A* scale read 225, the answer.

Multiplying more than two numbers together simply means proceeding with



the product of the first two and the third number as with two numbers.

Division.—The following is the rule for division. Place the divisor read on the *A* scale over the dividend read on the *B* scale and under either index of the *A* scale (whichever lands on the rule) read the quotient on the *B* scale.

Example. 750÷15 = 50.

Place 15 read on the *A* scale over 750 read on the *B* scale, and under the left index of the *A* scale read the quotient 50 on the *B* scale.

Position of the Decimal Point.—In any number all the figures to the left of the decimal point are known as the characteristic of the number, and the characteristic of a number is expressed by the number of figures which make it up. Thus, in the number 643.57 the characteristic is 643 and it is expressed as 3, *i.e.*, there are three figures to the left of the decimal point; the characteristic of 6435.7 is 4, etc. In multiplying, the characteristic of the product is—(1) if the slide projects to the left, equal to the sum of the characteristics of the two factors; (2), if the slide projects to the right, equal to the sum of the characteristics of the two factors less 1.

Example. 4,500 x 2,000 = 9,000,000.

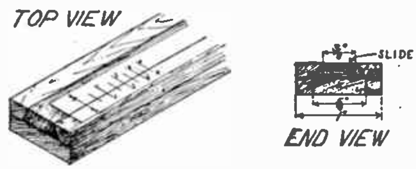
The slide projects to the left so we have the sum of the characteristics of 4,500 and 2,000, *i.e.*, 4 + 4 = 8, for the characteristic of the product.

Example. 320 x 3,000 = 960,000.

The slide projects to the right, so we have the sum of the characteristics less one, or 3 + 4 − 1 = 6 for the characteristic of the product.

In dividing on the slide rule, if the slide projects to the left the characteristic of the quotient is equal to the characteristic of the dividend less the characteristic of the divisor, and if the slide projects to the right the characteristic of the quotient is equal to the characteristic of the dividend less the characteristic of the divisor plus one.

Of course there are limitations to this instrument as to the number of figures



that can be read on it other than zeros, because of the inability of the eye to judge distances between graduations; but this slide rule may be a stepping-stone to one of the finer instruments that are more closely divided, and on which not only multiplying and dividing, but squares, square roots, cubes, cube roots, trignometric functions, logarithms, etc., may be rapidly and accurately read.

A Laboratory Electric Furnace

(*Continued from page* 288)

In melting small quantities of materials where the maximum temperature of the furnace is not required, it will be found more convenient to use a smaller crucible for the actual melting placed inside the one shown, thereby not disturbing the resistor material in lifting out the main crucible.

This concludes the building of the furnace. In the next paper the construction of a transformer to be used with the furnace and the operation of the furnace will be taken up.

(*To be continued*)

FOR THE LABORATORY

EXPERIMENTAL HIGH-FREQUENCY APPARATUS—Part V

STANLEY CURTIS

By no means the least important adjunct to the set of high-frequency apparatus is the spark gap across which the condenser discharges. It is a notorious fact that many a well-constructed and correctly-designed wireless telegraph station has been rendered inefficient and ridiculously low in power through inattention to the spark gap. That the same condition holds true in the case of high-frequency apparatus for exhibition purposes is very quickly made apparent while the outfit is in use.

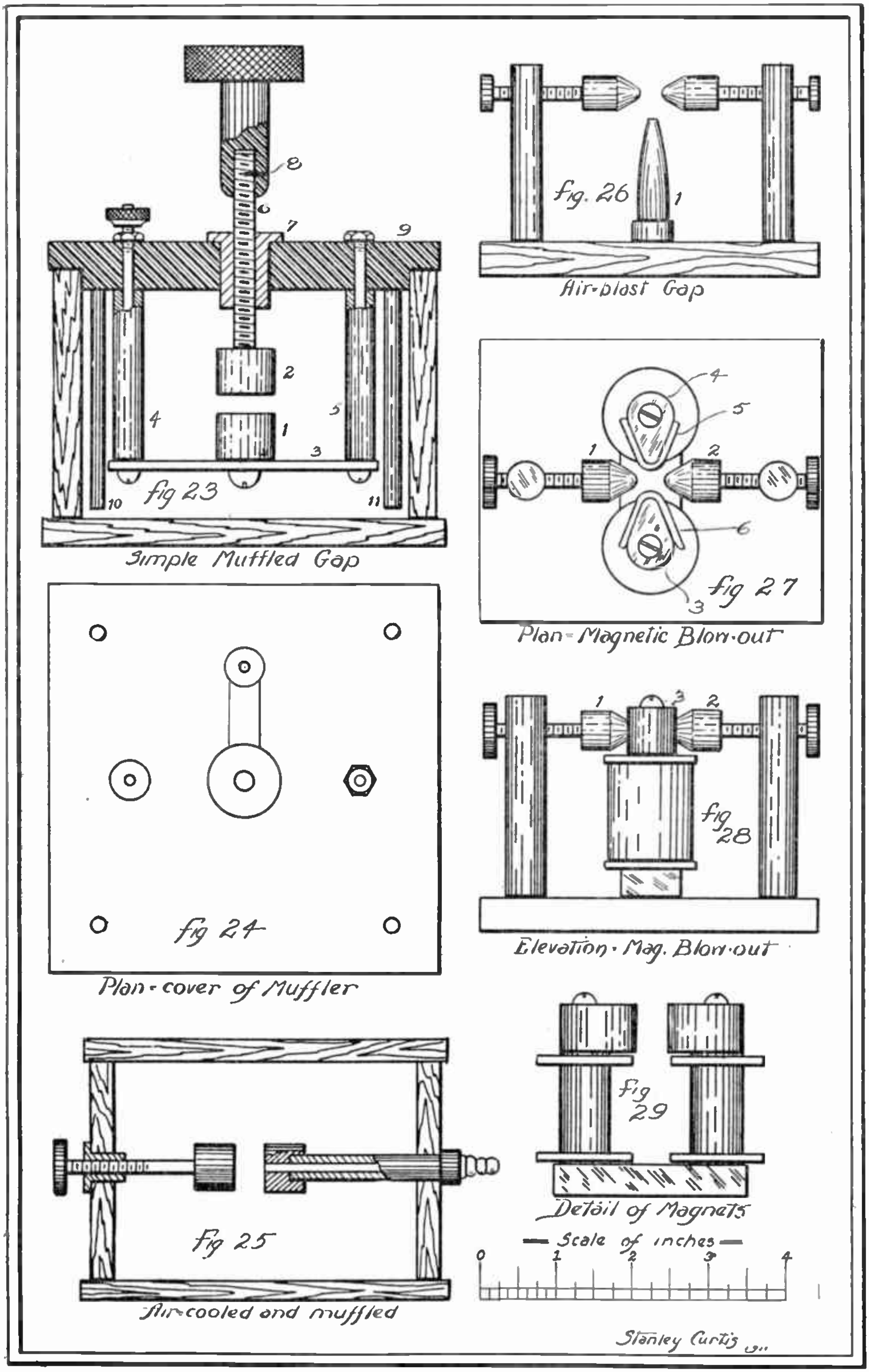
The builder has a choice of many types, each type having its own peculiar advantages and drawbacks, and it will be the aim of the author in the present instalment to point out the distinctive features of each form of gap, after which the builder may form his own conclusions as to which is most suited to his particular requirements.

The simplest form of gap and the one which has been most universally adopted on apparatus of comparatively low power is the form illustrated in Fig. 23. This gap is made in various forms, but it consists essentially of two plugs or electrodes of zinc, silver or aluminum, so mounted that one or both may be moved by means of their supporting rods which are in turn supported in pillars of insulating material or in metal pillars insulated one from the other, so that the distance or gap between the electrodes may be varied at will. The form illustrated in Fig. 23 has several points of superiority over the pillar type of mounting, and the construction of this mounting will be considered first of all.

The discharge of the condenser from even a small transformer is decidedly loud and unpleasant, particularly in the case of exhibition apparatus, and for this reason some means for muffling the noise of the discharge is highly desirable. This may be accomplished in several ways, but the plan suggested in the drawing will be found very effective. The construction of the gap will no doubt be readily understood on reference to Fig. 23, which shows a part sectional view. The electrodes, 1 and 2 in the drawing, are preferably of zinc. Several very successful alloys have been tried from time to time, and in the author's opinion, a mixture of one part of aluminum with two of zinc is very good. If the alloy cannot readily be made, the builder is advised to use zinc alone in preference to aluminum. Silver is said to be superior to either of the two other metals, but the author has found no decided advantage in its use. The electrodes may be cast roughly, after which they should be held in the lathe chuck, drilled, tapped and then mounted on an arbor for the facing off of the ends and the turning of the outside. It is imperative that the opposite faces should be quite true. The dimensions of the parts may be found by means of the scale to be found at the lower right-hand corner of the plate.

One of the electrodes is mounted permanently on a bar of brass, 3 in the figure, while the second electrode is carried on the end of a threaded brass rod, 6, which passes through a collar, 7, in the cover of the muffler case. An adjusting knob of fiber or hard rubber is fitted to the end of the rod and secured in place by means of the pin, 8, which is inserted in a hole drilled through fiber and brass. The fit between threads of the rod and collar should be a good one as it is perferable to use no setscrew to retain the rod in a given position.

If it is found necessary to use some


8
6
7
9
2
4
5
1
3
10
fig 23
11
Simple Muffled Gap
fig. 26
1
Air-blast Gap
4
5
1
2
6
3
fig 27
Plan - Magnetic Blow-out
1
3
2
fig 28
Elevation - Mag. Blow-out
fig 24
Plan - cover of Muffler
fig 29
Detail of Magnets
fig 25
Air-cooled and muffled
Scale of inches
0
1
2
3
4
Stanley Curtis

means for stiffening the action of the rod through the collar, the latter may be slotted with a hacksaw and the two halves slightly compressed.

The cover of the muffler or case, 9, should be of heavy fiber. The bar which carries the lower electrode is fitted to the cover in an obvious manner by means of the long sleeves, 4 and 5, which are drilled through and fitted with lengths of threaded brass rod. To the end of one rod is fitted a knurl to serve as a binding post. The fiber rods, 10 and 11, of which there should be four, are a convenience when the gap is lifted out of the muffler, as they furnish a support for the gap, so that it may be used without its case when desired. The case should be constructed of well-seasoned wood and lined with asbestos. The connections are shown in the plan view, Fig. 24.

This gap is simple in construction, and it serves very well for short periods of operation, but its disadvantages must not be overlooked. In operation a vapor is liberated inside the case and the tendency of the gap under such circumstances is to arc badly. One of the simplest and at the same time most effective methods of eliminating this bad feature is to use the arrangement shown in Fig. 25. This plan is adopted by one of the best-known makers of high-grade wireless apparatus in the field today, and it has been found highly satisfactory. The permanently-located electrode, 1, is carried on the end of a piece of brass tubing which may be connected to some source of compressed air supply, such as a small blower, and when the discharge takes place across the gap, the arc is immediately wiped out by the current of air which strikes the opposing surface at the center and clears the gap equally on all sides. The second electrode is made adjustable, as shown in the drawing.

Still a third form of gap is illustrated in Fig. 26. A muffler may be readily fitted to this gap, although the case must obviously have openings in it for the air to escape through. The compressed air is forced through a jet, 1, in a fine stream, and the arc is very effectively blown out thereby. The jet should be of glass, and for the amateur worker, a medicine dropper will be found satisfactory.

The magnetic blowout gap is a most excellent one, although some builders may find it a "poser" to construct. It is a well-known fact that a powerful and highly concentrated magnetic field will immediately quench an electric arc, and this principle is applied in the gap shown in Figs. 27 and 28. The discharge takes place between the conical points of the gap 1 and 2. Placed at right angles with the gap are the pole pieces of an electromagnet 3 and 4. Over these pole pieces are placed two shields of heavy mica, 5 and 6, which prevent the spark jumping to the magnet instead of across the gap. The drawings clearly show the construction of this device, and the dimensions may be taken from the scale. The magnets may be excited by means of current from a battery, and the winding will depend upon the voltage to be used. The author highly recommends this form of gap for its efficiency, compactness and general reliability.

Of all the gaps described, none can combine the points of superiority to be found in the revolving gap, illustrated in Figs. 30 and 31. This discharger not only quenches the arc and remains remarkably cool, but it produces a high-pitched spark, which has a distinct and very pleasing musical tone. The gap is no doubt quite familiar to most readers, and several excellent articles on its construction have appeared. As many readers have complained of the difficulty of obtaining the desired results through lack of proper material, and inability to follow the suggested construction, the author offers a few suggestions on the building of a simple but highly successful rotary gap which should be within reach of most readers, as the materials can be obtained at reasonable prices from firms advertising in this magazine.

One of the most important points to consider in the construction of this gap is the rotating disc, 1, of ⅛ in. aluminum. It is imperative that this disc should run very truly on the motor shaft, as the length of the gap may be quite short. The plan suggested for working up the disc will be found practicable and effective.

Referring to Fig. 32, the reader will note that a square of aluminum is cen-

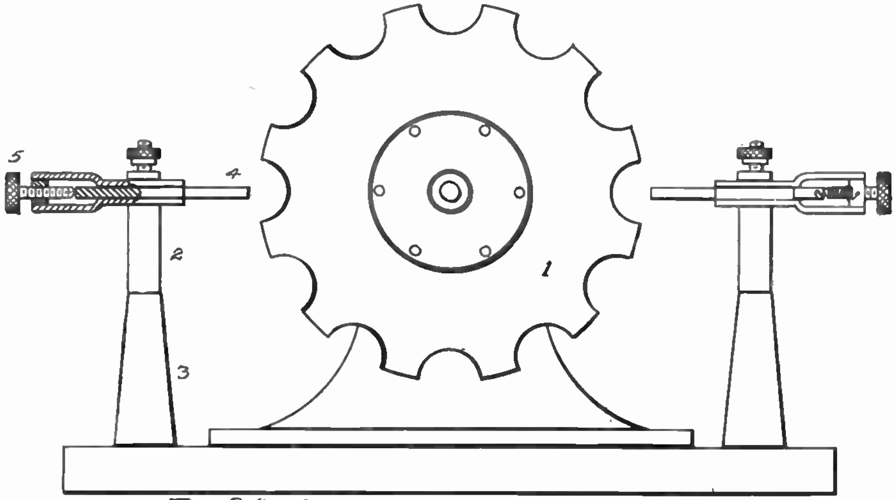


Fig 30 Side elevation of Rotary Gap

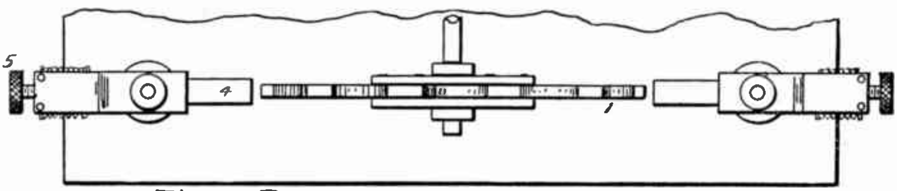


Fig 31 Plan of Rotary Gap

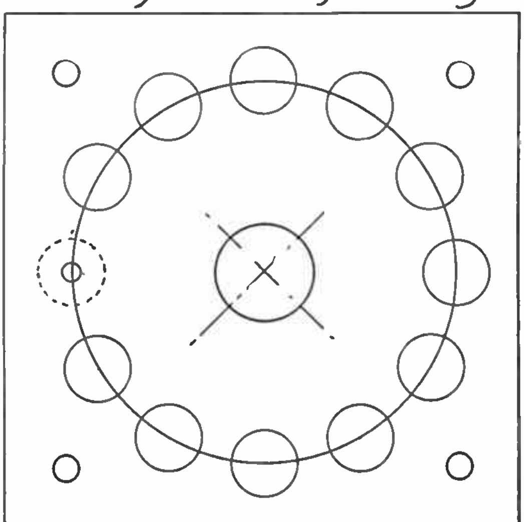


Fig. 32 Laying-off disk

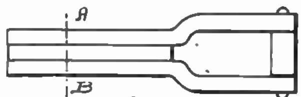


Fig 33

Fig 34

Section on "AB"

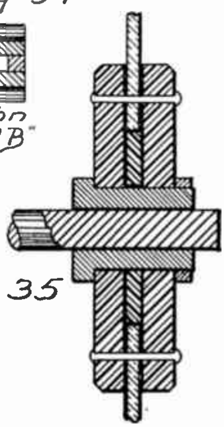


Fig 35

Scale of inches for Figs. 30, 31 and 32
Detail drawings Twice this scale

Stanley Curtis 1911

tered by means of its diagonals, and a circle having a diameter of 6 in. is struck off. The circumference of this circle is then divided into twelve parts and each point marked with a center punch. A hole is drilled in each corner of the plate so that it may be fastened to a wooden faceplate by means of heavy screws. A 1 in. counterbore will be required for cutting the holes which form the teeth of the gap. Each of the twelve divisions on the plate is to be drilled through with a suitable size of drill to take the tongue of the counterbore, after which the holes may be bored to their finished size. In drilling, or otherwise working aluminum, the metal should be generously lubricated with kerosene oil. After the holes have been cleared, the work should be mounted on the lathe faceplate and the center hole cut to 1½ in. in diameter by means of a very small parting tool. After clearing any burr which may be on the edge of the central hole, the disc may be cut from the square plate on the 6 in. circle. In taking this cut, the feed must be very slow and the greatest of care be taken so that the tool will not catch on the teeth of the disc.

The aluminum disc is mounted in an insulating bushing as shown in the sectional drawing, Fig. 35. The bushing may be of heavy fiber made up in the form of washers, as shown, or preferably turned up from two thick pieces of stock, thereby doing away with the central washer. The aluminum plate is riveted between the fiber discs by means of brass escutcheon pins, and the whole is mounted on a brass bushing which fits the shaft of the driving motor. The final cut on the edge of the aluminum disc should be taken while the brass bushing is mounted on an arbor. This will insure the disc running truly when it is in position on the motor shaft.

The motor may be of the induction type and any of the small power motors on the market will answer. A small fan motor is very satisfactory. The speed of the motor will depend upon the tone it is desired to produce. The average induction motor runs at about 1,800 revolutions per minute on 60-cycle current, and this speed is sufficient unless a very high tone is desired.

The electrodes of the gap may be of round stock if extreme simplicity of construction is demanded, but the flat aluminum electrodes, as shown in the drawings, will be found more efficient. The holders illustrated may present some difficulty in construction, but they represent time and labor well spent. The electrode slides in a brass holder and its movement is controlled by the screw 5, Fig. 30, while a couple of spiral springs secured to pins in the electrodes and to the stock which holds the screw, keep the aluminum back against the screw.

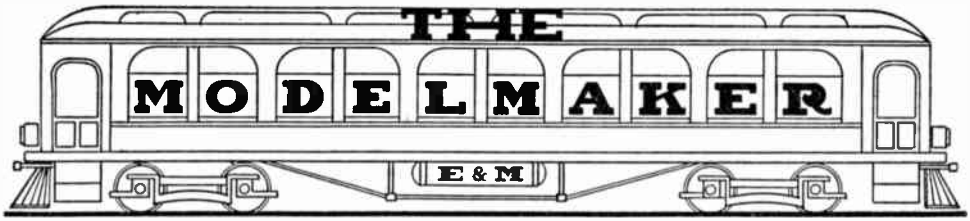
The construction of the holders will be understood more clearly on reference to Figs. 33 and 34, which are drawn to double size. The stock is ⅛ in. brass bar and the upper and lower pieces are made identical with each other. They are joined, either by means of small rivets or by sweat soldering, to the pieces of ⅛ in. square rod, which serve to form a nicely-fitted opening through which the electrodes pass.

The holders are mounted on short pieces of brass rod, 2, in Fig. 30, which are in turn supported by the fiber pillars, 3.

While the present article concludes the constructional features of the high-frequency apparatus, the author hopes to present a few suggestions in the next number on the adjustment and use of the apparatus, together with some hints on the possibilities of the outfit from the lecturer's standpoint.

Cutting Square Threads

Here, according to a writer in *Popular Mechanics*, is a trick in cutting square threads in a lathe that is worth knowing. With an ordinary V-shaped tool cut first a thread of the proper lead that will be equal in depth and width to the cut of the finished square thread. Then follow down with the regular square tool. This relieves the square tool of a considerable part of the work, and makes it cut a divided or broken chip, which is easy both on the tool and the work. In any thread-cutting, use a roughing tool first. If more than one piece is to be threaded, rough first and then finish. This keeps the good tool sharp and gives a nice finish. Speed up the roughing tool and let it dig out the metal, disregarding the finish.



THE EQUIPMENT OF A MODEL ENGINEERING WORKSHOP

W. S. FARREN

In equipping his workshop, the model engineer of today has many advantages over his fellow of ten years ago. He also labors under one disadvantage. Whereas it is now an easy matter to get practically anything that is likely to be required in his work simply by producing the necessary money, then many things, now quite common, were absolutely unobtainable. In fact, then it was a case of making things serve purposes for which they were not expressly designed, for lack of the proper articles, which was good training, although at times wearisome and discouraging. Nowadays, the beginner is apt to be discouraged by the very simplicity of everything. His path is, in fact, too easy. If he is not particularly hampered in the matter of money he is much tempted on starting his hobby to get an array of catalogues (generally with a preference for the gratis variety), and from them to make such a selection as he deems necessary to put him in a fair way of being a model engineer. This seems to me (and I am sure it must seem so to many other readers) a very poor and tame way of doing things. Most of us look back with pleasure to those days when we struggled along on a corner of the kitchen table with a few files and drills. We remember with amusement our pride in our first home-made lathe; not for worlds would we *now* have started in any other way; *then*, perhaps, if we had had the chance, we might have done so. Accordingly we bless Providence that gave us little money, but much patience. This is a digression. It will serve, however, to impress on the beginner—for whose benefit this is written—to be careful at first not to overdo things. Tools will be bought of the use of which he has but a hazy notion, and ten to one spoilt in the process of finding out. In the old days one had to *make* one's tools, and by making them one learned to know and respect them.

In this respect the beginner of today, whose purse is limited, is better placed than his more fortunate confrere. The very nearness of the things, which, on account of their price, are inaccessible to him, is but another encouragement to him to make them. I am aware that what I have said is by no means new, but I have thought it well to say it in

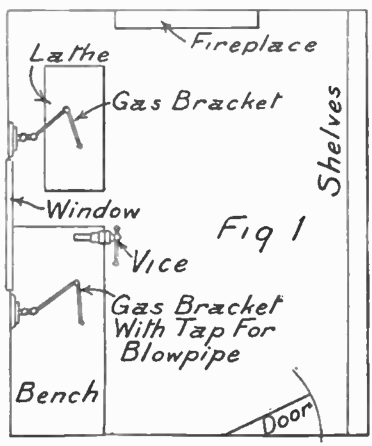


FIG. 1.—ARRANGEMENT OF A TYPICAL WORKSHOP.

order to make it plain that if I were asked by a friend who, say, had occasionally visited me in my workshop, and had been attracted by the evident charms of model engineering, what was the best way to start on his own account, I should not say, "Take this list to So and So's, write out a cheque (even if this were possible), and then fire away;" but rather I should advise him to do as I and many others did, or had to do, and start humbly, gradually adding to his stock of tools as he added to his stock of knowledge.

In order to guide him, the following hints may serve; but in no way do I advise getting all, or, indeed, anything like all, of the tools enumerated in a block at the beginning. Rather let him accumulate gradually on the lines indicated, never getting an inferior tool with the intent to replace it later when worn out, but either one of the best quality at first, or one which lends itself to improvement as he acquires the ability to effect it.

In the first place we will suppose he has secured a room or shed to himself. If a room, it will probably have gas laid on (if in a town). If not, it will pay to have it done by a gas-fitter (unless he feels capable of doing it himself), as it will save much annoyance later on. He should carefully plan where his various tools are going to be placed, paying especial attention to the bench-vise and the lathe.

Fig. 1 shows a very ordinary room, with the positions of the various parts of the outfit suggested. Here, of course, each one must suit his own convenience, according to the resources at his command. If in the country, or at the end of a long garden, gas will probably be inaccessible, in which case oil lamps must be used, unless petrol gas is installed, a system which from experience I strongly recommend as cheap, safe, and convenient. If he does have gas, he should make provision for a branch tap over the bench for fixing blowpipe or gas stove.

The first consideration is the bench. It is absolutely unnecessary to have a very thick top, as is used on a carpenter's bench. It merely adds to the expense, and for metal work, especially light metal work, is not essential. If fixed to the wall securely (practically made a part of the building) a very suitable material is planed floor-boarding, 7 in. wide by ⅞ in. thick. I have tested this by experience. Only do not stint for legs, for which 3 x 2 in. is ample, with a 3 x 3 in. at the corner where the vise is mounted. If, as is probable, the beginner has had some experience in carpentry, there is ample scope for him to show his ability in the drawers, which should be deep, with shallow sliding trays for small work. He should also put up shelves in convenient places, and not in general above the level of his chin, unless to be kept for boxes and other large and easily seen articles. Lower shelves for small articles should have edging put on ½ in. above the surface to stop things rolling off. While installing this part of his equipment he should be careful to repair any places in the wall where rain-water might leak in, as it is fatal to keep good tools in a damp place. Time spent thus will be well repaid later on.

The first tool to be bought should be a vise, which should be of the parallel jaw variety. If he has not much space he will probably content himself with one, in which case 3½ in. jaws will be found suitable. If he can afford the space and money for two, let one be 5 in. jaws for heavy work, and one 2 in. jaws for light work. Copper jaws should be made for both, and later on lead ones. When he becomes very luxurious he may add a leg vise, which, for really heavy work, such as forging, etc., cannot be beaten. Much, however, can be done without it; it must be classed as very optional. I advise mounting the vises so that one can work at the light vise sitting down, and at the heavy one standing up.

We next come to hand tools in general. Hammers are important, and should always be seen before purchasing, as it is important to get those which suit the user. Two are sufficient—one about 4 oz., with a cross-pane; and one (1½ to 2 lbs.), with the ball pane. If these are not bought together, the smaller one may be got first, as much can be done with it alone. As an optional accessory may be mentioned a brass or copper hammer for use on finished work. The 4 oz. size is sufficiently heavy.

On the quality and suitability of one's files depends the pleasure of one's work. They should therefore be carefully chosen. For a start the following is a good selection:

(*a*) *For heavy work.*—One 12 in. hand, second cut; one 12 in. half-round, second cut.

These will be found invaluable in taking off a lot of metal, as a good sweep can be got without fear of knocking one's knuckles.

(*b*) *For medium work.*—One 7 in. hand, second cut; one 7 in. hand, smooth;

one 7 in. half-round, second cut; one 7 in. half-round, smooth; one 7 in. three-square, second cut.

(*c*) *For very light work.*—One or two sets of six 3½ in. files of various shapes (round, square, knife, etc.) on card.

A file card for cleaning files is necessary, and the third variety is the best. The medium files should be purchased first, as they are the most useful, then the fine ones, and finally the heavy ones.

For cutting sheet metal and chipping castings, etc., chisels are used. They are really best made at home, as one can then suit one's fancy as to length and size. A useful selection is: One 6 in. x ½ in. flat, and a set of four on a card 4 x ¼ in. (half-round, diamond, cross-cut and flat).

Center punches come in the same category. Two are sufficient, 4 in. long, one large (about ³⁄₁₆ in. at the end), and one small (about ³⁄₃₂ in.).

A hacksaw is a necessity. Beware of the cheap variety, as they are a snare and a delusion. A first-class one of American make to take blades of any size from 6 to 12 in. costs from 75 cents to $1.50, and will last forever. The tension is adjusted by the handle, which does *not* come off at the critical moment. The blades should always have fine teeth (23 per inch), and 9 in. is a convenient length. It is as well to find a good make by experience and keep to it, as nothing is more annoying than to break one's last hacksaw (when all the shops are shut), simply because it was a waster. As optional may be mentioned a piercing saw, which is handy for small work, though a fret-saw can be made to do most of its work.

The important question of stocks and dies now arises. For a start I advise getting the following sizes: 2-56; 3-48; 4-36; 6-32; 8-32; 10-24; 12-24 and 14-20.

I find that one seldom requires to go above ⁵⁄₁₆ in. Later on the intermediate sizes up to ½ in. can be added, but above ½ in. is entirely unnecessary. These sets include taper and plug taps, which are generally sufficient. Those below ¼ in. will be found very fragile, and when replaced only the very best quality should be bought. For the smallest sizes, squared taps have the advantage of greater strength, but, with careful use the grooved type will be found superior. A "tap-die" should be included for each set, which makes the stock into an adjustable tap wrench.

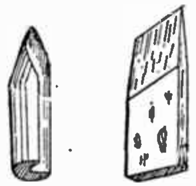
Before the screwing tackle can be used, some drills must be procured. These should be of the twist variety, and for a start the following set is recommended: Nos. 48, 44, 41, 33, 28, 23, 15 and 10 for tap drills; Nos. 42, 37, 31, 27, 18, 9, 1 and ¼ in. for body drills. As time goes on the intermediate sizes may be added: but the first set will do most of the work required for a long time. Stands for the drills should be made of ¾ in. polished hardwood, each drill standing in a hole ½ in. deep, the sizes being marked plainly. It will be found that the hole drilled at first in the wood block will fit the drill that made it tightly; it may be loosened by working the drill backwards and forwards. The holes must be drilled vertically, otherwise the whole thing will be an eyesore. If made before the lathe is purchased, it is best to get a friend who has either a lathe or a vertical drill to do it, as it is almost impossible to make sure of them being vertical if drilled with a breast drill. The latter is a necessity. The choice lies between one taking up to ⁵⁄₁₆ in. at about $1.50, or one taking up to ⅜ in., with mushroom head and two-speed gear, at about $2.50. The latter is much the better. A couple of combined center drills should be procured when the lathe is ready, one small (size E) and one large (size A).

Among the hand tools not yet mentioned are pliers and snips. For the former I recommend the well-known make with parallel jaws. These are but little more expensive, and are infinitely above the ordinary kind. A selection which will fill most requirements is as follows: Heavy flat-nose, 4½ in.; heavy round-nose, 4½ in.; toggle-jointed cutting nippers, 5 in.; to which may be added at a later date: Light flat-nose, 4½ in.; and gas pliers, 5 in.

The snips should not be less than 10 in. in length, as they should be able to cut ¹⁄₁₆ in. sheet brass.

Among the sundry hand tools to be found in every workshop may be mentioned hand vises, of which two sizes are sufficient, and broaches and reamers, which are best accumulated gradually, as wanted for specific purposes. A handy accessory is a magazine screw-driver, with a set of four blades. For small work this is invaluable.

We now have a very good assortment of hand tools, which will start a model engineer well on his way, until he finds the need of a lathe. And here there are three courses open to him, depending both on his inclination and on his means.



WOOD-TURNING TOOLS.

He may either decide to start with a plain lathe of good quality, so constructed as to admit of conversion to screw-cutting at a later time (such are readily obtainable), or he may get one of the several makes of low-priced screw-cutting lathe now on the market, or he may "go the whole hog" and spend, say, from $75.00 to $200.00 on a really first-class lathe. Some words of guidance may be of use. It is necessary in the first place to decide what form of motive power is to be used. I advise that for at least a year he rely entirely on foot drive. This is safer, both for him and for the tool, and is in many ways handier. Personally, I never feel so at home with a power drive as I do with a foot drive; but, like everyone else, I appreciate its advantages when a heavy job is being done. When he has become thoroughly accustomed to foot drive, and is complete master of his lathe, he may then aspire to power. For this I recommend a well-known ½ h.p. two-stroke vertical gas or gasoline engine as being amply sufficient, and very easy to start (I know of one which will start with one pull over). This may be used later on to drive an emery wheel, vertical drill and shaper, if required (not, of course, all at the same time).

We will suppose, then, that it is decided to use the treadle at first, at any rate. The question now arises: Shall the lathe be complete in itself, or a bench lathe with separate treadle? After experience of both kinds, I recommend for ordinary model work a bench lathe for the following reasons:

(1) It is slightly cheaper (inclusive of treadle).

(2) The bench being fixed to the wall, the lathe is firmer than if on its own legs, which are seldom quite steady longitudinally.

(3) The bench is all round the lathe, which is infinitely better than the usual tray at the back, or small iron tray underneath the bed.

Let us then decide on a bench lathe. If the "gradual building up" scheme is adopted, a lathe (back-geared, with a gap bed) may be obtained (without treadle) at a low figure. To this may be added, as time goes on and experience accumulates, saddle, slide-rest and screw-cutting gear—all of which are stock things—until a complete screw-cutting lathe is attained of excellent make and ready for anything within its capacity. The treadle should be as heavy as possible.

If this process appears less desirable than the acquiring of a complete lathe, one's mind turns to the $25.00 variety. Of these there is one which, by reason of its novelty, workmanship, and material stands head and shoulders above the others, and the beginner need have no hesitation in investing in one, if unable to afford more money. Its great disadvantage is the absence of a back gear, but there are many ways of overcoming this difficulty.

To those who can afford the higher-priced lathe, the 3½ in. model by the same makers may be recommended as *the* model-maker's lathe. Description is needless, as it must be familiar to all readers. It has lately been improved, and may be said to represent the maximum value for its price. A larger lathe than this is unnecessary for model work, and this will work to its full capacity (perhaps I ought to add that I have no interest in these, or, indeed, in any other lathes, beyond the fact that I own one of the $25.00 ones).

A very good way for a beginner who can afford one of the last-mentioned lathes is to invest first of all in a fairly cheap single-geared lathe of good quality, and for some months to spend his time in acquiring facility in using hand-turning tools, both wood and metal. He will then be in a better position to manage his more complicated lathe, and he will never regret the time spent. If space is scarce, he may sell it on getting the screw-cutter, but if not it is an excellent plan to keep it for wood-turning and odd jobs, thus saving the other lathe from getting messed up with wood shavings. I strongly advise *some* preliminary experience before the novice tries his hand with a really first-class lathe.

The lathe as purchased will include a faceplate, driver-plate and two centers. These, with the addition of a dozen ¼ in. bolts and nuts, and one or two clamping plates, and two carriers—one taking up to ⅜ in., and the other to 1 in.—will enable him to do a great deal of turning, but he will very soon find the need of a grip-chuck of some kind. In spite of much that is said against them, I think the very popularity of the self-centering chucks shows that they are a real help. Personally, I should feel lost without one, though before I had one I got on very well with a bell chuck. The best size of self-centering chuck for model work is 3 in.; and two sets of jaws should be included. It must be used with great care. Straining at the key to put on extra grip is bound to force it out of truth, as is knocking work held in the jaws. If used properly it will last for years.

We now come to the question of turning tools. A certain amount of wood-turning will be done, for which two gouges (⅜ in. and 1 in.) and two chisels (½ in. and 1 in.) will be found suitable (see Fig. 2). For hand metal work, those shown in Fig. 3 will be all that the beginner will require. Most of the work will be done with the graver. This is not an easy tool to learn to use, but once the knack is found, practically anything can be done with it. The parting tool is best left alone until the others have been mastered. It is a very tricky one, and it is advisable to get some practical help from an expert. Slide-rest tools are practically innumerable, but most ordinary model work can be done with those shown in Fig. 4. The first four are for brass and cast iron only. No. 5 is a boring tool, Nos. 6 and 7 external and internal screw-cutting tools respectively, and No. 8 a parting tool (as dangerous as the hand one, or perhaps rather more so!). For turning mild steel I never use anything but a tool-holder. Mine (home-made, as, indeed, are all my tools) is shown in Fig. 5, together with the most frequently used cutters. These are made from 3/16 in. square self-hardening steel, and can be made by filing only in a very few minutes. Heated to cherry red, and left to cool, they are ready for work at once. My experience is that this is much more suitable for mild steel than the ordinary tool steel, and in addition the expense is very small compared with the latter.

As optional accessories may here be mentioned hand-chasers. The finer ones are generally the most useful, say 40, 30, 26, 24, 22 and 20 t.p.i. Also one to suit the lathe mandrel thread (internal only). Knurling tools are also useful. By far the best is the slide-rest held variety, with double knurls, but this is expensive. For knurling such articles as terminals, and thumb-screws, hand knurls may be bought to fit into a simple handle. Two each, flat and concave, of different degrees of fineness, will suffice (the con*cave* knurl will, of course fit con*vex* work, which is the most common).

This completes the equipment of the lathe, and the beginner will find the tools enumerated sufficient for most model-making. Later on he may add a 4-jaw independent chuck, but the faceplate will be found to act as a good

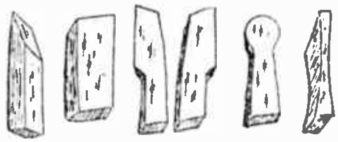


Fig 3.

METAL-TURNING TOOLS (HAND.)

substitute. Such accessories as mill ng attachments must be mentioned as desirable, but expensive. They really come under the heading of advanced apparatus, and in such an article as this, intended primarily for a beginner, are out of place. In the same category may

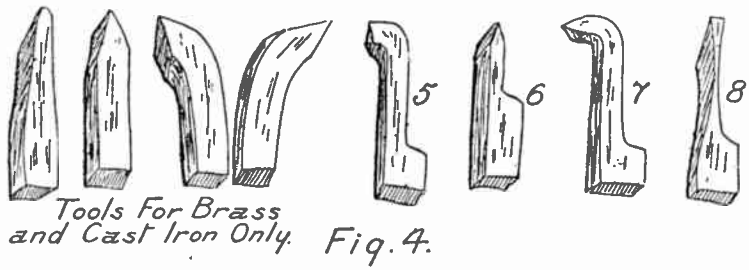


Fig. 4.

METAL-TURNING TOOLS (SLIDE-REST).

be placed shaping machines and vertical drills.

A good supply of tools is handy, but unless kept in good order they are an annoyance to their owner. For this a corundum wheel is required. This is superior to emery. I recommend the self-contained variety, driven by a treadle acting on the free-wheel principle. This costs about $6.25 complete, with a wheel 6 x ¾ in. The beginner is inclined to think this expenditure unnecessary, and to be content with a wheel mounted on a spindle in the lathe. But once let him get an important job set up in the lathe and his tool get blunt! He will then appreciate the separate affair. In addition, it is very bad practice to have anything in the shape of emery near a good lathe. Another consideration is that on the lathe it is impossible to get up sufficient speed really to *grind* tools. An oilstone is also a necessity, more especially for wood-cutting tools. For putting a finish on metal-cutting tools a carborundum hone is recommended as being quicker and giving a sufficiently fine finish for metal work.

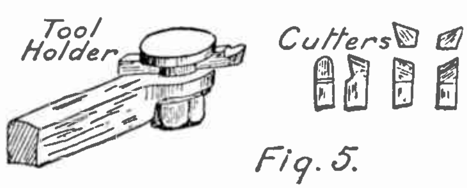


Fig. 5.

TOOL HOLDER AND CUTTERS.

An important part of the equipment is the apparatus for measuring. A 6 in. steel rule graduated in 32ds and 16ths is required for setting dividers and other general measuring work. The well-known American type of slide gauge, with vernier, micrometer adjustment, inside and outside jaws, and depth gauge, may be classed as a necessity. It will be found to fulfil most of the uses of ordinary calipers, and is much quicker to use. A pair each of inside and outside calipers may also be provided, being much used for testing parallelism in turned and bored work in the lathe. In addition, for scribing and setting out work a pair of spring dividers is required. Four-inch is a convenient size for calipers, etc. It is a mistake to have these too big, as they become clumsy to use.

Under this head may be mentioned surface-plate, scribing block, and vee-blocks. For accurate work of even the most elementary kind these are absolutely invaluable. The surface-plate should be as large as possible. It is better to have a large one planed only, than a fiddling little one—which is always just too small—fully finished; 8 in. square is the very least it should be, and for lining up bedplates, field-magnets, etc., 12 x 10 in. will be found better. (The oblong shape is more useful for its size than the square.) A very good substitute for a surface-plate is a piece of plate-glass. Two pieces should be obtained and rubbed together with carborundum and oil until a matt surface is obtained. This prevents the work from slipping. The scribing block may be of the ordinary type; in fact, it is best home-made. The elaborate ones are unnecessary for model work. 8 in. high is the best size for the spindle. A very good form of vee-block is obtainable with four vees. They are sold in pairs, together with a clamp for holding round rod to be drilled transversely. The price is very moderate.

Upon the availability or otherwise of gas depends the form of heating apparatus to be used for soldering and forging. If gas is on the spot nothing can excel a blowpipe and foot-bellows.

Various forms of blowpipe are sold, the one with separate gas and air controls being much used. In my opinion the "automatic" type, in which one tap controls both gas and air, thus keeping the mixture constant, is better, but it is much a matter of taste. Bellows are of two types—one having an India rubber bag, and the other having double bellows. The latter are better, but more expensive. A convenient size is 12 x 10 in. A piece of firebrick on a sheet of iron makes a simple forge. For soft soldering two irons are required—one about ½ lbs and one 2 oz. The hatchet-shaped kind will be found the handiest. An ordinary gas ring may be adapted for heating.

If no gas is available a blow-lamp is required. It is best to get a fairly large one, say, the 2¼ size, burning kerosene or gasoline. Later on a small self-blowing lamp may be added for light work. These cost about $1.00, and are quicker to light than the larger ones.

Before concluding I should like to impress once more on the reader the necessity for going slowly, and not getting too many tools at once, but thoroughly to master one before getting the next. When his equipment has reached the extent indicated in these notes, he may fairly deem himself a full-fledged model engineer.—*Model Engineer and Electrician.*

MR. A. V. ROE'S MODEL BIPLANE

Winner of London "Daily Mail" $375 Prize

Mr. A. V. Roe, whose early prize model we are describing, may well be counted among the British pioneers of aviation. He holds the proud position of being the first British aviator to pilot a machine in England, and this machine an original one of his own design and construction. The Roe triplane, or as it is known the aeroplane, flew with a lower horse-power than any other machine, and although the particular design is not used much now, some of the essential features are retained in the Roe biplane.

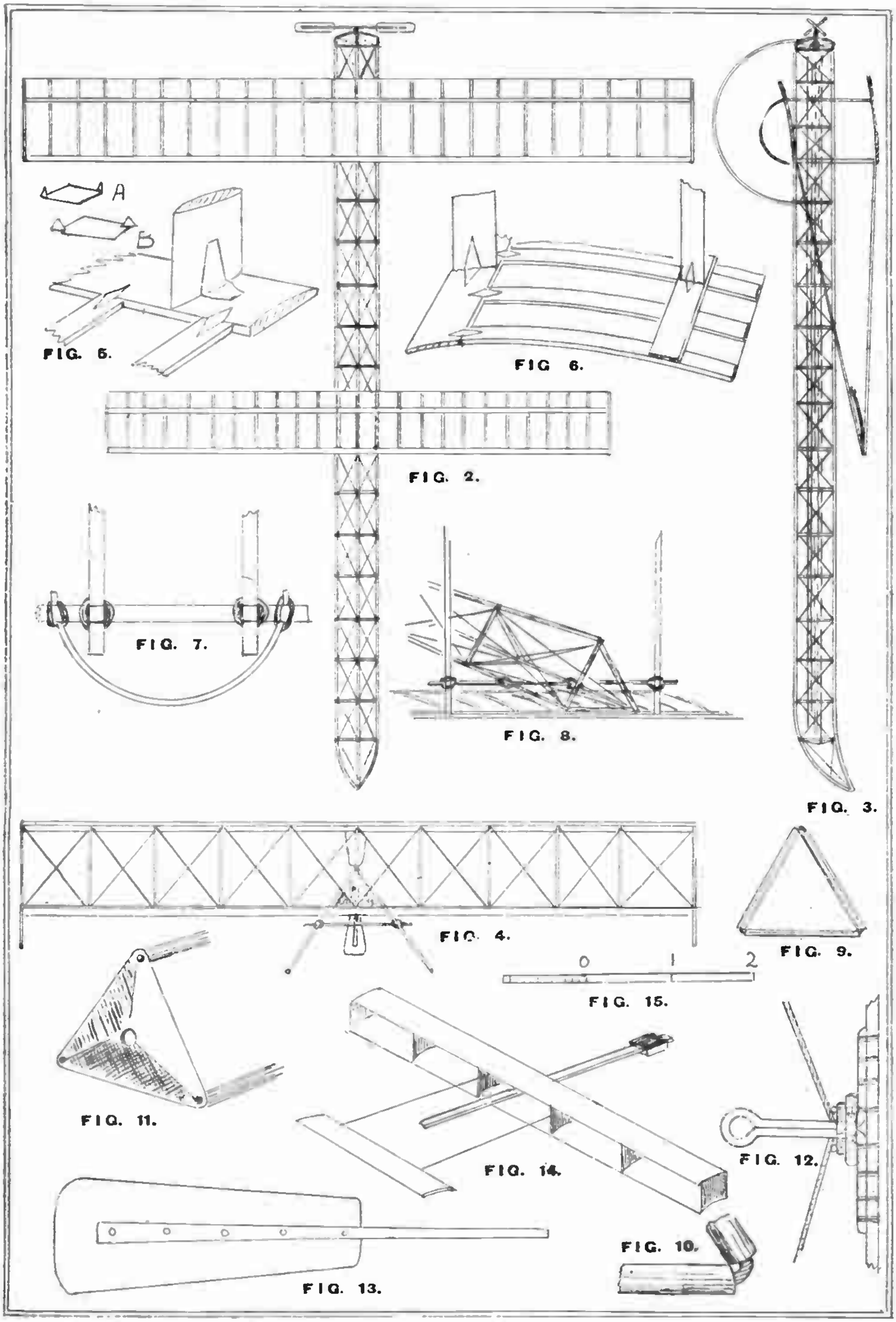
From early years Mr. Roe has been interested in the problem of artificial flight, and while at sea made a model fashioned on the lines of an albatross. For a time he was unsuccessful, and his interest flagged until hearing of the experiments of the Wright brothers in this country, he renewed his efforts, and built paper models of all sorts and descriptions.

About this time the *Daily Mail*, London, always a generous supporter of artificial flight, offered a prize for a successful flying model; this stimulated Mr. Roe to still further efforts. As paper models were easily and cheaply made, he tried almost every conceivable shape and form of aeroplane, and one of the most successful types had the main planes or plane (if a monoplane) in front with a non-lifting tail; in fact, the tail had a slight negative angle, so that the air beat on the upper side. The result of these experiments was seen in the biplane model, which won for its designer and constructor the prize of $375.

Mr. Roe was encouraged by this to commence on a full-size machine, and after a long and expensive series of experiments his well-known triplane, engined only by a 10 h.p. J.A.P. air-cooled engine, weighing only 250 lbs. and driven by a flour-bladed propeller of 7 ft. diameter, was the first English-built and driven aeroplane to leave the ground, and still remains the only successful triplane.

There is no doubt that Mr. Roe owes his success as a designer of aeroplanes to his early experiments with models, and every aero-model maker has a good example in front of him. It is yet possible to invent a new type of flying machine, and what one inventor, or, one may say, several inventors have done by experiments with models, others may do as well.

The framework, 8 ft. long, is of triangular shape, the main spars being either ash, spruce, or bamboo; the struts which occur at every 6 in. along the frame are made of bamboo, an old Japanese curtain providing struts about 4 in. long and 3/16 in. diameter. These pieces are strung together with string as



Length of main planes, 8 ft. Width of main planes, 12 in. Depth between planes, 12 in. Size of elevating plane, 6 ft. by 9 in. Length of frame, 8 ft. 6 in. Width of frame, 6 in. Propeller, 18 in. diameter. Motive power, 1/2 h. to [illegible] h., [illegible] square. Weight, 5 1/2 lbs.

2. Plan of model. 3. Side elevation (with dotted lines, showing position of elastic motor.) 4. Section in front of main planes. 5. Method of attaching ribs and struts to main spar. 6. Section of the lower main plane 7. Method of protecting the ends of lower main plane. 8. Method of attaching triangular fusilage to main planes. 9. Method of joining triangular struts. 10. Enlarged detail of above joint. 11. The hammered steel-end of fusilage. 12. Section of propeller shaft. 13. One-half of propeller, showing method of fixing blade. 14. The type of glider, which led up to the design of model. 15. Scale of feet.

shown at Figs. 9 and 10, the three pieces being tightly drawn together, the string tied up, and the knot pushed down one of the tubes. The long spars were kept in place by tin joints, as shown at Fig. 5A, and the whole fusilage strengthened by mild steel wire placed diagonally in each opening. The wire is lashed around each point about three times in screw-like fashion, left and right-hand alternately, until finished.

The main planes, 8 ft. x 1 ft., are built up of spruce, a front main spar, 7/8 in. by 5/32 in., carrying most of the strain. Ribs 5/16 in. by 1/16 in. are attached every 4 in., and are secured by tin clips, the ends being pressed into the wood by pliers. The tin for these clips is cut into an elongated diamond shape, the two sharp ends are bent up at right angles, and then the point twisted round so as to run the same way as the grain of the wood. The method is illustrated at *A* and *B*. (Fig. 5). The rear spar is attached about one-third of the width from the back, and the whole of the under surface of each plane is covered with tracing paper, glued to the ribs and the front spar. Upright struts 12 in. long are attached with bent tin clips to the long spars at intervals and the triangular frame is fixed to a cross bar by elastic, and this crossbar is then attached also by elastic to the vertical struts; thus the triangular body can be moved and adjusted in both directions immediately.

The elevating plane, 6 ft. by 9 in., is built up in similar fashion to the main planes, and is attached by means of rubber bands to the end of spars fixed to the main plane. The front edge of the elevator is exactly 3 ft. 6 in. from the front edge of the main planes. Adjustment is arranged for in a very simple manner, the normal angle of incidence being that shown in the side elevation. There is no rudder or means of obtaining directional control in the model, but in his full-size machine Mr. Roe relies on wing warping, for which he has a novel method.

A pair of semi-circular skids are attached to the triangular framing, and to the end of the lower main plane a round cane of 1/4 in. diameter is attached by rubber bands to a crossbar, fixed in the same way to the upright struts and shown at Fig. 7.

The propeller, 18 in. diameter with an effective pitch of 2 1/2 times the diameter, is made in two pieces, and attached to a brass rod 1/4 in. diameter. Fig. 13 shows the shape of one blade, which is made of No. 18 gauge aluminum riveted to the flattened end of the 1/4 in. brass rod. The hook for attaching the elastic is formed, as shown at Fig. 12, by a stout split pin bound with wire and soldered to the 1/4 in. rod. A ball thrust taken from the pedals of a bicycle runs against a steel plate, about No. 18 gauge, hammered out to give great compression strength. The plate is attached to the end of the fusilage, as shown at Fig. 11, a similar plate being fixed, the other end to take the other end of the elastic.

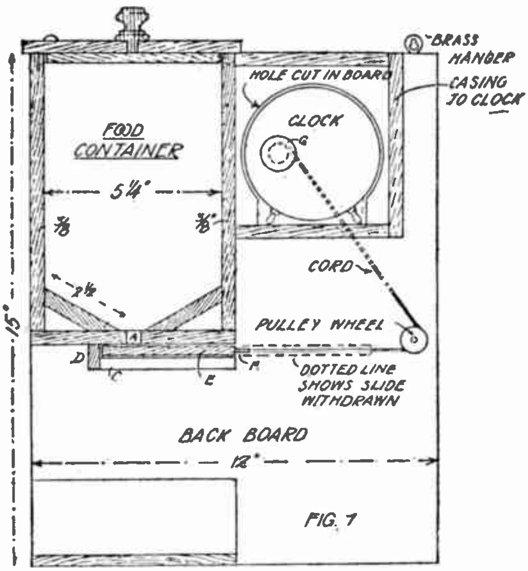
For the motive power, from 1/2 to 3/4 in. to 1/8 in. square finest quality rubber was used for the propeller.

Mr. A. V. Roe's model contains many original and novel methods of construction, and for a model of such large dimensions the weight of 5 1/2 lbs. showed that a lot of attention must have been devoted to details. The average distance attained by this model is between 150 and 200 ft., and when one considers the perfection to which models have reached at the present time, and the distances they are capable of, the utmost credit must be given to Mr. Roe for his efforts in producing a practical flying model as far back as April, 1907.

AUTO CHICKEN FEEDER

The diagrams printed on the following page indicate clearly the nature of this automatic feeding arrangement. By its aid chickens may be fed at any time according to the setting of the clock. It stands to reason that the clock must be re-wound and the box re-filled with food each time.

It may be asked by some why such an arrangement is necessary. It is within our knowledge that amateur poultry keepers occasionally find it necessary to go out in the early morning, after the chickens have received their first feed, and do not return until too late at night for their evening meal.



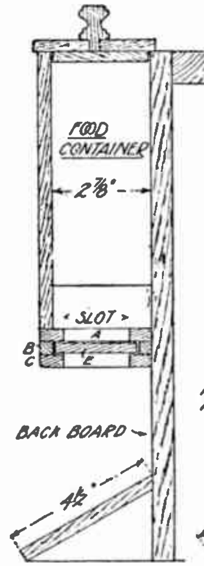
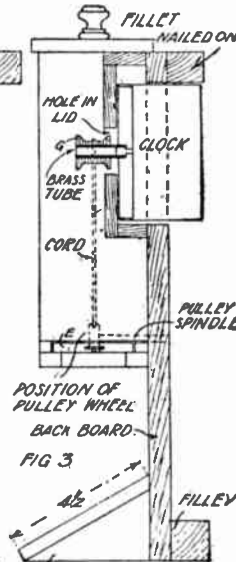


FIG. 2



BRACKET TWO OUT OF 3¾"x2⅛"x⅜"

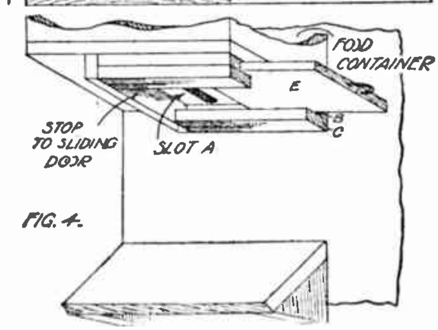


FIG. 4.

This arrangement in such cases comes to their rescue.

The whole is fixed upon a back board, which is to be made 12 in. wide by 15 in. long. A circular hole, 4¼ in. in diameter, is to be cut in its right-hand top corner, in order to receive the small alarm clock, which is a necessary part of the arrangement.

The receptacle for the food is a rectangular wooden box, constructed at the left-hand top side, with an overall measurement of 6 in. wide by 9 in. high and 3¼ in. from back to front. A false bottom is inserted inside the box in order to guide the grain to the slot marked *A*, through which it is released. The top of the box is merely a lid which lifts off. A plain wooden slide, which must run smoothly, is arranged to cover the slot underneath the box. This slide works in the fillets shown at *B* and *C* (Fig. 2). A staple, *F*, is driven into the forward end of the slide.

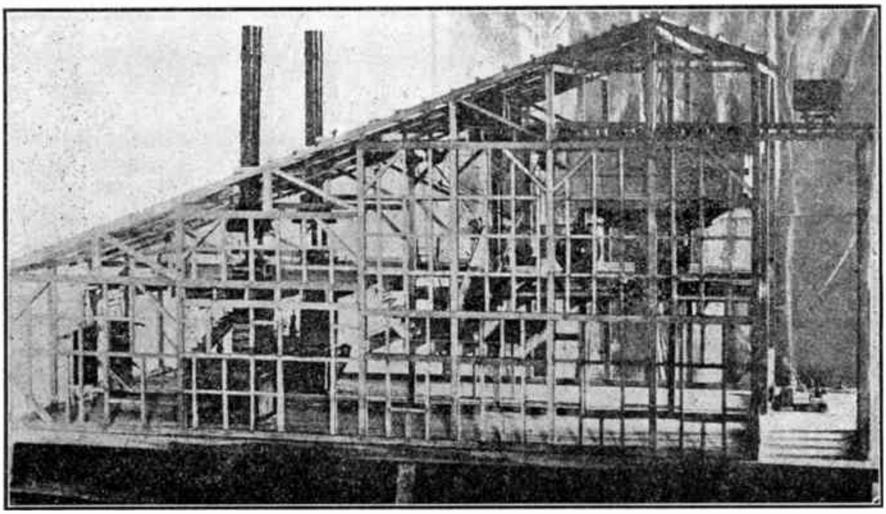
The clock has to be fixed in a casing, which is shown in Figs. 1 and 3. The handle for winding the alarm is taken off, and a small piece of ⅜ in. brass tubing is brazed or pinned on to the shank of the winder, from which the handle has been removed, and a small deeply-cut cotton reel is made to fit tightly over the brass tube. A simple pulley is thus formed, which will revolve when the alarm goes off. A pulley spindle, indicated in Fig. 3, has to be fixed securely in the back board. This must be of metal, possibly a large wire nail would answer the purpose, provided it was supplemented by washers. Care must be taken in fixing this spindle to see that it is fixed in the back board exactly level with the staple in the slide, and in such a position that there will be room for the slide to be withdrawn. A strong piece of thoroughly flexible cord must be fixed to the pulley at the back of the clock, while its free end is fixed to the staple on the slide. It must be tight when the clock is in its position, and the slide is right home.

Two fillets, the full width of the back board, 1¼ in. square, must be fixed top and bottom of the board to get clearance for the clock. These are shown in Fig. 3. A small sloping shelf should be fixed as shown at Figs. 3 and 4, in order that when the grain is released it may fall upon this and be well scattered.

MODEL ELECTRIC SMELTING PLANT

J. W. EVANS

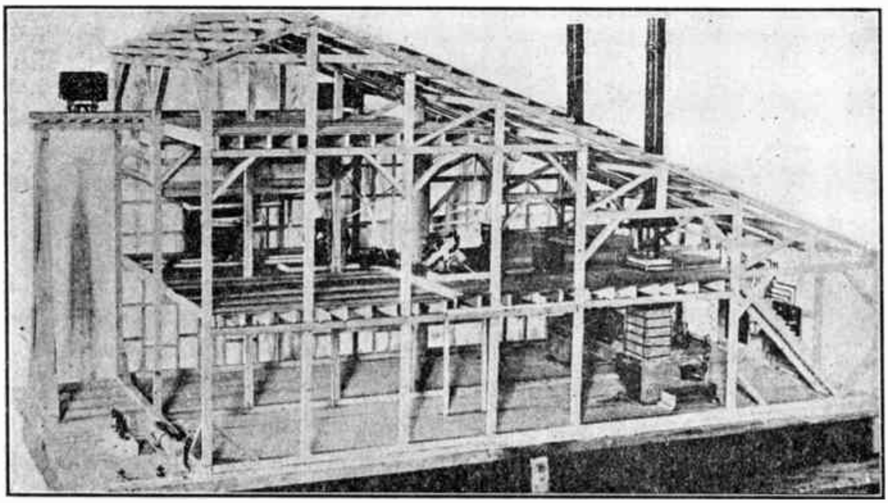
(*Editor's Note.*—We take pleasure in reprinting Mr. Evans' description of his admirable piece of model-making from the *Model Engineer*, London, in order to give our readers an idea of the development which this fascinating hobby has received in the hands of our English cousins. No doubt many of our readers will share our feeling of admiration for the ability and patience displayed by this enthusiastic model maker.)



Reproduced herewith are two prints of a working model of a 5-ton electric steel smelting plant for making high-grade tool steel directly from iron ores. All the machinery had to be designed and built up from solid metal. The only casting used was the main part of the mixing machine, which was cast from a pattern. It is interesting to note that in this electric smelting plant the writer has made 7-lb. bars of high quality tool steel from 14 lbs. of 51 per cent ore in an hour from the time the crude ore has been placed in the furnace. On one occasion a lathe tool, 1¼ x ½ x 6 in. long, was cast direct, and the mold chilled, the tool taken out, tempered and ground, and was in use in a 16 in. lathe two hours after the crude ore was placed in the furnace. This is a record. The model smelting plant is on a scale of ½ in. to 1 ft. Everything connected with it is exactly to scale.

The process of operation is as follows: The side dump car shown on top of the trestle conveys ground ore, limestone, charcoal and fluorspar from the grinding building to their respective bins, there being openings in the floor through which the materials are dumped. These four bins have openings operated by levers, the openings being all at one point, so that a car can be placed under these openings on the weigh-scales and the respective quantity of each material for the charge can be weighed out without moving the car. This car is then run along the track to the mixing machine, into which the contents are dumped, and the mixing machine is started. When thoroughly mixed, lime-water is added for a binder, and the movable blades on the mixing machine shaft are turned so that the material is moved towards the outside of the machine, which is circular, and a door in the side of the machine is opened and the material emptied upon a belt conveyer, where it is carried up to the briquetting machine. From the briquetting machine the briquets are taken to the drying shelves above the furnace, and when dry are dumped into the pre-heater stacks. The steel is tapped out from the furnace into molds in the usual manner.

An adjustable feeding device is attached to the back of the furnaces, which is run by power, and feeds the pre-heated and partially reduced briquets gradually into the furnace. The building is lighted by fourteen incandescent lamps, also to scale, as they are metal filament lamps less than ¼ in. in diameter. All the machinery is run by a small enclosed type motor, 2 in. in diameter. There are two slate switchboards with measuring instruments, switches, etc., all exactly to scale, with shaded lights on brackets above the instruments, and the necessary cut-out, etc. The electrodes in the furnaces are operated by hand wheels, being provided with rack and pinion movement. Every bolt and nut was made by hand on a small lathe, and every nut and bolt have hexagon heads. The cylinder contracted to 3 in., which compresses the briquets sufficiently. The furnaces are the double electrode type, being the Evans' patent steel furnace, having both horizontal and vertical electrodes. When the furnace is started the horizontal electrodes are first used until the bath is fluid and some slag has been formed; then the horizontal electrodes are withdrawn and the vertical electrodes are used, an arc being formed between each electrode and the charge. The furnaces are built of fire-clay, banded with iron and lined to represent firebrick. The frame work of the building is entirely of maple, with the posts, caps and bracing, etc., all pinned and glued. One side of the building is framed ready for the corrugated iron, the rest is left open to facilitate handling



belt conveyer is 12 in. long, representing 24 ft., and has sixty rollers, ten bearings above and ten bearings below the frame, with three rollers between each. The top bearings have studs placed at the proper angle to hold the angle rollers for supporting the edge of the belt. The belt is made of kid from ladies' long sleeve gloves, the flat belt used being also of the same material. All pulleys are slightly convex, and flat belting is used throughout. No trouble has been experienced from the belt running off. The briquetting machine is of the horizontal cylinder type, is self-feeding, and the cylinder is contracted from ¼ in. to ⅛ in., which represents a 6 in. the cars, etc. Sheets of corrugated galvanized iron were made by stamping out in a pair of dies, the corrugations being cut in a shaping machine, using the coarsest feed, *i.e.*, 1/16 in. center-to-center of corrugations. This gave 32 corrugations in each sheet of 2 x 3 in., representing sheets 4 x 6 ft. long. A portion of the roof is covered with this material, the balance being left open for better inspection of the shafting and machinery. All the machines have brass bearings, and are adjustable with movable caps, held down with hexagon studs. The connecting rod of the briquetting machine has studs made from an ordinary sewing needle, 3/128 in. diameter.

The model was begun on January 4th, that is, the drawings were begun. Then all the machines had to be designed, the building planned and framed, and the whole was completed in running order by the 25th of February, in time for exhibit at our Canadian Mining Institute meeting in Quebec on March 1st, 2d and 3d. That is, in 51 days it was completed. Needless to say, it was a case of night and day work continuously, with an average of less than six hours' sleep. The Geological Survey have purchased this model for their new museum at Ottawa.

MEASURING HIGH FLIGHTS

How Science Comes to the Aid of Aviation

FRANK WALDO, PH.D.

It is interesting to see how older methods of working out problems are adaptable to new problems. Thus when aviation became an assured fact, and it became a practical necessity to determine the elevations reached by the flying machines, and also the velocities attained by them, a number of methods were taken almost bodily from other applied sciences. In all the new applications of old methods to aviation there are, however, certain new features which have to be dealt with and new difficulties to be overcome.

We have before this had the problem to solve of finding the height of some object above the sea level or above some level of the ground which has been assumed as a base or plane of reference.

Lofty mountains rear their heads proudly above the lowlands and science has determined in feet or meters the elevation of the summits up to nearly six miles. The clouds fly at all various elevations above the ground up to heights of perhaps ten miles; and these altitudes have been measured.

The length of auroral streamers have been measured up to altitudes of many miles.

The elevation of meteor "smoke" or mist has been measured up to altitudes of thirty, forty, and fifty miles.

Kites have been sent up to elevations of over two miles and these distances aloft have been measured.

Balloons have carried men aloft to elevations of six miles and upwards, and the altitude has been measured.

Smaller balloons without passengers have been sent up to altitudes of eleven miles.

All these measurements have been made with scientific accuracy—that is, have been made by means of methods and apparatus that permit of definite quantitative results and furnish also an idea of the limits within which this result may be relied upon as to accuracy.

There are two methods, totally independent of each other, by which the elevation of the flying machine is determined. First, the method of triangulation in which the observations are made from the ground by observers who work totally independently of the aviator.

Second, the method of barometry, in which an aneroid barometer is carried along in the flying machine, and the instrument shows automatically, the pressure of the air at the flying machine, and from this the altitude is calculated. When a common aneroid barometer is used the aviator has to read the instrument when he wishes to observe the elevation of the flying machine; but when a self-recording aneroid barometer is used the reading of the aneroid is registered automatically on a sheet of paper.

HOW PROFESSOR WILLSON OF HARVARD WORKED IT OUT

It is a very pretty practical problem to determine the elevation and speed of a flying machine, and the interest of Professor Robert W. Willson of Harvard was enlisted in this matter. It is one thing to say how the problem should be worked out, but it is quite another thing to carry out the detailed work with satisfying success. The schoolboy glibly describes a method of obtaining the solar parallax, but it requires the skilled astronomer to determine its amount. Those who know the skill and experience of Professor Willson in solving somewhat analogous problems, know that he is probably the best person in the country for this task.

Professor Willson has worked out in detail two separate methods of triangulation for the Atlantic meet. In one method he used the theodolite transit instruments at the end of a base line extending nearly east and west, as described in this article. In the other method he used two specially mounted sextants located at the ends of a base line extending north and south. This sextant method appealed strongly to Professor Willson at the outset (perhaps because he is the best authority that we have in this country on sextant observations), but as a result of his experiences last year at Atlantic he seems to find that the theodolite transit method has superior advantages.

Regarding this sextant method as applied at Atlantic, Professor Willson says in a report made by him to the American Academy of Arts and Sciences: "A measured base of 5,000 ft. was established on the line *HS*, reaching from the extreme northern limit of the course, across the field, passing above the center of the grandstand, and terminating at a point just beyond the boulevard recently built by the Metropolitan Park Commission. The north and south direction was chosen in order that the observations might not be interfered with by the sun at the time of day most favorable for flight. It was expected that the aviators would cross this line near its center on each coil of the ascending spiral, and that the greatest height attained at such crossing would be taken as the height of record."

Regarding the practicability of this matter from the aviator's point of view, Professor Willson says: "It may be remarked that the use of (the other) method seems preferable to any that requires the aviator to attain his maximum height at a given point or line. If thus restricted, the Bleriot monoplane especially is at a disadvantage, as its construction makes it extremely difficult for the operator to see the ground at points anywhere near directly beneath him. This discussion of his ascending spiral, checked by observations of his descent, fixes his highest point quite accurately without placing any burden upon the aviator himself."

In this sextant method Professor Willson made a most ingenious arrangement of an artificial horizon which is too technical for description here. Two observers manipulated the two sextants, and were in telephonic communication (by private wire) with each other, as well as with the committee-room at the grandstand. A chart was constructed on which could be read off at once the height of the flying machine corresponding to simultaneous observations of its altitude as made at the sextants at the ends of the base line. From this chart altitudes up to 15,000 ft. could be read off.

THE THEODOLITE-TRANSIT

The first method of triangulation is carried out in detail as follows: The line of reference, or base line as it is called, is measured along the ground; at each end of the line there is an unobstructed view of the flying machine. At the two ends of this line are mounted instruments which measure both the vertical and horizontal angles over which a small telescope is moved. An observer placed at each telescope can, by means of the horizontal and vertical motion, keep the telescope pointed at the flying machine in the air. There are placed in the telescope two cross lines, of the apparent thickness of a fine hair, and these intersect each other at right angles at the center of the circular field of view when the eye looks through the telescope. Such an instrument is what the astronomers call an "alt-azimuth" instrument. Special forms of a surveyor's theodolite or a mining transit instrument are well suited for this work.

As a matter of fact, a special theodolite by Berger and a mining transit by Buff were used by Professor Willson in his application of this method to the aviation meet at Atlantic. It is needless to say that these instruments must be of the very best construction, as the accuracy of the results depends largely on this exactness of construction.

But when the base line has been measured, and the theodolites carefully set up there still remain accessories to be prepared. Observations of the position of the flying machine must be made at exactly the same instant by the two observers at the end of the base line. The general procedure in making an observation is about as follows: A telephone line between the two observers permits them to decide upon just what part of the flying machine the telescope is to be pointed (namely, the intersection the cross wires shall cover). Having decided this, an observer says to the other, "ready," and this means that both the observers are keeping the intersection of the wires directly covering that particular point of the flying machine. Then a few seconds later the first observer says to the other "set;" and each theodolite is left in just the position that it was when the signal "set" was given. The observers at the two theodolites are provided with timepieces which have been compared with the standard timepiece of the aviation meet.

Each of these observers notes the time on his own timepiece when the word "set" is spoken over the telephone. So that the time when the flying machine was at the place of observation by the theodolites, is known to a second. The watches of the theodolite observers are compared with the standard timepiece by means of telephonic signals. Some person counts off into the telephone the seconds on the standard timepiece and the two observers hear this and note the time by their own watches. Time comparison of this nature can be made between two good watches with an accuracy of about a quarter of a second, when some facility in this sort of procedure has been acquired through practice. There is probably not more than a difference of a single second of time in the actual making of the observation on the two theodolites. It has been found by practical experience that when the two observers are working quickly, complete observations could be made by this method at intervals of from 30 to 40 seconds. This may be further reduced.

This is the general method by use of theodolites that was carried out by Professor Willson and his assistants last year in the first Atlantic meet.

This year what may be termed an extension of this method has been made, which expedites the whole process and permits observation for definite altitudes.

THEODOLITE OBSERVATION

A third apparatus is called into play in connection with the theodolite observation. A horizontal table (called a "plane table") is set up and provided with two ruler arms. These arms are separated at one end by a distance proportional to the length of the base line. When the angles or the horizontal circles of the two theodolites are read off, after the telescopes have been "set" on the flying machine in making an observation, these angles are telephoned to the "plane table" operator and each ruler is set at the angle shown by the respective theodolite which it represents. The free ends of the rulers therefore intersect at a point representing on the paper the point on the ground directly beneath the flying machine. A calculated numerical table now shows just what vertical angle has to be observed on the theodolites in order to determine when the flying machine is at a certain height above the aviation field, so that by the plane table operator forewarning the observers at the two theodolites at what vertical angle the theodolite must be when a certain elevation of the flying machine is reached, an accurate observation may be obtained at that elevation. By this means the actual altitude of the flying machine in feet is known within a few seconds after the observation has been made.

This theodolite method of triangulation was given a second place in the preparation for the measurement of last year. Since, however, this year this method of observation has been given the preference, some specific mention of the base line will be of interest. It extends nearly east and west for a distance of 6,236 ft., and lies about 2½ miles south of the Aviation Field. One end of the base line is on Forbe's Hill, in Quincy, and has an elevation of 128 ft. above the Aviation Field. The other end of the base line is on the estate of Mrs. E. M. Carey, in Milton, and has an elevation of 71 ft. above the Aviation Field. The observers at the end of the base line could see each other, but they could not see the grandstand, and could not see the aeroplanes until they had risen to a height of from 50 to

75 ft. Concerning this choice of location Professor Willson says:

"The position of the base was selected so that observations could not at any time be interfered with by the sun, and that the angle of elevation could be measured without an eye prism (*i.e.*, by looking straight through the telescope) up to an altitude of more than 15,000 ft. above the center of the field. The distance from the field was not so great that it was necessary to read the angles with great accuracy (from an astronomical standpoint), while it was sufficiently great to reduce materially the difficulty in following the rapidly moving aeroplanes, so that it was possible to observe quickly and accurately both horizontal and vertical angles without a finding device."

This theodolite method of observing the height of aeroplanes is very accurate, and the error is not more than 10 ft., and is probably even less than that amount. During an hour's flight upward of sëventy-five observations may be taken, and this permits the heights and the times to be plotted on cross-section paper and a curve drawn showing the upward and downward course of the aeroplane.

If the aviator happens to turn from the ascent to the descent in between two observations this gap in the curve may be filled in with considerable certainty unless some accident has suddenly changed the course of the aeroplane.

The accuracy with which an aeroplane can be observed varies with the rapidity of movement. When the motion is very rapid, as that in descent, which may be from eight to ten times as rapid as the ascent, the making of an observation becomes very difficult, since the intersection of the cross wires in the telescope of the theodolite have to be set on the rapidly moving object in both instruments simultaneously.

The theodolite method, while of great accuracy, has certain limitations. Only one aeroplane can be conveniently observed during its flight. It would be possible, certainly, to have three or four machines in the air at once and observe them in succession, but this would leave each one too long without an observation, and there would undoubtedly arise many errors due to confusion of the aeroplanes. Thus this method is distinctively a single-flight method.

If it is desired to observe several flights simultaneously, then a pair of theodolites and two observers must be provided at the end of a base line for each machine.

A more serious drawback is the interruption of observations by the aeroplane passing out of sight of one or both of the theodolite observers owing to fog, cloud or a sudden shower.

The skill required on the part of the observers in making accurate observations is much greater than would be imagined, and a long preliminary training in this particular work is undoubtedly necessary. Probably good training with the sextant such as Professor Willson gives his pupils in his college instruction is the best preparatory training offered by any of the usual processes of scientific observation. The work requires much concentration and rapidity of manipulation on the part of the observer—a combination of the accuracy of geodetic work, the co-ordination of astronomical work and the facility of field surveying.

THE BAROMETER

The only rival and the supplement of the theodolite at the end of a measured base line, in observing the height of aeroplanes, is the aneroid barometer. This comes in two forms. The instrument has the form of a watch or small round clock, and in which the reading is made from a hand moving around over a clock-face or dial. This hand shows the atmospheric pressure on a scale of inches (or centimeters), which takes the place of the hour and minute divisions on a watch dial. Such a barometer, if well made and in good condition, may be read to hundredths of an inch (or tenths of a millimeter). The position of the hand on the dial must be read by the person using it just as a watch must be read to tell the time.

The barometer works on the principle that the pressure of the air is the weight of the air pressing down from above, and with ascent above the ground there is less air above and consequently a reduced air pressure. This air pressure at sea level is about the same as the weight of a layer of mercury about 30 in. deep, but the air pressure decreases with ascent above the ground at the rate of about one-thirtieth for each 1,000 ft. of ascent. So that for each 1,000 ft. of ascent (in the lower part of the atmosphere) the weight equivalent to one inch of mercury would be taken off the air and the pressure of the air be reduced accordingly. The aneroid barometer is a little metal box from which the air inside has been removed. The outside air presses on the sides of the box and causes them to spring in slightly. The amount of this springing, which varies with change of outside air pressure, is measured by the hand moving over the division on the dial.

The hand of the aneroid barometer reads lower and lower as the instrument is carried aloft by the aeroplane. A good aneroid ought to show a noticeable shifting of the hand for each 10 or 20 ft. of ascent or descent—about 1/10 in. change on the dial for each 100 ft. of rise or fall.

Self-recording aneroid barometers are also made in which the movement of the hand is registered on a piece of paper which is drawn under the hand by means of a little clockwork. The barometer hand carries a little pen which traces the movement of the hand on the piece of paper. By this means a continuous record is made of the movement of the hand, and consequently of the elevation of the aeroplane which carries the instrument.

These little self-registering aneroid barometers are now sent up in the aeroplane on each important ascent where a sure, unbiased record is desired. The aviator has nothing to do with the instrument which is put on the machine by the "committee" and at the end of the flight is removed by them. It furnishes an independent and fairly accurate record of the whole flight.

It must always be remembered, however, that an aneriod barometer is a very fragile mechanism and very liable to get out of order—a self-registering aneroid being particularly liable to disturbance.

The best form of self-registering aneroid barometer is that constructed by Richard of Paris, but several modifications have been effected for special uses. A very light form of Richard barograph was designed by M. Du Bort of Paris for use in small balloons which have carried these instruments up to a height of about 11 miles above the sea. Such instruments have been made to register elevations of 15 miles.

A very small pocket-registering aneroid was noticed recently in an optician's window in Boston which was designed to register continuously up to altitudes of 15,000 ft. above sea level.

Aneroid barometers, whether self-registering or not, must be compared with a standard barometer just before and just after a flight, in order to see that they have undergone no change during the flight.

But before an aneroid is used in aviation at all, it must be placed in the receiver of an air pump and a comparison made with a standard barometer at such low air pressures as will be encountered during the flight. These air-pump comparisons should be made at frequent intervals during a meet; and an air-pump outfit should form part of the equipment of any aviation grounds.

Even under the best conditions of using an aneroid barograph possible errors of from 5 per cent at low altitudes to 1 per cent at high altitudes may enter into the records and not be detected. An error of 100 ft., or even 200 ft., might be possible.

It is probable that at low altitudes the theodolite is much more accurate than the barometer (it certainly is more certain) in determining heights of aeroplanes; but at very great heights the barometer would probably be more accurate. Still with such good instruments as Professor Willson would use for measuring angles the method of triangulation is undoubtedly more accurate than the barometer at the low altitudes of the Atlantic meet.

One great advantage of the recording aneroid barometer is that there is a continuous record of the flight through cloud as well as through clear sky.

Aneroid barometers which are not self-recording are also used by aviators. A large one as big as a small dollar clock may be attached to the frame of the aeroplane, convenient for the aviator's observation; or a small one the size of a medium-sized watch may be worn on a strap encircling the wrist.

A SIMPLE BATTERY TELEPHONE

HOWARD S. MILLER

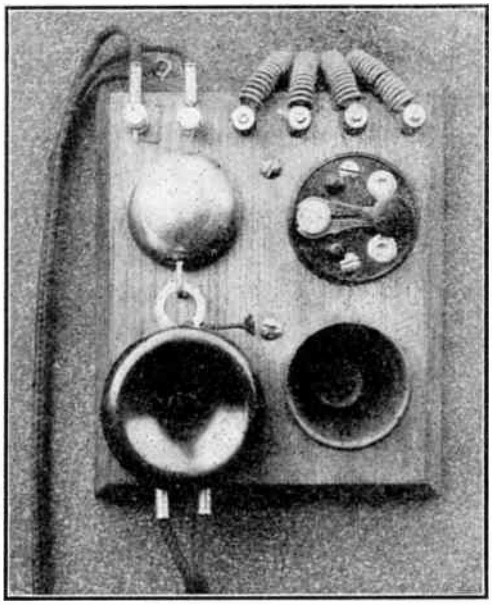


Fig. 1

The short-line battery telephone, as commonly wired, comprises transmitter, receiver, induction coil, automatic switch hook, double contact push button, and a call bell or buzzer. All of this apparatus, however, is not needed to secure efficient service, and where one desires to assemble the parts for his own telephone instruments, there is a simpler system available which gives excellent results.

A SIMPLE PHONE

Fig. 1 is a photograph of one of a set of instruments made by the author, in which the number of working parts has been reduced to four, without sacrificing either the talking or operating qualities of the instrument. It consists of a suitable backboard on which are mounted transmitter, pony receiver, watch-case buzzer and a three-point battery switch for controlling the circuits.

ITS OPERATION

The operation of this instrument is as follows: *To make or to answer a call:* Move the lever of the switch from the lowest contact to the uppermost contact. The other party has then been rung up, and the circuits are connected for talking. If the party called does not answer on the first call, make another call by moving the lever down to the middle contact for a second, and then returning it again to the upper contact. When the conversation has been finished, return the switch lever to the bottom contact. There is but one system whose operation is simpler than this, and that system will be mentioned in the paragraph titled "An Automatic Phone."

ITS WIRING

The wiring of the instrument illustrated in Fig. 1 is shown in Fig. 2, and from this figure the circuits brought into operation as the switch is moved can be traced. In this figure *R* is the receiver, *T* the transmitter, *S* the three-point switch, *B* the bell or buzzer, *C* the battery, and *L*, *L'* the line terminals connecting with the distant station

It is seen that when the switch lever is on the lower contact, the bell is connected across the line wires, ready to receive a signal if one is made. As the lever is moved upwards to make a call, it touches the middle contact, connecting the battery across the line and sending the signaling current to the other

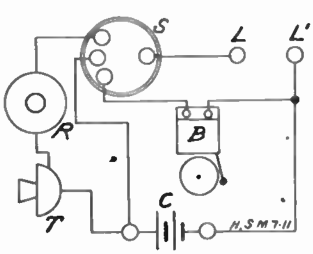


FIG. 2

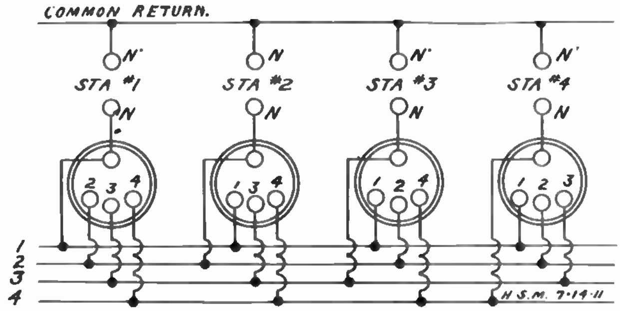


FIG 4

station. When the lever reaches the upper contact, the transmitter and receiver, in series with the battery are across the line ready for talking.

One cell of battery at each station is sufficient for short lines. For longer lines enough cells are added to make the call bell or buzzer work clearly.

It will be noticed that, from the arrangement of the switch contacts, the party who, after a conversation, last returns his switch to the lower position, will ring the bell at the other station. This is to be considered a "ring-off," and not a recall.

AN AUTOMATIC PHONE

If the operation of moving the switch lever across the contacts were performed by a switch controlled by a receiver hook instead of by hand, we would have an automatic phone which would merely require the removal of the receiver from the hook to ring up a distant station and establish talking connections. Such a system would make the operation of the instrument the simplest possible.

Fig. 3 gives a sketch (side view) of a hook which can be substituted for the three-point switch of Figs. 1 and 2 to make an automatic phone. This is offered as a suggestion which the experimenter may work out. The lever may be made from a piece of brass tubing, or from a flat piece with a short piece of tubing soldered on one end to contain the spring and ball. This ball in the end of the lever, rolling along the contacts causes the switch to operate very easily and smoothly.

INTERCOMMUNICATION

A number of the simple instruments described above may be wired up for intercommunication, according to the usual method; or they may be connected as shown in Fig. 4, which shows a system with four stations wired in. The terminals N, N' at each station in Fig. 4 connect to the terminals L, L' respectively, of the instrument shown in Fig. 2.

An ordinary battery switch is required at each station, having one less points than the number of stations to be accommodated. There is no "home" point, and when not in use, the intercommunicating switch lever does not rest on any point at all. The battery is retained at each station, and may be placed on the floor under the instrument or in a nearby closet.

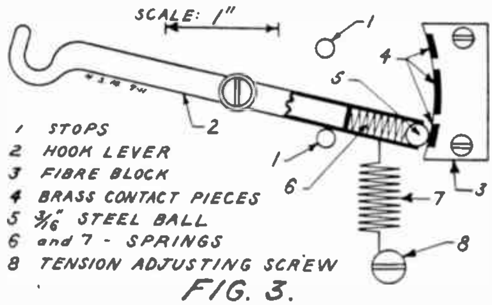


FIG. 3.

For information concerning line wires, cables, testing, etc., the reader is referred to page 110, Volume XXII of *Electrician and Mechanic.*

Origin of Artesian Water

Whence comes artesian water? It is believed by many persons that artesian water is stored up in the depths of the earth in great reservoirs or exists as mysterious underground rivers which eventually find their way to the surface. It is true that the water is stored up in underground reservoirs, but not as popularly supposed. With the exception of a few caverns of comparatively small extent such reservoirs bear no relation to open basins of the surface type, but are as a rule rock strata or masses in which the only openings are spaces between the grains or along lines of solution, planes of jointing, cleavage, or bedding, or other fissures.

The probable source of underground waters has been widely discussed, and while every one would doubtless agree that by far the greater part is derived from rainfall, there is considerable variation of opinion as to the relative importance of the other sources, such as seepage or absorption of water from the ocean, or the release of otherwise unavailable waters in the earth's crust which have been set free by physical or chemical exclusion.

Bulletin 319 of the United States Geological Survey, entitled "Summary of the Controlling Factors of the Artesian Flows," by Myron L. Fuller, discusses the subject of the theory and behavior of artesian wells. A copy may be obtained on application to the Director of the Survey at Washington.

THE HOME CRAFTSMAN

RALPH F. WINDOES

DESK SET

The desk set, comprising a number of small articles, forms one of the most interesting as well as one of the most useful problems which the craftsman has the opportunity of working out. A large number of shapes and designs can be originated for each piece, but the general outline, design and finish must be the same on all. The set we here illustrate offers about as simple a problem of this kind as we are capable of producing. It consists in a blotting pad with metal corners, a pen tray, a rocking blotter, a stationery rack, an ink well and a paper knife. There is no etching upon any of the pieces and the finish is simply a high polish, after which it has been lacquered.

The copper or brass needed to construct these pieces consists in the following:

Corners:—2 pieces 4⅞ x 4⅞ in. No. 18 gauge.

Tray:—1 piece 3 x 12 in. No. 18 gauge.

Blotter:—1 piece 3½ x 5½ in. No. 18 gauge; 1 piece spring brass 2½ x 5 in.

Stationery rack:—1 piece 5½ x 6¾ in.; 1 piece 5½ x 5½ in., No. 18 gauge.

Ink Well:—1 piece 3¼ x 3¼ in.; 1 piece 1¾ x 5¾ in.; 1 piece 2⅛ x 2⅛ in., No. 18 gauge.

Paper Knife:—1 piece 1 x 7 in., No. 18 gauge.

PAD CORNERS

Considerable time and material can be saved by working the corners up in pairs. The drawing shows very clearly how each should be laid out. The cutting is done along the solid lines and the bending along the dotted. Sharp bends must be obtained if the work is to look well. The right angle bends may be made sharp by placing the metal between two strips of hardwood held in the vise, and pounding it over with the hammer. Next a piece of metal, about 3/16 in. thick and with sharp edges, should be placed so that the return bend can be made over it. The edges should show the hammer marks of the ball pein, as this breaks up the monotony of a plain edge.

The cross section shows a piece of felt glued on the under side of each corner, so that the metal will not scratch the desk upon which it is placed. It also shows the pad and the blotter in position. The pad may be purchased or it may be made by the craftsman. It is composed of a piece of heavy cardboard around the edges of which is fastened a strip of gummed cloth.

PIN TRAY

Directions for the forming of a tray have already been given in this course, so that few instructions are here deemed necessary. Notice that the edges of this tray run out straight and are not curved over as in the case of the former one. The bottom of this tray should be covered with felt the same as the corners, and for the same reason.

BLOTTER

The blotter is very easily formed, the drawing showing but four bends to make. The cross section shows a strip of spring brass holding the blotter in position. Remember to order spring brass for this, as the ordinary soft metal will not do.

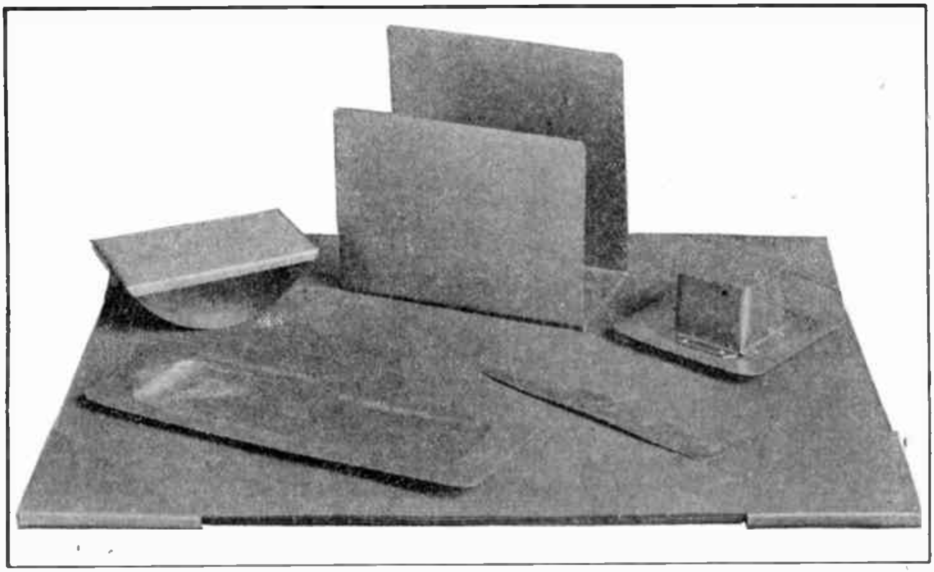
STATIONERY RACK

This rack shows two pieces of metal bent at right angles and riveted together with about six rivets; the edges being hammered before the riveting was begun. A piece of felt should be glued on the bottom of this rack as explained before.

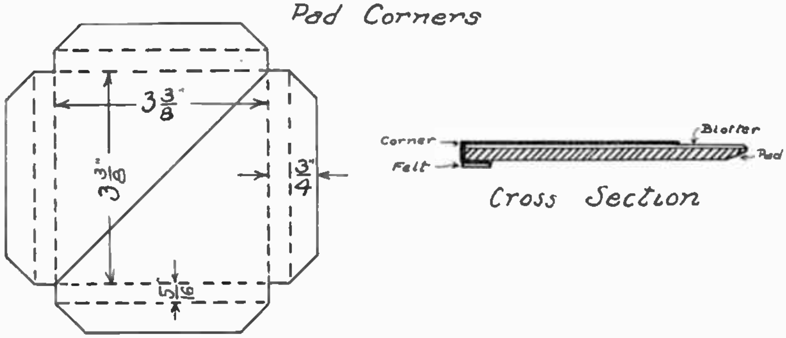
INK WELL

The ink well offers the most difficult problem of this set, but it suggests noth-

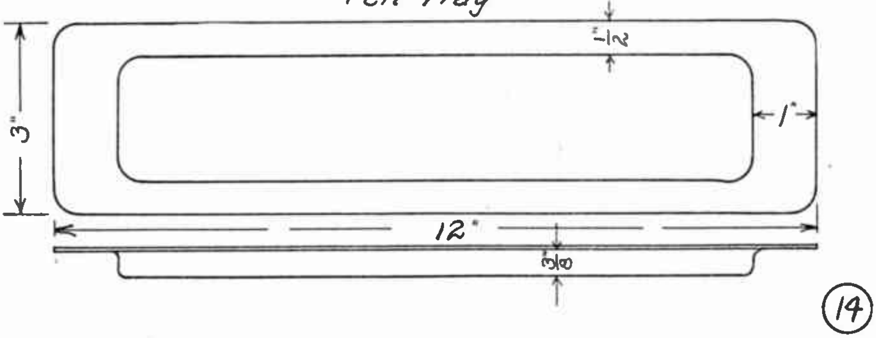
Desk Set

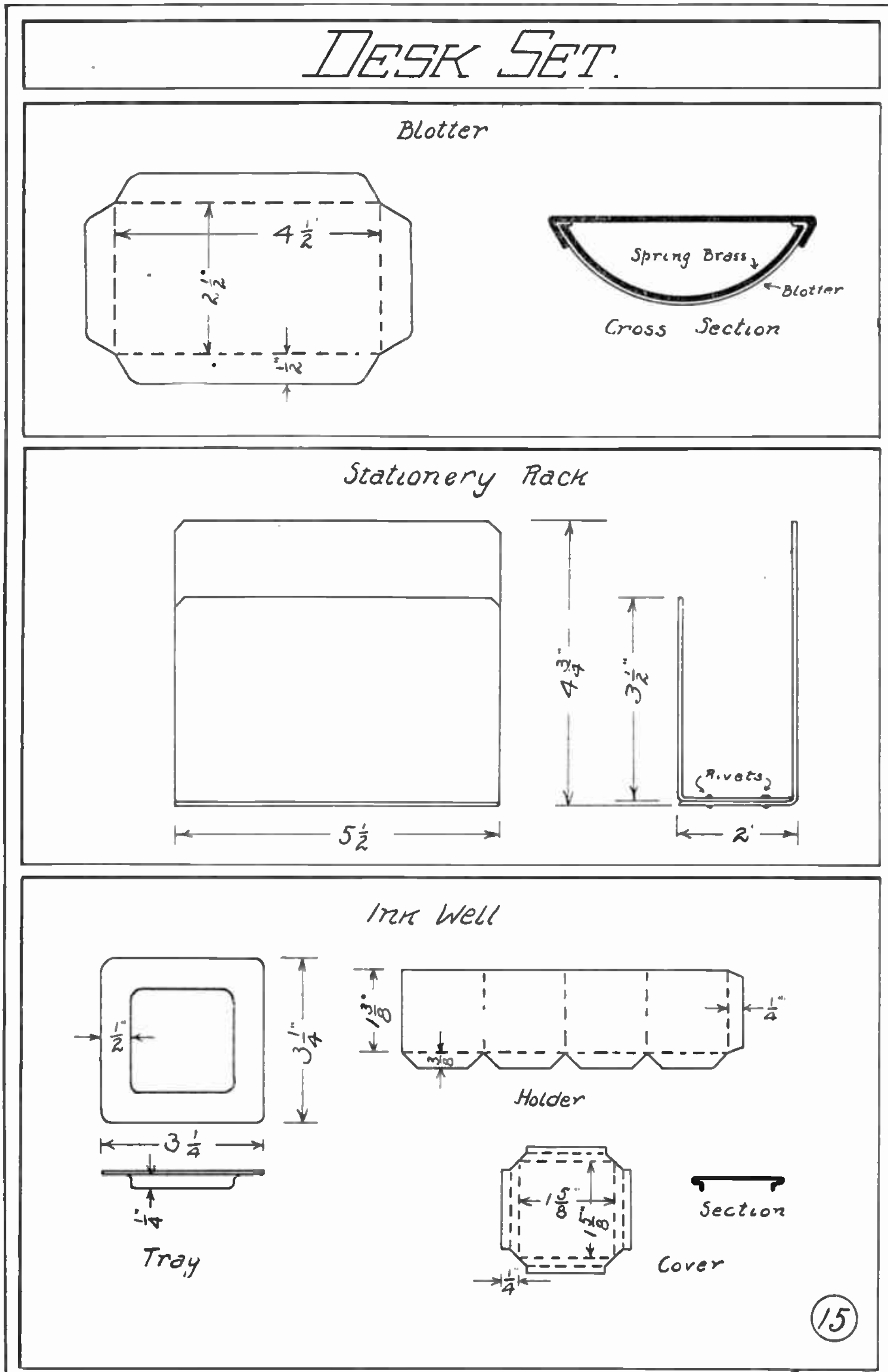


Pad Corners



Pen Tray




Desk Set.
Blotter
4 1/2"
2 1/2"
1/2"
Spring Brass
Blotter
Cross Section
Stationery Rack
4 3/4"
3 1/2"
Rivets
5 1/2
2"
Ink Well
1/2"
3 1/4"
1 3/8"
1/4"
3/8"
Holder
3 1/4
1/4"
Tray
1 5/8"
Section
Cover
1/4"
15
R.F.W. 1911

ing that the craftsman is not capable of performing. The glass bottle for this well is 1¼ in. square.

The tray is the first part to construct. It is exactly like the pen tray except in size.

Next comes the holder. It is patterned as shown, the bending coming on the dotted lines. The flange left on one side is for riveting the piece together, and the flanges left along the bottom are for riveting the holder onto the tray, as shown in the photograph.

The cover is formed as illustrated by return bends on the edges. Great care must be taken to obtain the correct dimensions, or it will not fit in place.

The paper knife is made exactly like the one explained in a former article, and for the sake of brevity, it has not been repeated here.

Each article should be polished, and it should receive a coat of lacquer to retain this polish.

(*To be continued*)

SOME UNEXPLORED FIELDS IN ELECTRICAL ENGINEERING*

C. P. STEINMETZ

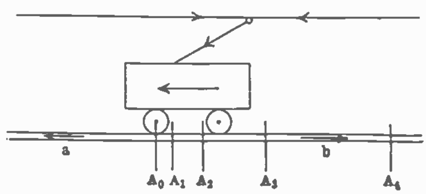
Summary.—The author suggests a number of electrical phenomena which require further investigation. Among these are: the current distribution in a conductor conveying alternating current, lightning discharges, the conduction of gases and vapors, the loss of energy by a cyclic change of magnetism, magnetic alloys. Two vast fields in which increased knowledge is of immediate industrial importance are: the properities of materials beyond the elastic limit and transient phenomena resulting from the readjustment of the stored energy of systems.

A lot of work has been done along many lines since the early days of electrical engineering, and a lot of different fields have been uncovered; but there are larger fields still unexplored and there are regions that are still unknown. For example, there is no simpler and apparently better known phenomenon than the resistance of a conductor. A conductor has a definite resistance which varies with the temperature, etc. With alternating current the resistance apparently increases in large conductors, because the current flowing in the conductor is not uniform throughout the entire section. We can calculate the phenomena of the lack of uniformity of the current density in the conductor for the case where the current density is not yet very un-uniform (the current density at the center being only 5 to 10 per cent lower than at the periphery) and get an approximation which is satisfactory for all purposes of electrical engineering. There is also the other extreme, where the current density in the middle of the conductor is practically zero, and the current is limited to a thin shell on the outer surface, as in the rail return of the single-phase railway, or in ordinary conductors at very high frequencies, as with lightning discharges. This case we can also calculate, determine the current distribution in the conductor, the apparent penetration and the effective resistance of the conductor, with an approximation as close as our knowledge of the constants of the material, the conductivity and permeability permits. But when you come to the intermediate and probably most interesting case, where there is current even in the center of the conductor, but a material difference in the current density between the outside and the center of the conductor, we find as solution an infinite series, which in this case converges so slowly as to be practically useless, and this case thus is still practically unexplored.

Another unexplored phenomenon of every-day occurrence: there are many thousands of trolley cars running all over the country with a direct-current supply of about 500 volts, and rail return. While the car passes along the

*Abstract of a Paper presented at a joint meeting of the electrical section of the Franklin Institute and the Philadelphia Section of the American Institute of Electrical Engineers.

track, the current flows from the wheels down into the rails, and then in the rails to the station, as sketched diagrammatically in Fig. 1. At the point A_0 the current enters the rail from the wheel. To the left of this point, it flows towards the left, as indicated by the arrow a. To the right of A_0, it is supposed to flow towards the right, as indicated by b, and at the point A_0 the current in the rail thus is supposed to reverse. However, the current cannot instantly reverse in the entire rail section, but the same screening effect of the magnetic field in the conductor, which causes unequal current distribution with an alternating current, makes it impossible for the current inside of the conductor to reverse instantly, and in the first moment, the reverse current b thus flows only on the very top surface of the conductor and only gradually penetrates deeper into the conductor, and before the current flows uniformly throughout the entire rail section in the new direction b the car has moved hundreds or even thousands of feet. Thus, the current distribution in the rail behind the moving car, in the successive sections A_1, A_2, ... is as indicated approximately in



Fio 1.

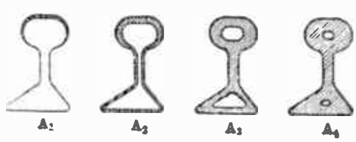


Fig. 2.

Fig. 2, where the black or shaded portion of the rail shows the section in which the current has already reversed, the unshaded portion, the unreversed part, that is, that part in which the current still flows in opposition to the resultant current flow, is running forwards instead of backwards. The obvious result is an increase of the effective resistance of the rail return, which immediately behind a high-speed car may be very considerable. Still this phenomenon, which occurs daily all over the country, has never been investigated, not even been recognized in its existence.

In some fields of electrical engineering or of electrical science we might almost say that we know less now than we knew, or rather believed we knew, a quarter of a century ago. There are things which had been investigated a quarter of a century ago and which were explained in a satisfactory manner to our limited knowledge in the early days, but this explanation does not seem satisfactory now, with our greater knowledge. A curious example we might cite from the text-books on natural history. There are supposed to be some fishes which are capable of giving electric shocks, fishes which have an organ which generates electricity; it has been described as being constituted like a Volta-pile. That theory was quite acceptable twenty-five years ago, but is not satisfactory now. To give a severe shock would require about 500 to 1,000 volts, and it is not intelligible how such voltage could be generated in the conducting animal tissue, without being short-circuited. Furthermore, the fish is immersed in water, which is a fair conductor, especially sea water, and 500 volts or more would produce hundreds of amperes in the surrounding water, representing hundreds of kilowatts, and it is not intelligible how such a large power could be generated even momentarily. Just why that phenomenon has not been investigated by electrical engineers we do not know; especially when considering that one of the electric fishes, *raja torpedo*, lives in the Mediterranean and is frequently caught on the Italian shores, that is, within easy reach of engineers.

But we do not need to go so far from home; right at hand we have some of the most important uninvestigated phenomena of electricity. The thunderstorm, the lightning, and so forth. Speculations were made in the early days as to how the clouds became charged, and as then the only method of producing electricity was by friction, it was said it might be the friction of the vapor through the air, or the rain drops through the air, or some other form of friction. That explanation used to appear satisfactory, but with our present knowledge of dielectric phenomena, it is not satisfactory any more. It was thought that lightning was the discharge from the cloud to the ground. That means that the electric field between the cloud and the ground must be beyond the breakdown strength of air. In a uniform field, the breakdown strength of air is about 75,000 volts per inch, or nearly a million volts per foot. Even if the cloud is only 1,000 ft. above ground, this would require a thousand million volts. If there were an electrostatic field between the cloud and the ground of a thousand million volts extending over the whole area of the thunder cloud, this would represent such an immense amount of electric energy that it is inconceivable how any reasonable source of energy can produce it; how it can exist without having a destructive effect far beyond anything known of lightning. Furthermore, a uniform field cannot well exist between clouds and ground, on account of the unevenness of the ground surface.

Let us look into another conception, not a uniform electrostatic field, but an un-uniform field, like that of the discharge between points. With long striking distances between points, the average gradient is about 170,000 volts per foot. This would require only 170 million volts between a cloud 1,000 ft. high, and the ground. This would be more reasonable. It would not require such an unreasonably vast amount of stored electric energy. But we know that in such an un-uniform field the spark is preceded by a brush discharge covering more than half the distance. Thus, lightning should be preceded by a brush reaching down from the cloud and up from the ground, for several hundred feet. Now such an enormous brush has never been observed, and is inconceivable; the brush discharges occasionally observed at points during storms are only a few inches long. Furthermore, a 300 ft. brush is inconceivable, because the resistance of the ground is not low enough to conduct the energy necessary to maintain such a brush discharge. Furthermore, most of the lightning discharges are not between the cloud and the ground, but are internally in the clouds, frequently reaching the length of several miles.

With our present knowledge we must consider as the most probable explanation—although not certain by any means—that the lightning discharge is the phenomenon of the equalization of internal electric stresses in the cloud, and is analogous to the splintering or breaking of an unevenly stressed brittle material, like glass. But how do those uneven electrostatic stresses originate in the cloud, and how do they reach such values as to cause internal equalization by rupture?

It is not so difficult to make a preliminary estimate of the building up to very high and uneven voltage distribution in the cloud as soon as you have assumed some initial voltage. We do not know where the initial voltage comes from, but we must accept the fact that there is normally a voltage gradient in the air, a potential difference between different altitudes which may amount to a hundred volts or more per foot. In the air 100 ft. above the ground there may be a potential difference against ground amounting to thousands of volts. Possibly, this potential gradient in the atmosphere may even be of cosmic origin: the earth having a high negative potential against our solar system, against the universe, which would mean that there must be a positive voltage gradient from the surface of the ground into space.

If condensation takes place in the higher regions of the atmosphere, rain drops form, minute drops at first, which necessarily must be at the potential of the air in which they form. That means they have a potential difference against the ground, and therefore an electrostatic charge against the ground corresponding to this potential difference. Assuming now that many of these minute rain drops conglomerate to larger drops, it means that many small condensers conglomerate to one condenser, which is somewhat larger in capacity than each component, but very much smaller in capacity than the sum of the capacities of its components. But it contains all the electrostatic charges of the rain drops, and at the much smaller capacity the same charge gives a higher potential difference. Conglomeration of minute drops into larger ones thus must give a great increase of potential difference against ground. We know the clouds are not uniform in density, and where the density is greatest conglomeration of condensed drops takes place to a much greater extent, building up to a much higher voltage, and thereby between the parts of the cloud of different density, the light and the dark portions, potential differences must appear and increase with increasing condensation, until somewhere the disruptive gradient is passed, equalization occurs by a lightning discharge, and then the same play repeats again and again. Lightning discharges, then, are the result of the voltage inequalities produced in the clouds by the unequal rate of conglomeration of rain particles due to the unequal cloud density. In agreement with this is that heavy lightning strokes are usually followed by a heavy downpour of rain; in reality they are preceded and caused by it, but it takes time for the rain drops to come down.

Let us assume now that the process is reversed, and after conglomerating to high voltages the rain drops evaporate again. Since gases apparently do not carry electrostatic charges, the rapidly dwindling rain drop retains its entire charge, hence must rise in potential, and finally must discharge, and this progressive evaporation of the rain drops must also result in the building up of potential differences and therefore the formation of lightning, and this may explain the two forms of lightning—that accompanying rain-storms and thunderstorms, and the so-called "heat" lightning. The former is the result of condensation and conglomeration, the latter the result of evaporation of rain drops.

Again, we must abandon the conception of the theory of electrostatics of the early days—which still largely is used in theoretical text-books—as incorrect and useless. Capacity is not the capability of the conductor to store electric quantity, but is the ratio of the number of lines of dielectric force to the e.m.f. which produces them; "charging current" is no more a current charging the conductor with electricity than the "inductance voltage" is a voltage charging the conductor with magnetism; the former, as "capacity current," supplies the energy stored in the dielectric field, just as the inductance voltage supplies the energy stored in the magnetic field, and dielectric and magnetic phenomena are very largely analogous and treated in the same manner and with the same simplicity.

Next, as to the conduction of gases and vapors, it is a field in which an enormous amount of investigation has been carried on in late years by the physicists, so that it may almost be called the best explored branch of modern physics. Unfortunately, there has been very little, if any, benefit from all this work to the electrical engineer. If you ask some simple engineering questions, as, for instance, you have a Geissler tube, 4 cm. diameter and 10 m. long, filled with nitrogen gas under 0.1 mm. pressure. What will be the voltage required to pass a current through the tube; what will be the amount of light given by it; and how will the voltage vary with the current and with the gas pressure? The answer is unknown.

We now have some data on the electrical constants of gas conduction, and our knowledge is rapidly increasing by the work of engineers, who finally, as in other fields of research, despairing of ever getting the scientific investigators to drop metaphysical speculations long enough to determine physical facts, have started to investigate the engineering facts themselves.

The same applies to arc conduction, though arc conduction has been investigated by the engineers for a much longer time, and more is known about it. Much of the work done on arc conduction is worse than useless, by unjustified generalisation. Too often investigators have taken a pair of carbon terminals—since carbon terminals are mostly used in arc lamps—have put various things on them, and then written a treatise on "the arc," without ever realizing that whatever applies to the carbon arc does not necessarily apply to any other arc.

The conductor in the Geissler tube is the gas which fills the space between the electrodes, and the material of the latter is therefore of secondary importance; but the phenomena, as the voltage, the color and the spectrum of the light, etc., essentially depend on the nature of the gas in the space between the electrodes, and on its pressure. In the arc, however, the conductor is a stream of electrode vapor; the material of the electrode, therefore, is of fundamental importance on the voltage, luminosity, color and spectrum of the arc stream, while the surrounding gas is of secondary importance only. The conducting vapor stream, or "arc stream," usually is at the boiling point of the electrode material. The carbon arc thus is the hottest arc. The dielectric strength of gases decreases with increase of temperature, and at the temperature of the carbon arc stream has fallen below the voltage drop in the arc stream, so that in the carbon arc all the phenomena resulting from the dielectric strength of the vapor stream are absent, since the surrounding air has a disruptive strength less than the supply voltage of the arc. Nearly the same is the case with a few other very hot arcs. The carbon arc thus is not a typical arc, but is one of the extremes in a series of arc conductors, of which the other extreme probably is the mercury arc, as the coldest arc. The latter thus gives the phenomena of the dielectric strength of the arc stream most pronounced.

As the phenomena of arc conduction essentially depend on the temperature of the arc stream, that is, the boiling point of the electrode material, typical conditions we can expect only from electrode materials having boiling points intermediate between the extremes, carbon and mercury. Such are many metals, as iron, copper, etc. The iron arc thus is a typical arc, but not so the carbon arc. In the study of a typical arc we find that the vapor stream, which conducts the current, issues from the negative terminal, as shown by its spectrum, and by the character of the arc; the latter depends on the material of the negative terminal, but is unaffected by any change of the positive terminal. The vapor conductor of the arc is moving rapidly from the negative terminal towards the positive, and is a conductor in the direction from the negative terminal to any point reached by the arc stream, which is positive towards the negative arc terminal, but is non-conducting with regard to any body negative towards the negative arc terminal. The arc stream is a unidirectional conductor, and is extensively used for rectification.

The voltage range, within which an arc stream is non-conducting towards a negative body, or, as usually called, the "rectifying voltage range of the arc stream," is determined by the disruptive strength, and thus is a function of the temperature. It is many thousand volts with the low temperature mercury arc, is still several hundred volts with the iron or copper arc, but vanishes below the temperature of the carbon arc, and the latter thus does not show any more the uni-directional conductivity of the arc stream to any marked extent. It is, therefore, an exception, and is not a typical arc.

As in arc conduction the conductor is the unidirectionally moving electrode vapor stream, this stream has first to be produced, by the expenditure of energy, before arc conduction can begin. In an alternating current arc at every half wave a new arc stream has to be started, in opposite direction from that of the preceding half wave of current, and the supply voltage thus must be high enough to jump a static spark across the arc terminals through the residual hot vapor of the preceding half wave. This voltage is low with the carbon arc, but becomes very high with a lower temperature arc.

Entirely different from arc conduction apparently is the conduction of the Geissler tube and of the electrostatic spark. Geissler tube conduction and the electrostatic spark, however, apparently are the same phenomena, differing only by the difference of gas pressure. Thus we can pass gradually from the noisy and brilliant short-circuiting spark to the streamer, brush discharge, corona and to the silent discharge or steady glow. But while a gradual transition from Geissler tube conduction to spark conduction exists, I have never been able to get any gradual transition from Geissler tube conduction to arc conduction. Under conditions where both can occur, the one always changes abruptly into the other, and these two classes of conduction thus seem to be different in their nature: the one conduction by the gas in the space between the electrodes, the other conduction by a stream of electrode vapor. Thus, if we have a Geissler discharge through mercury vapor, of limited current and high voltage, and gradually cut the resistance or reactance out of the circuit, or increase the supply voltage, the Geissler discharge suddenly, with a "flash," changes to arc conduction; the current rises and the voltage drops. Cutting resistance in again, just as suddenly the arc drops, and is superseded by the Geissler discharge. Here, then, we have a very interesting and very important field, in the conduction of gases and vapors, in which still very much is unknown.

"Permanent magnetism" is still an unexplained and mysterious phenomenon. The question is, What is permanent in the permanent magnet? The magnetic flux, or the magnetomotive force, or the flux density or flux distribution, or the magnetic energy?

Another interesting and important phenomenon of magnetism is the loss of energy by a cyclic change of magnetism, as occurs in an alternating magnetic field. Twenty years ago I found this loss to be expressed empirically by the 1·6th power of the magnetic flux density, with sufficient approximation over a wide range of magnetic densities. Since that time, some observers have found that for very high magnetic densities the loss is less than that given by this law of the 1·6th, and other observers find that it is more. Considering the great difficulty of getting exact results at high densities, it appears probable herefrom that even at high densities the law of the 1·6th power still applies at least approximately. For very low densities I have shown that it finally cannot continue to hold, but the coefficient must increase to 2·0. However, with all the work done on magnetism, we still are entirely in the dark regarding the cause of this strange coefficient 1·6. The only other instance of such a fractional exponent is the exponent of the adiabatic expansion curve of gases, 1·4.

Only recently another instance has been found, where the coefficient 1·6 appears. The resistance of pure metals, as the tungsten filament, is proportional to the absolute temperature: $r = aT$. The black-body radiation, however, is proportional to the fourth power of the absolute temperature, and if no other loss of power occurs, as when the radiator is enclosed in a high vacuum, as in the tungsten filament incandescent lamp, the power input equals the radiation power, and thus also is proportional to the fourth power of the absolute temperature, $p = bT^4$. Substituting $r = e/i$ and $p = ei$, and eliminating T, gives $e = ci^{1·6}$.

That is, in a perfect metal, which gives black-body radiation, in a high vacuum at high temperatures the impressed voltage varies with the 1·6th power of the current. This is the only other instance of a 1·6th power law which I found. It may be a mere coincidence, but it is interesting to reflect that here as well as in the hysteresis law, a conversion of electric energy into heat takes place.

Even in fields where very much is known, there are numerous trails leading into unexplored regions. Magnetism, for instance, is one of the most explored branches of electrical science. It was known many years ago that manganese has some curious magnetic properties: a few per cent added to iron makes it practically non-magnetic. However, it is non-magnetic only in its virgin state, and by heat treatment it is brought into a magnetic state, where it has about the same characteristics as other steels. Here, then, you find a material which may be magnetic or unmagnetic. This trail was never followed up until a few years ago, when a strongly magnetic alloy of manganese, copper and aluminum was discovered. It seemed to overthrow all our conceptions on the nature of magnetism as an elementary property. Even then, however, most investigators followed the same trail, making various alloys of these three metals, and speculating on the cause of the magnetic property of the alloy of three unmagnetic metals, without following the trail further, to the study of other alloys of these metals. Such study shows that copper and aluminum are immaterial for the magnetic property, but that manganese is essential, and is indeed a magnetic metal. Pure manganese has never been produced in the magnetic state, but numerous alloys of manganese, as those with antimony, tin, zinc, etc., are magnetic or may be brought to a magnetic state. Most interesting is the manganese-antimony alloy, as it can be produced much easier than the Heussler alloy of manganese, copper and aluminum. Mixing coarsely powdered manganese and antimony, in the proportion, for instance, of 1:3, by moderate heating—in a test-tube over the bunsen burner—the mass becomes strongly magnetic and can be used to show the lines of force of a magnet, just like iron filings. When I tried the magnetic properties of a collection of various alloys, which I had for a considerable number of years, I found quite a number of manganese alloys which showed magnetic properties. Thus after all we do not have to change our conception of magnetizibility as a property of the element, but it merely means that manganese—and possibly chromium—have to be added to the list of magnetic metals.

Oxygen also is magnetic, and now should be easily available, but I do not know that its magnetic characteristics have ever been investigated, except very roughly and qualitatively. While it may not be of industrial importance, it certainly is of great scientific interest, as the only magnetic non-metal and non-conductor. We do not know its magnetization curve, whether magnetic saturation occurs, and what the saturation value is, whether there is a hysteresis loss, etc., whether and how far ozone shows the magnetic properties, etc.

A curious oxide of chromium has been mentioned for years which has strongly magnetic properties. It is formed by the reduction of chromylchlorid, within narrow temperature limits.

With manganese, a lower oxide of the metal seems to exist, which has much greater magnetic properties than any of the manganese alloys investigated and even on the old and well-known magnetic oxide of iron, the only data which we have are investigations made twenty years ago, but which apparently have never been continued further.

You see, there is really no lack of unexplored phenomena in the realm of electrical science and engineering. But the two vast fields in which an increased knowledge is of immediate industrial importance, and in which, indeed, energetic investigating work is going on, are the study of the properties of materials beyond the elastic limit and the study of transient phenomena resulting from the readjustment of the stored energy of systems.

Most investigations of physicists have dealt with the properties of materials below the elastic limit, where the processes are reversible. But of almost greater interest is the range beyond the elastic limit, where the action of forces is not reversible, where mechanically the materials are deformed, such as where steel is rolled into rails, or wire is drawn. So with electrical forces, in the electrostatic field, irreversible phenomena occur at high voltage, in the corona; energy is stored into the dielectric field, but is not returned, but dissipated as heat, if the dielectric flux density reaches beyond the disruptive strength of the material, and in our modern high voltage transmission lines we have closely approached this limit. In the field of magnetism, the phenomena of hysteresis represent such an irreversible process. So also the aging of many kinds of magnetic materials, etc.

The second important field of investigation is the study of the transients. Transients are the phenomena by which stored energy adjusts itself to changed conditions of the system. Most of our electrical engineering theory deals with the steady flow of electric power, by direct or by alternating current. But accompanying the flow of electric power is a storage of electric energy in the magnetic and in the dielectric field of the conductor, and any change of the circuit conditions, any change of current and of voltage, thus usually involves a change of the stored magnetic and dielectric energy. Since a change of stored energy cannot occur instantly—as this would represent infinite power—a transition period thus must intervene after every change of circuit condition, that is, an electrical transient occurs. When the electric systems were small, these transients usually were of negligible energy; but with our modern huge systems, the stored energy is such that the transients frequently may reach destructive powers, and therefore their study has become of great industrial importance.

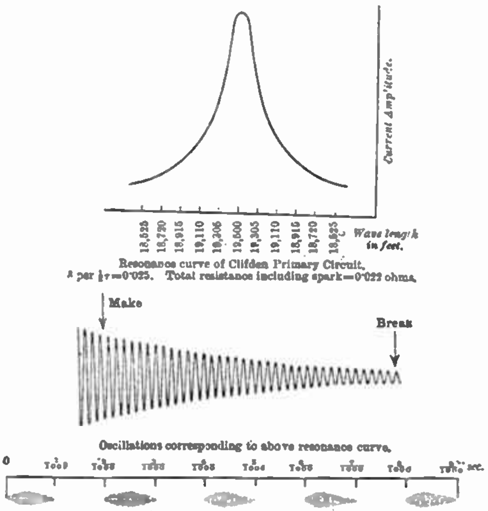
WIRELESS TELEGRAPHY

In this department will be published original, practical articles pertaining to Wireless Telegraphy and Wireless Telephony

RADIO-TELEGRAPHY*

GUGLIELMO MARCONI

The practical application of electric waves to the purposes of wireless telegraph transmission over long distances has continued to extend to a remarkable degree during the last few years, and many of the difficulties which at the outset appeared almost insurmountable have been gradually overcome—chiefly through the improved knowledge which we have obtained in regard to the subject generally and to the principles involved. Although we have all the data necessary for the satisfactory production and reception of electric waves, we are yet far from possessing any very exact knowledge concerning the conditions governing the transmission of these waves through space—especially over long distances. Although it is now perfectly easy to design, construct and operate stations capable of satisfactory commercial working over distances up to 2,500 miles, no really clear explanation has yet been given of many absolutely authenticated facts concerning these waves. Why is it that when using short waves the distances covered at night are as a rule enormously greater than those traversed in the daytime, while when using much longer waves the range of transmission by day and night is about equal and sometimes even greater by day? What explanation has been given of the fact that the night distances obtainable in a north-southerly direction are so much greater than those which can be effected in an east-westerly one? Why is it that mountains and land generally should greatly obstruct the propagation of short waves when sunlight is present and not during the hours of darkness?



Resonance curve of Clifden Primary Circuit.
λ per ½τ = 0·025. Total resistance including spark = 0·022 ohms.

Oscillations corresponding to above resonance curve.

Series of wave trains radiated from Clifden aerial. Spark frequency 500 per sec.

FIG. 1.

After referring to the general principles on which practical radio-telegraphy is based and the various systems which had been used by him to obtain wireless transmission, Mr. Marconi continued: At the long distance station situated at Clifden in Ireland, the arrangement which has given the best results is based substantially upon my syntonic system of 1900, to which have been added numerous improvements. An important innovation from a practical point of view was the adoption at Clifden and Glace Bay of air condensers composed of insulated metallic plates suspended in air at ordinary pressure. In this manner we greatly reduce the loss of energy which would take place in consequence of dielectric hysteresis were a glass or solid dielectric employed. A very considerable economy in working also results from the absence of dielectric breakages, for,

* Abstract of a Discourse delivered at the Royal Institution.

should the potential be so raised as to produce even a discharge from plate to plate across the condenser, this does not permanently affect the value of the dielectric, as air is self-healing, and one of the few commodities which can be replaced at a minimum of cost.

Various arrangements have been tried and tested for obtaining continuous or very prolonged trains of waves, but it has been my experience that, when utilizing the best receivers at present available, it is neither economical nor efficient to attempt to make the waves too continuous. Much better results are obtained when groups of waves (Fig. 1) are emitted at regular intervals in such manner that their cumulative effect produces a clear musical note in the receiver, which is tuned not only to the periodicity of the electric waves transmitted, but also to their group frequency. In this manner the receiver may be doubly tuned, with the result that a far greater selectivity can be obtained than by the employment of wave-tuning alone. In fact, it is quite easy to pick up simultaneously different messages transmitted on the same wave-length, but syntonized to different group frequencies. As far as wave-tuning goes, very good results—almost as good as are obtainable by means of continuous oscillations—can be achieved with groups of waves, the decrement of which is in each group 0.03 or 0.04, which means that about 30 or 40 useful oscillations are radiated before their amplitude has become too small perceptibly to affect the receiver. The condenser circuit at Clifden has a decrement of from 0.015 to 0.03 for fairly long waves.

The lecturer then gave a description of his well-known disc discharger, a patent for which was taken out in 1907. In this apparatus, with the frequency employed at Clifden, namely, 45,000, when a potential of 15,000 volts is used on the condenser, the spark gap is practically closed during the time in which one complete oscillation only is taking place, when the peripherical speed of the disc is about 600 ft. a second. The result is that the primary circuit can continue oscillating without material loss by resistance in the spark gap. Of course, the number of oscillations which can take place is governed by the breadth

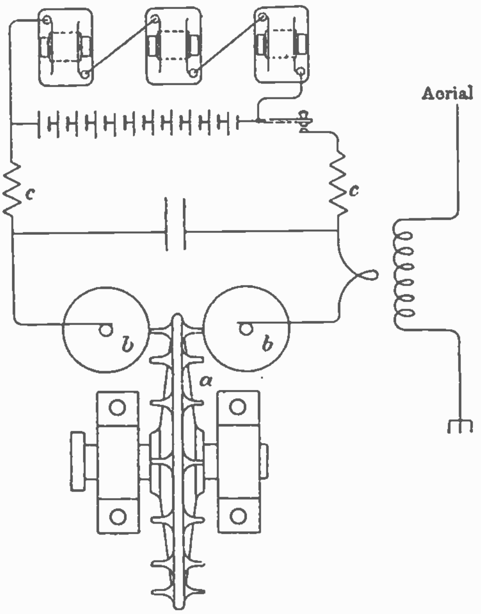


Fig. 2. Disc Discharger. (Continuous Current.)

or thickness of the side discs, the primary circuit being abruptly opened as soon as the studs attached to the middle disc leave the side discs.

This sudden opening of the primary circuit tends immediately to quench any oscillations which may still persist in the condenser circuit; and this fact carries with it a further and not inconsiderable advantage; for, if the coupling of the condenser circuit to the aerial is of a suitable value, the energy of the primary will have practically all passed to the aerial circuit during the period of time in which the primary condenser circuit is closed by the stud filling the gap between the side discs; but, after this, the opening of the gap at the discs prevents the energy returning to the condenser circuit from the aerial, as would happen were the ordinary spark gap employed. In this manner the usual reaction which would take place between the aerial and the condenser circuit can be obviated, with the result that with this type of discharger and with a suitable degree of coupling the energy is radiated from the aerial in the form of a pure wave, the loss from the spark gap resistance being reduced to a minimum.

An interesting feature of the Clifden plant, especially from a practical and engineering point of view, is the regular employment of high-tension direct current for charging the condenser. Continuous current at a potential which is capable of being raised to 20,000 volts is obtained by means of special direct-current generators; these machines charge a storage battery consisting of 6,000 cells all connected in series, and it may be pointed out that this battery is the largest of its kind in existence. The capacity of each cell is 40 ampere-hours. When employing the cells alone the working voltage is from 11,000 to 12,000 volts, and when both the direct-current generators and the battery are used together the potential may be raised to 15,000 volts through utilizing the gassing voltage of the storage cells. For a considerable portion of the day the storage battery alone is employed, with a result that for 16 hours out of the 24 no running machinery need be used for operating the station, with the single exception of the small motor revolving the disc. The potential to which the condenser is charged reaches 18,000 volts when that of the battery or generators is 12,000. This potential is obtained in consequence of the rise of potential at the condenser plates, brought about by the rush of current through the choking coils at each charge. These coils are placed between the battery or generator and the condenser *c*, Fig. 2. No practical difficulty has been encountered, either at Clifden or Glace Bay, in regard to the insulation and maintenance of these high-tension storage batteries. Satisfactory insulation has been obtained by dividing the battery into small sets of cells placed on separate stands. These stands are suspended on insulators attached to girders fixed in the ceiling of the battery room. A system of switches, which can all be operated electrically and simultaneously, divides the battery into sections, the potential of each section being low enough to enable the cells to be handled without inconvenience or risk.

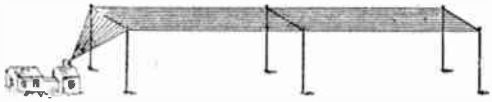


FIG. 3.

The arrangement of aerial adopted at Clifden and Glace Bay is shown in Fig. 3. This system, which is based on the result of tests that I first described before the Royal Society, in June, 1906,* not only makes it possible efficiently to radiate and receive waves of any desired length, but it also tends to confine the main portion of the radiation to any desired direction. The limitation of transmission to one direction is not very sharply defined, but nevertheless the results obtained are exceedingly useful for practical working. In a similar manner by means of these horizontal wires it is possible to define the bearing or direction of a sending station and also limit the receptivity of the receiver to waves arriving from a given direction.

Turning to the detrimental effect produced by daylight on the propagation of electric waves over great distances, the lecturer dealt with the generally accepted hypothesis of the cause of this, and stated that recent observations revealed the interesting fact that the effects varied greatly with the direction in which transmission was taking place; the results obtained when transmitting in a northerly and southerly direction being often altogether different from those observed in the easterly and westerly one. In regard to moderate power stations, such as are employed on ships and which in compliance with the International Convention use wave lengths of 300 and 600 meters, the distance over which communication can be effected during day-time is generally about the same whatever the bearing of the ships to each other or to the land stations, while at night interesting and apparently curious results are obtained. Ships, over 1,000 miles away, off the south of Spain or round the coast of Italy, can almost always communicate during the hours of darkness with the Post Office stations situated on the coasts of England and Ireland, while the same ships, when at a similar distance on the Atlantic to the westward of these islands and on the usual track between England and America, can hardly ever communicate with these shore stations unless by means of specially powerful instruments. It is also

* "On Methods whereby the Radiation of Electric Waves may be Mainly Confined, etc.," "Proceedings" of the Royal Society, A., Vol. LXXVII, 1906.

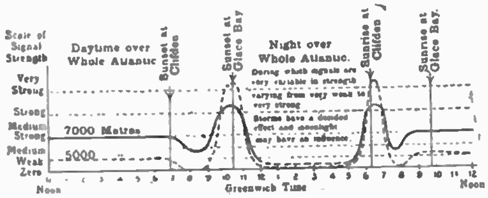


Fig. 4.

to be noticed that in order to reach ships in the Mediterranean the electric waves have to pass over a large portion of Europe and, in many cases, over the Alps. Such long stretches of land, especially when including very high mountains, constitute, as is well known, an insurmountable barrier to the propagation of short waves during day-time. Although no such obstacles lie between the English and Irish stations and ships in the North Atlantic en route for North America, a night transmission of 1,000 miles is there of exceptionally rare occurrence. The same effects generally are noticeable when ships are communicating with stations situated on the Atlantic coast of America.

The diagrams (Figs. 4 and 5) show the average daily variation of the signals received at Clifden from Glace Bay. The curves shown in Fig. 4 show the usual variation in the strength of these trans-Atlantic signals on two wave-lengths—one of 7,000 meters and the other of 5,000 meters. The strength of the received waves remains as a rule steady during day-time. Shortly after sunset at Clifden they become gradually weaker, and about two hours later they are at their weakest. They then begin to strengthen again and reach a very high maximum at about the time of sunset at Glace Bay. They then gradually return to about normal strength, but through the night they are very variable. Shortly before sunrise at Clifden the signals commence to strengthen steadily and reach another high maximum shortly after sunrise at Clifden. The received energy then steadily decreases again until it reaches a very marked minimum a short time before sunrise at Glace Bay. After that the signals gradually come back to normal day strength. It can be noticed that, although the shorter wave gives on the average weaker signals, its maximum and minimum variations of strength very sensibly exceed that of the longer wave. Fig. 5 shows the curve for the first day of each month for one year from May, 1910, to April, 1911.

I carried out a series of tests over longer distances than had ever been previously attempted in September and October of last year between the stations at Clifden and Glace Bay, and a receiving station placed on the Italian S.S. *Principessa Mafalda*, in the course of a voyage from Italy to the Argentine (Fig. 6). During these tests the receiving wire was supported by means of a kite, as was made in my early trans-Atlantic tests of 1901, the height of the kite varying from about 1,000 ft. to 3,000 ft. Signals and messages were obtained without difficulty by day as well as by night up to a distance of 4,000 statute miles from Clifden. Beyond that distance reception could only be carried out during night-time. At Buenos Ayres, over 6,000 miles from Clifden, the night signals from both Clifden and Glace Bay were generally

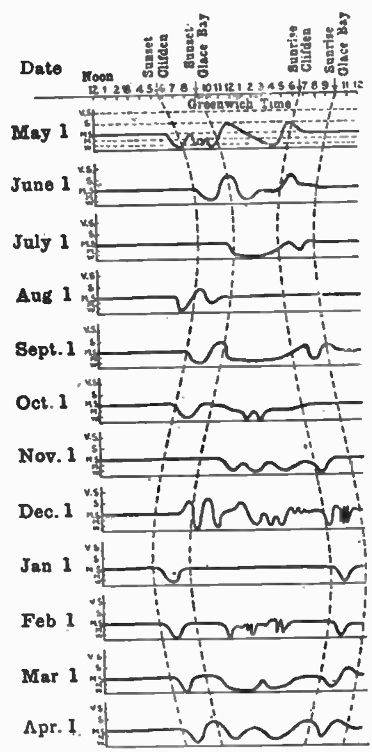


Fig. 5
Variation of signals at Clifden from May, 1910, to April, 1911; curve for the first day of each month being shown.

good, but their strength suffered some variations. It is rather remarkable that the radiations from Clifden should have been detected at Buenos Ayres so clearly at night-time and not at all during the day, while in Canada the signals coming from Clifden (2,400 miles distant) are no stronger during the night than they are by day.

Further tests have been carried out recently for the Italian Government between a station situated at Massaua in East Africa and Coltano in Italy. Considerable interest attached to these experiments in view of the fact that the line connecting the two stations passes over exceedingly dry country and across vast stretches of desert, including parts of Abyssinia, the Soudan and the Libyan desert. The distance between the two stations is about 2,600 miles. The wave-length of the sending station in Africa was too small to allow of transmission being effected during day-time, but the results obtained during the hours of darkness were exceedingly good, the received signals being quite steady and readable. The improvements introduced at Clifden and Glace Bay have had the result of greatly minimizing the interference to which wireless transmission over long distances was particularly exposed in the early days. The signals arriving at Clifden from Canada are as a rule easily read through any ordinary electrical atmospheric disturbance. This strengthening of the received signals has, moreover, made possible the use of recording instruments which not only give a fixed record of the received messages, but are also capable of being operated at a much higher rate of speed than could ever be obtained by means of an operator reading by sound or sight. The record of the signals is obtained by means of photography in the following manner: A sensitive Einthoven string galvanometer is connected to the magnetic detector or valve receiver, and the deflections of its filament caused by the incoming signals are projected and photographically fixed on a sensitive strip which is moved along at a suitable speed. On some of these records there are characteristic marks and signs produced among the signals by natural electric waves or other electrical disturbances of the atmosphere, which, on account of their doubtful origin, have been called "X's."

Although the mathematical theory of electric wave propagation through space was worked out by Clerk Maxwell more than fifty years ago, and notwithstanding all the experimental evidence obtained in laboratories concerning the nature of these waves, yet so far we understand but incompletely the true fundamental principles concerning the manner of propagation of the waves on which wireless telegraph transmission is based. For example, in the early days of wireless telegraphy it was generally believed that the curvature of the earth would constitute an insurmountable obstacle to the transmission of electric waves between widely separated points. For a considerable time not sufficient account was taken of the probable effect of the earth connection, especially in regard to the transmission of oscillations over long distances.

Physicists seemed to consider for a long time that wireless telegraphy was solely dependent on the effects of free Hertzian radiation through space, and it was years before the probable effect of the conductivity of the earth was considered and discussed. The importance or utility of the earth connection has been sometimes questioned, but in my opinion no practical system of wireless telegraphy exists where the instruments are not in some manner connected to earth. By connection to earth I do not necessarily mean an ordinary metallic connection as used for wire telegraphs. The earth wire may have a condenser in series with it, or it may be connected to what is really equivalent, a capacity area placed close to the surface of the ground. It is now perfectly well known that a condenser, if large enough, does not prevent the passage of high-frequency oscillations, and, therefore, in this case, when a so-called balancing capacity is used, the antenna is for all practical purposes connected to earth. I am also of opinion that there is absolutely no foundation in the statement which has recently been repeated to the effect that an earth connection is detrimental to good tuning, provided of course that the earth is good.

In conclusion, the lecturer remarked that wireless telegraphy was tending

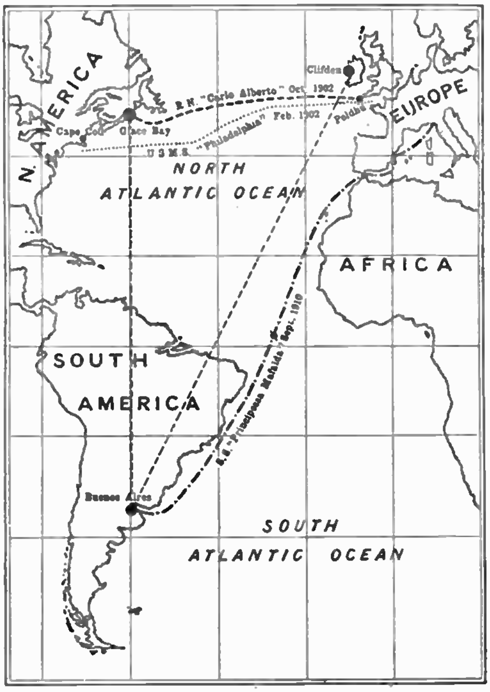


Fig. 6.—Chart of North and South Atlantic.

to revolutionize our means of communication from place to place on the earth's surface. For example, commercial messages containing a total of 812,200 words were sent and received between Clifden and Glace Bay from May 1, 1910, to the end of April, 1911. Wireless telegraphy has already furnished means of communication between ships and the shore where communication was before practically impossible. The fact that a system of Imperial Wireless Telegraphy is to be discussed by the Imperial Conference now holding its meetings in London, shows the supremely important position which radio-telegraphy over long distances has assumed in the short space of one decade. Its importance from a commercial, naval and military point of view has increased very greatly during the last few years as a consequence of the innumerable stations which have been erected or are now in course of construction on various coasts, in inland regions and on board ships in all parts of the world. Notwithstanding this multiplicity of stations and their almost constant operation, mutual interference between properly equipped and efficiently tuned instruments has so far been almost entirely absent, and in regard to the high power trans-Atlantic stations the facility with which interference has been prevented has to some extent exceeded my expectations. The extended use of wireless telegraphy is principally dependent on the ease with which a number of stations can be efficiently worked in the vicinity of each other. Apart from long distance work, the practical value of wireless telegraphy perhaps may be divided into two parts: (1) when used for transmission over sea; (2) when used over land. Its chief benefit, however, lies in the facility which it affords to ships in distress of communicating their plight to neighboring vessels or coast stations; that it is now considered indispensable for this reason is shown by the fact that several governments have passed a law making a wireless telegraph installation a compulsory part of the equipment of all passenger boats entering their ports.

An Electric Burglar Catcher

FELIX J. KOCH

Pending in the Patent Bureau, at Washington, are application papers for one of the most novel inventions ever conceived, and one which, if as much a success as the inventor claims it will be, will almost revolutionize the work of police departments in discovering burglars.

The invention, the work of a Cincinnatian, is an arrangement, whereby, if a window, door or screen be opened, or even slightly disturbed, after the time at which the apparatus has been set, the disturbance induces an electric current, which sets a bell in motion, as in other burglar alarm appliances, and also generates a light, by which an instantaneous photograph of the burglar is secured.

The photograph is taken in such short space of time that the intruder has no chance to avoid it, the flash-light accompanying the ringing of the alarm. The patent rights will be followed by a series of practical tests by police the country over.

WOOD-CARVING

CHARLES GODFREY LELAND, M.A., F.R.S.L., ETC.
Revised by
FRANK H. BALL
Director of Manual Training and Wood-Carving in the Elementary Affiliated Schools of the University of Chicago
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Lignum tortum haud unquam rectum—"a crooked stick can never be made straight"—said the ancient physician Galen; but that would be a stubborn stick indeed which steam and machinery could not soften and straighten now. And, in fact, there is no art whatever which is not easy to any person of ordinary capacity who will "go the right way to work." This right way is to master perfectly the first easy lesson, and practice what it teaches until the pupil is quite at home in it—which is not done in one case in a hundred.

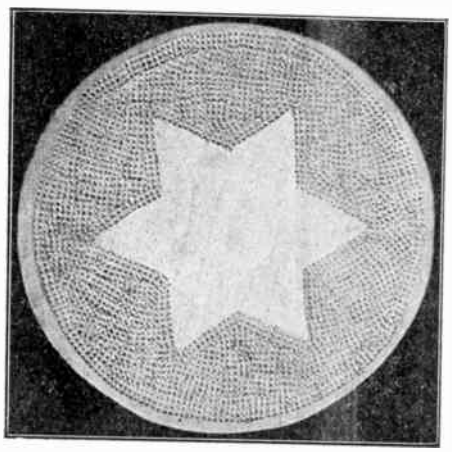


Fig. 1. Stamped Carving

THE FIRST STEP

If the first easy lesson is *thoroughly* learned, the second will invariably prove easier than the first, and so on. This, though it taxes the impatient, who are always in a hurry to produce something to show, instead of learning how to do it well, is by far the most rapid course in the end.

Wood-carving, which is generally admired as "so very difficult" and "so ingenious," is, on the contrary, very easy even for children, when this simple rule of learning one thing at a time very thoroughly is observed. It should, however, be noted that beginners are generally put too far ahead at once. Also, that it is too generally forgotten that the simple first easy lessons, thoroughly mastered, may enable the student to make handsome and profitable things. One thing should be emphasized, "What is worth doing at all is worth doing well."

It will be the aim of this article not to deal too largely with the different kinds of wood-carving, but, by the illustrations and designs, offer to the beginner in this most fascinating of the useful arts suggestions that will lead him on to the more difficult styles that are really sculpture in wood.

The photographs and drawings shown here have been gathered from a variety of sources, and in a great many instances the designer or author is not known, so that credit can not be given to whom it is due. We have endeavored to select the best examples of the different styles in each case.

The first kind of wood-carving usually taught in American schools is what is known as flat carving, stamped carving or tracing.

Fig. 1 shows one of the simplest of geometric designs for stamped carving. If made of wood, 3/8 in. thickness, it can be used as a tea or coffee pot tile, and is a useful example of beginners' work. The same design, or a leaf or trefoil, could be used for the center of the top of a simple box.

The design is drawn with a compass or sketched in free-hand. As the work progresses and the designs grow larger and more complicated, the design is transferred by the use of carbon paper to the object to be carved.

Generally a border line of 1/4 in. to 1 in. is left around the design.

Taking a flat chisel and holding as illustrated, a line is cut around the inside of the border 1/16 in. deep, or if greater

Fig. 2

rapidity is desired, the line may be cut with a knife placed against a rule or straight stick, cutting with the point of the knife. Following the same general directions, cut all around the design itself.

After a few lessons the beginner should have gained strength and skill, so that the line may be cut with a veiner or V-shaped tool.

Fig. 4 shows two views of a veining tool without the handle. It is advisable to get a ⅛ in. veiner to start with, and it should be "handled and sharpened," as it is a difficult tool for the novice to sharpen at first.

It is implied that the wood is fastened to the table or bench by one of the methods shown in Figs. 2, 5 and 6.

In Figs. 5 and 6 we show cuts of the iron clamp, which is made in various sizes and ranging in price from a few cents up to a dollar, and in Fig. 7 of the wooden hand screws.

If the first lesson is on thin soft wood a carvers' punch may be next used to indent or "stipple" the background.

After a few pieces have been made this way the worker will be ready for the next step, which is to cut panels, circles or almost any shape that may appeal to the taste, with a flat back-ground. Mark out the pattern on the piece to be carved by any of the methods spoken of. Then with the veiner, knife or chisel cut all around the border and pattern. In this case the cut will be deeper, for the background is to be cut away with a gouge that is almost flat, or a ¼ in. flat carvers' chisel may be used. This flat gouge will be found a most useful tool, and one or more widths should be obtained. We suggest a ¼ in. or ⅜ in. to start with. As the work grows more difficult more tools will be needed, but we want to emphasize this: only the best makes of tools should be bought, and only one or two kinds at a time. Learn to do several kinds of cuts with one tool. The wood should not be cut away more than ⅛ in. deep. This brings the pattern into slight relief. There will be a tendency on the part of the young carver to make this cutting or "grounding-out" too deep unless care is used.

It is advisable to cut across the grain as much as possible, to avoid accidental cutting of the design, as in such a case the glue pot must be resorted to and that never improves the looks of a carving.

If the background has been cut fairly even it can now be stippled with the punch and stained or varnished if the piece is only a practice piece.

The work should be done as far as possible standing at the bench. The beginner should avoid large pieces or difficult patterns for some time, because one's patience may give out before the completion of a large article, whereas several small articles might have been made giving greater satisfaction and more variety of work, as well as practice, to the beginner.

Fig. 3

The pupil should be ready by this time to try some slight modeling, such as a leaf, a scroll or interlaced geometric pattern. This adds much to the effect and gives "feeling." Get a *good* plaster-of-paris cast of a simple leaf and model it in clay or wax. After a satisfactory model has been made, draw the leaf on the board to be cut and very carefully imitate whatever curves and lines there are in it by cutting away all the stock

Fig. 4

outside of the leaf to the depth of ½ in. As soon as the general form of the leaf is complete, finish or smooth the leaf with shallow gouges. A very effective way of leaving the background is called "egg-shell." This consists of a series of short cuts or chips with the gouge.

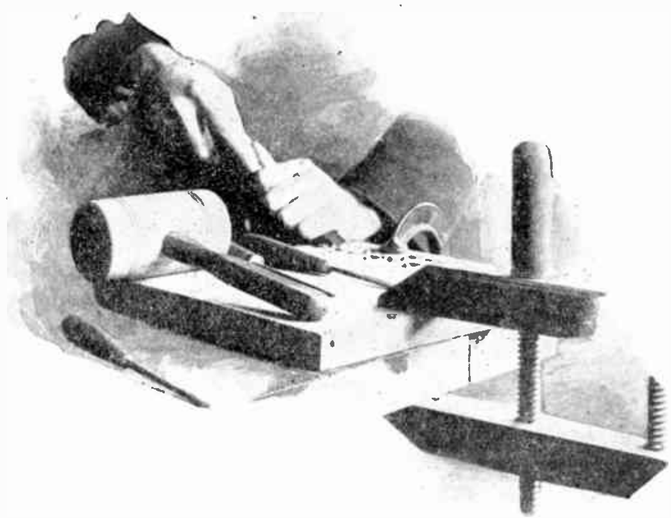


Fig. 5

BOLD CARVING

By making the leaves rounder and higher, lesson after lesson, we come to bold carving. This is very nearly sculpture. Now the pupil may begin to venture on deep and long cuts, but he must continually practise these with the utmost care on waste wood.

Boldness in cutting is a matter of very great importance, since no one can carve really well till he gets beyond "chipping" or "wasting." To carve

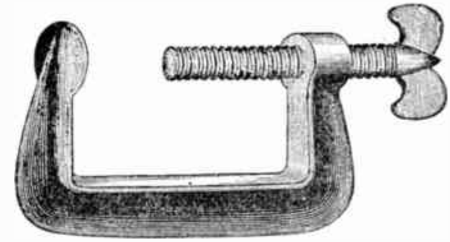


Fig. 6.

boldly we must use the sweep-cut. It may be observed that in modeling in clay there are certain methods of shaping the material which are quite peculiar, as, for instance, when we press the modeling tool up or down, and at the same time turn it to the left or right. This makes an inclination upward or a depression downward, yet sloping to one side or the other. It is made by two movements in one; so, in cutting with a sword or long knife, if we chop, yet at the same time draw the blade, the result is a much deeper incision.

Very much like this is the double motion of the hand in the sweep-cut, which must be acquired by all who would learn to carve leaves well. It is not quite true—as more than one writer has declared—that all work must go through the three stages of blocking out, bosting, or rough sketching and finishing; for when leaves are carved with the sweep-cut, they are generally finished at one operation with this cut, which is generally performed with a flat gouge, the wood is removed so as to give a peculiar form or curve—as when a leaf slopes down or sideways—by a single, yet compound movement. That is, we must, while pressing the edge, also move it or give it a slight lateral motion. This sweep or side-cut is developed more fully in sloping larger

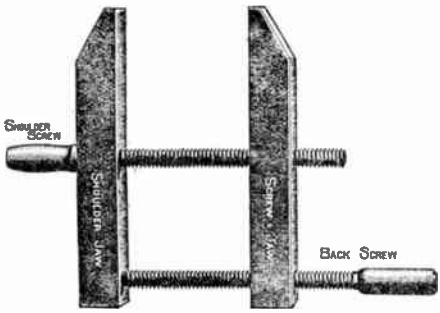


Fig. 7.

Fig. 8
Carvers' punches or "stippling" tools

and especially rounded surfaces like whole leaves, which rise and fall or undulate.

This cut, by means of which one can carve with confidence the most brittle and delicate wood, requires a tool of very good quality, which must be kept scrupulously sharp.

DESIGNS

The pupil is often at a loss to know "what to make next," and is constantly asking the teacher that question. The designs offered in this article, we hope, will act as suggestions for work.

Nearly all the art magazines give designs and suggestions for work. The same may be said of almost any magazine. Since advertising has become such a study and art in this country, one will find some suggestions for a border or panel in any current number. The suggestion should be the first help. Then the arrangement or combining of the leaf, flower, curve or geometric figure should be the work of the student. The more we do the easier it becomes. Our powers of observation are broadened and we see designs everywhere.

WOOD

For the amateur the best wood for practice work is sweet gum. It cuts easily, and has an even grain. Mahogany, walnut, pearwood, and oak are all suitable for different purposes. For the small useful articles suggested here and by many books on manual training, the softer woods are the best. For

Fig. 9. Flat gouge

larger pieces, such as heavy picture frames, book racks, bellows, footstools, photograph boxes, chairs, settees, etc., oak or maple will serve the purpose best.

All of these different woods can be obtained at a lumber yard or wood-working shop at a few cents per foot. The wood should be "kiln-dried," and planed or "surfaced two sides." It can be obtained in any thickness desired, and in long or short length. Nearly all lumber is sold by board foot, which is 12 in. long, 12 in. wide and 1 in. or less thick.

The wood of the tulip tree is considered an ideal wood for the carver. White holly is hard, strong, of firm texture, works well, and also stains well. It is a fine wood for carving or for fret-saw work. Another wood but little known to the carver is the osage orange. The heart wood turns a beautiful brown on becoming dry and being exposed to the action of the light. Pine, whitewood and basswood are apt to be too soft and spongy to make clean, sharp cuts, unless great care is used to keep the tools very sharp.

TOOLS

The first essential is tools of the best quality. They are always the cheapest, even though used for a short time.

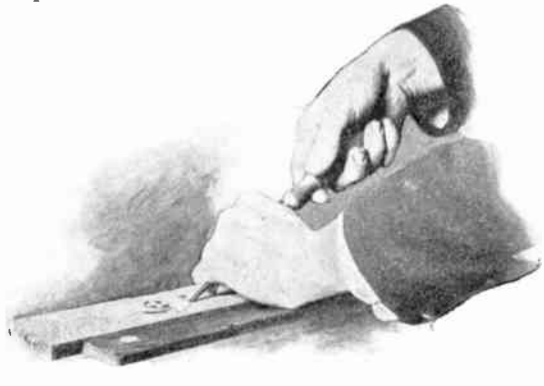


Fig. 10
Manner of holding the flat gouge for "grounding-out"

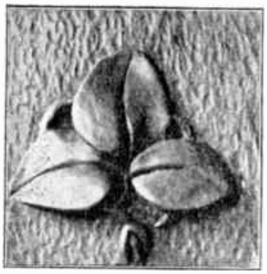


Fig. 11.

Fig. 12

Some of the cheap, trashy sets of tools put on the market, and supposed to be good enough for a boy, are positively criminal. The chisels won't sharpen or hold an edge. The saws bend and won't cut, and many a bright boy looks on life's shams for the first time through a set of poor tools, and never forgives the hardware man who sold them. Far better a very few tools of the best than a lot of poor ones.

Fig. 13
The carved front of a bellows. A fine example of the Viking style, with its free curves in low relief.

The child that asked her papa for a knife that would "stay sharp," hit the keynote.

The best carvers' chisels and gouges are Addis', of London, or Buck Brothers', of Milbury, Mass. The punches for stippling are made by the latter firm. The well-known D. R. Barton tools, made by the Mack Co., 18 Brown's Race, Rochester, N.Y., are also of the highest quality.

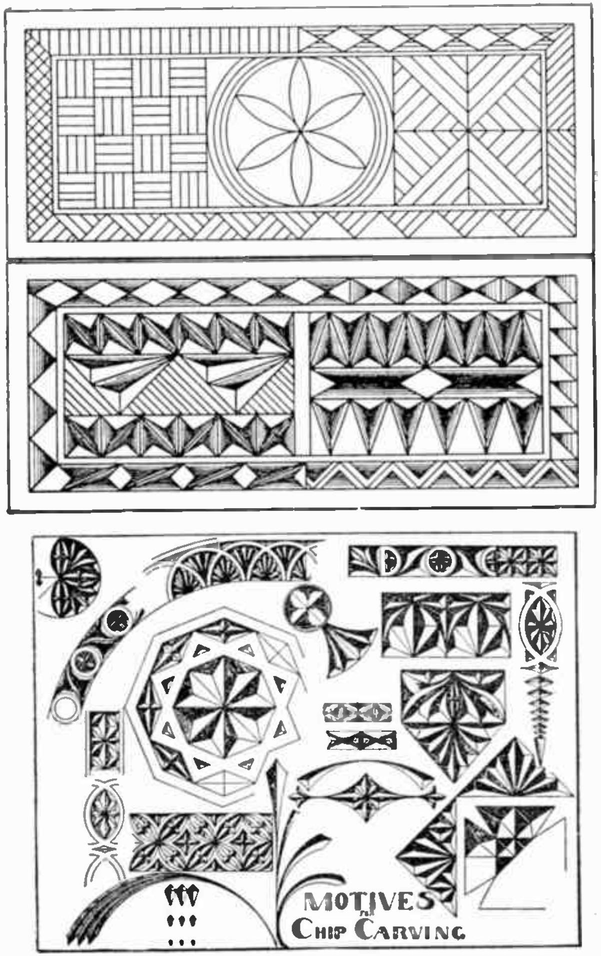
A bench or kitchen table will be needed, on top of which some of the articles shown can be clamped or screwed to hold the work in position while carving. The vise shown can be made at home, and will be found useful for holding work of different widths and thicknesses, which is to be sawed, planed or carved.

A 1/16 in. veining tool, and a 1/2 in. skew chisel, a 1/4 in. flat chisel, a 1/4 in.

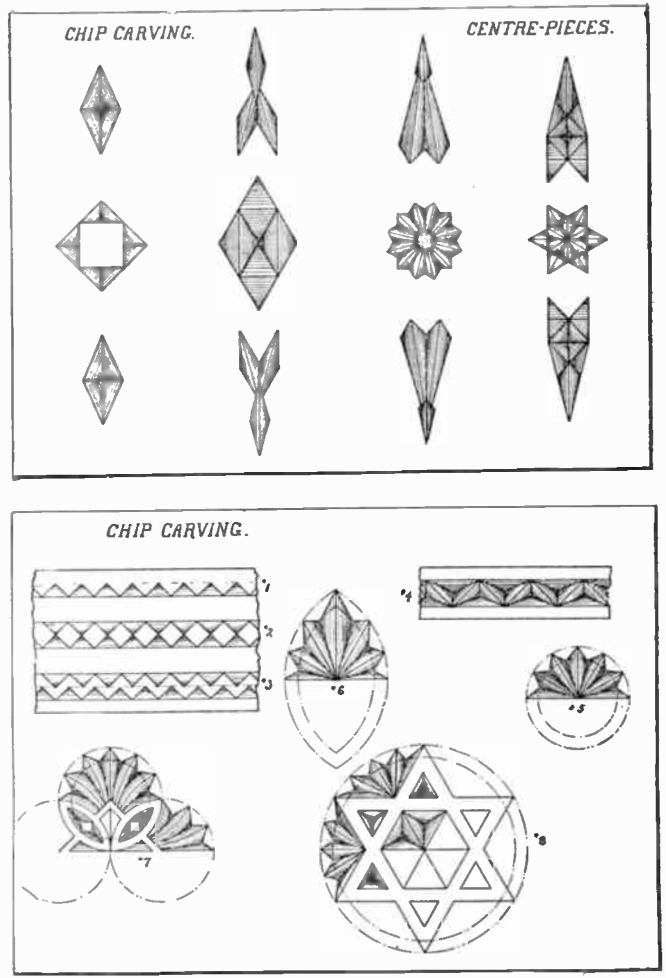
Fig. 14
Design of paper-knife, made of cherry, walnut or gum An example of interlaced carving.

No. 3 Buck Brothers gouge, and a 3/8 in. No. 4 gouge, a medium hard pencil, a rubber and a good compass, are the tools needed most. Here again the cheap tool is a snare and a delusion; buy the best. For the chip-carving in the soft wood, the special knife (Fig. 18) will be found best. It cuts well, but can not be used to pry chips out or the point will break. Among other necessary tools will be a try-square and a 12 in. rule.

Since the placing on the market of the India oil stones, made by the Norton Emery Wheel Co., of Worcester, Mass., a circular grindstone is not necessary to the home worker. Their No. 29, which has one side of the stone coarse and the other side medium, will do all the rough work, and the chisels, etc., can be finished on a No. 2 fine and a leather strop that has a little oil on it. A piece of 3/16 in. leather belting, glued face side out on a 5 x 2 1/2 x 7/8 in. block of wood, makes a good strop. These



Designs for chip-carving



Suggestions of designs for chip-carving.

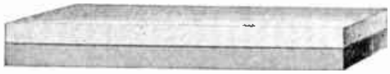


Fig. 15
Coarse and medium oilstone

stones are made in shapes and grades of fineness suitable for all tools. The carvers' slips shown here can be bought at any hardware store.

Wooden hand-screws or iron quilting clamps that can be purchased for a few cents each will be very useful in holding work if one has no vise.

In buying carvers' tools it is best to specify "handled and sharpened;" then they are ready for immediate use and can be kept in condition easily. There are for sale at hardware stores special carvers' clamps for holding the work to the bench or table, but with a little work on the part of the pupil much extra expense can be avoided.

The small coping or fret-saw shown can be bought for 25 cents, and will be found useful about much of the home work.

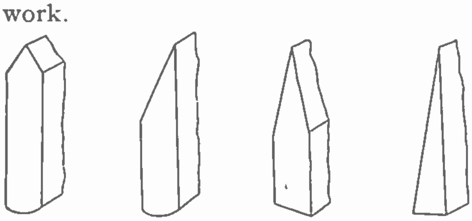


Fig. 16. Carvers' slips

A light carvers' mallet of wood or a rawhide mallet will be found a necessity at times. Be sure it is not too heavy and do not get a carpenters' mallet. It is not advisable to use it until the beginner can carve well, for too often the mallet is an excuse for using dull or blunt tools. The tools should be ground to a bevel on both sides to prevent nicks and breaks. This differs from the carpenter's way of grinding his chisels. One side of his chisels is straight, entirely unground, for cutting square holes like mortise and tenon work. The carver

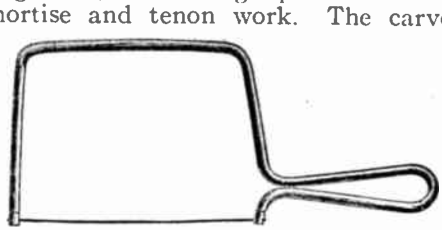


Fig. 17

has to make a variety of cuts with the same tool and must be able to work the tool without turning it around.

First, last and always have the tools sharp. A few moments spent in putting a cutting edge on the tools always pays in the greater satisfaction it gives to the worker.

CHIP-CARVING

Chip-carving has the greatest practical value in training the hand deftly to

Fig. 18. Knife for chip-carving

use a simple tool, and it also shows what artistic effects may be obtained by the use of geometrical drawing. Chip-carving, from the fact that it requires so few tools, is primarily a home craft, and can be done on any kind of a table or lap-board. It makes no litter and offers greater combinations of designs to one who has not a talent for designing or has not studied it. The work requires no mental or bodily strain and is not fatiguing. At the same time, a practical knowledge of geometry is obtained and a familiarity with the grains of the wood that will be of value to the carver in more advanced work. Neatness of fingers and accuracy, two most valuable qualifications whatever one's calling may be, are sure to follow.

For small work in soft woods, such as sweet gum, white wood or in black walnut, the special knife shown here is the best tool.

Fig. 19. Skew Chisel

If the student wishes to work in harder woods, such as maple, oak, etc., a ½ in. skew chisel will answer the purpose better.

The antiquity of this style of decoration is admitted, but perhaps it is to the Scandinavian countries that we owe its more recent adaptation to our work, their teachers having brought to us in the last few years so many fine examples of the work; boxes of various kinds, footstools, drinking horns, chairs, book covers, pen trays and a great variety

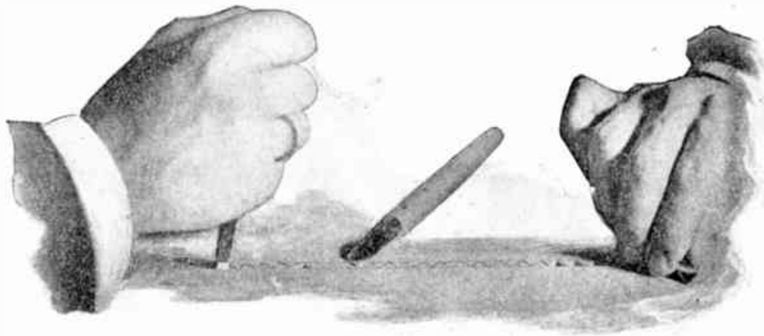


Fig. 20 Fig. 21 Fig. 22

Fig. 20 shows position of hand for making the first two cuts of chip-carving. Fig. 21 shows position for removing the chip. Fig. 22 shows position to hold the knife for curved and circular cuts shown in Fig. 25.

of picture frames. Our own ideas suggest stamp boxes, blotters, match boxes and an endless number of useful articles. One of the most effective the writer has seen was an oak chair of odd design, decorated in chip-carving stained a Flemish oak, with the incision stained a bright red.

Full sets of desk furnishings can be made and carved in this style. The

Fig. 23

A library or tea table made of oak or maple, having a low-relief border carved on the top. The background is to be punched and the design interlaced to give some modeling.

best wood for it is, perhaps, the heart wood of sweet gum. Its markings are handsome, besides being a close-grained, even-textured wood. The only objection to it is that large pieces are sure to warp.

Another way of treating wood for chip-carving is to glue a piece of 1/16 in. white holly on a piece of sweet gum; then cut the design through the holly, showing the brown of the gum through the white of the latter.

STAINS, COLORS AND VARNISHES

Very attractive effects may be obtained by the use of aniline stains, or inks and certain combinations of Diamond Dyes will give a most excellent old mahogany stain.

A nice finish is found in the use of beeswax and turpentine mixed to the consistency of soft putty. Apply with

Fig. 24

a cloth and let it stand for a few hours. Brush the object with a stiff clean brush, as one would polish shoes. This can be applied to the bare wood or after it has been stained.

A very good dull finish may be obtained by taking one part shellac and two parts alcohol and applying with a brush. The alcohol soaks into the wood and draws part of the shellac with it. This requires no other finishing.

Redwood dust or red sanders stain can be bought at a drug store or at any paint store; the color is easily extracted by using alcohol. The longer it stands the more color the alcohol extracts from it. By mixing this with other stains, various colors and shades may be produced.

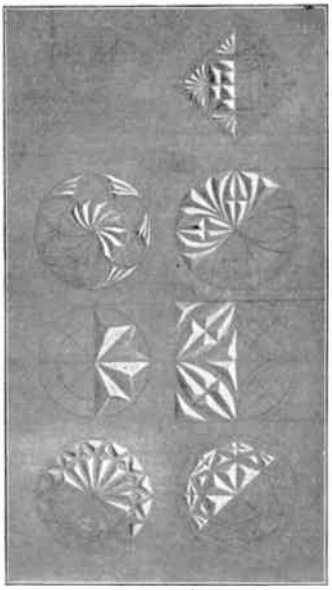


Fig. 25

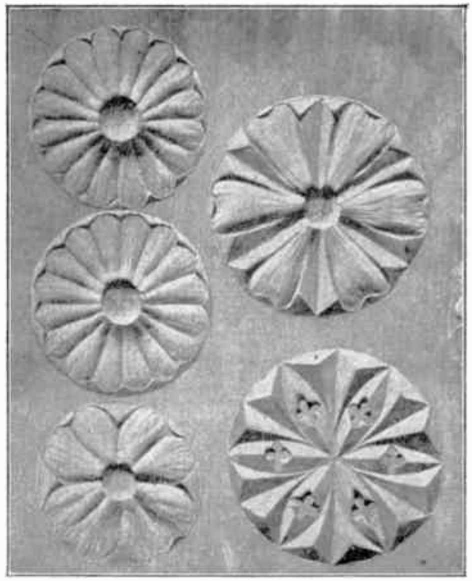


Fig. 26

Some low-relief rosettes, to be used on box covers, corners of picture frames. These conventionalized flowers should bring out considerable "feeling."

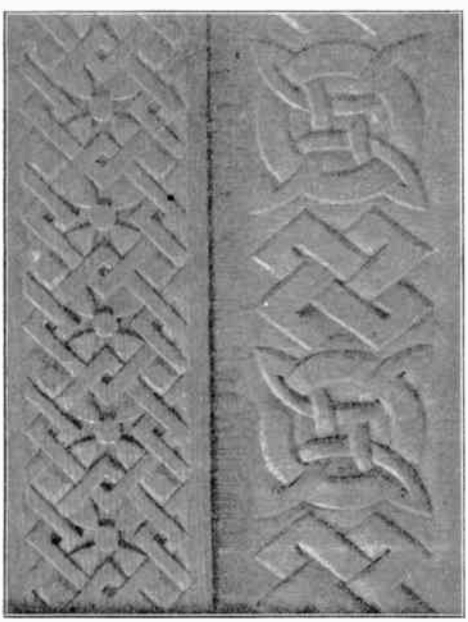


Fig. 27

Two examples of interlaced geometric designs carved in oak, suitable for wood boxes, large picture frames, backs of plate racks, etc. Low-relief carving.

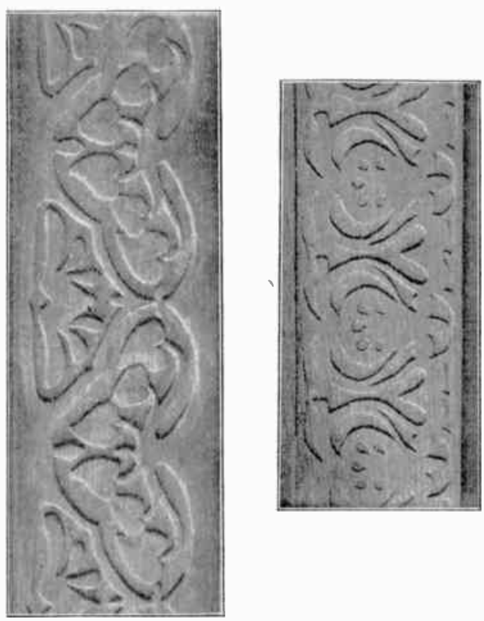


Fig. 28

Photographs of borders suitable for table tops and other articles. The first one shows some modeling of the leaves.

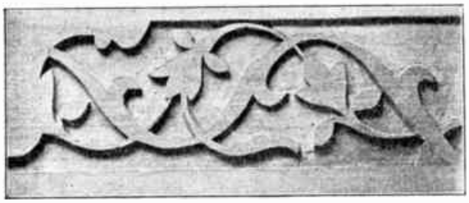


Fig. 29

So many paint stores and department stores keep ready for use stains and colors of all kinds that it may not be worth the time to mix many.

Fig. 30

Shellac or varnish of a standard make can be used on many things if one wishes a glossy effect. Often a coat of raw linseed oil, applied with a cloth or the fingers and, after drying, polished with the bare hand, gives a pleasing finish. It turns darker with time and exposure

Fig. 31

to light. Walnut and sweet gum are much improved by it. Wood exposed to the fumes of strong ammonia enclosed in an air-tight box takes on a rich dark color that is permanent. All stains, dyes or colors may be treated to one or more coats of varnish or shellac, which will help to preserve the wood. To produce the "Flemish Oak" effect which is so much in vogue at the present, the stains may be obtained from well-known varnish firms throughout the country.

It is not the mission of this article to speak of the more elaborate styles of wood-carving, like the Gothic and the Florentine, the Renaissance and the

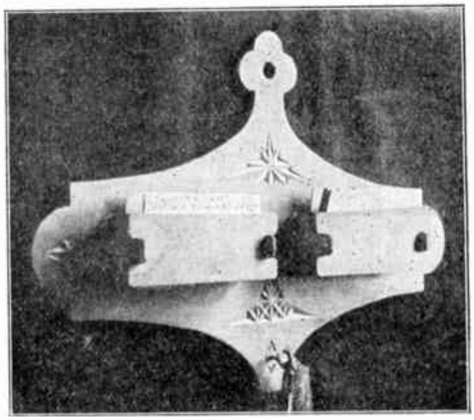


Fig. 32

Memorandum or shopping list. One box to contain blank cards, the other notes.

Rococo, the Viking, with its pure curves in low relief, or the flat Byzantine, in which there is a little modeling. We feel that enough has been said to start the beginner and lead him toward personal investigation along the lines spoken of and illustrated herein.

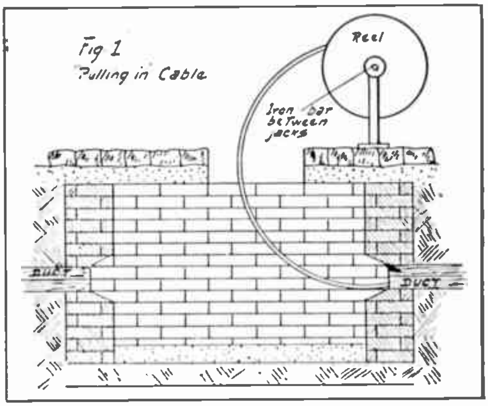
Sound not Transmitted

Many people think that when they speak over the telephone the transmitter, battery, and wire in some way carry the voice to the ear of the listener. This is not the case. The transmitter and the battery are a sort of miniature transforming station in which the vibrations of the air caused by the sound of the voice are caught upon the diaphragm and turned into electrical energy. As the diaphragm vibrator in front of the pole-piece of the transmitter it may assume many shapes. The vibrating areas and the nodes or non-vibrating lines are at one time star-shaped, at another like the spokes of a wheel, they are generally geometric figures, but the various forms of vibration cause varying pulses of electrical current flow to traverse the wire. At the receiving end the varying electrical flow attracts the diaphragm so as to cause, in similar sequence, the geometric figures to be formed by it, and thus give out the very tones of the speaker's voice. What traversed the wire was not sound, but current, and the ear-piece or sounder re-transformed this energy back into the form of sound.

CABLE SPLICING

GEO. M. PETERSON

A telephone cable consists of paper-insulated wires wound together and placed within a lead jacket or sheath. The insulation on one-half of the wires being one color, usually red, while the other half are usually white. Two wires, one red and one white, are twisted together and called a pair. These pairs must be kept together and carried straight through, being spliced up color for color, white to white and red to red. Having explained that the telephone cable consists of pairs of wires instead of "conductors," or single wires, we will see how the various kinds of cable are designated. A 300 pair No. 22 gauge cable is written or spoken of as a "300–22" while a 200 pair No. 19 gauge cable is called a 200–19. Then



there is the "combination" cable. This indicates that the cable has wires of two or more gauges, for example: 200–19 and 200–22. In this case the 22 gauge wires would be used for local subscribers, while the 19 gauge would be used for "Toll" wires between neighboring towns, or "Trunk" wires between distant exchanges.

Cables, for telephone and telegraph uses, came into popularity about thirty-five years ago and in the one size of 50–22. These wires were insulated with two layers of cotton tape, boiled in paraffin, twisted into pairs, insulated with two more wrappings of paraffined cotton, and placed in the sheath. The sheath was then filled with paraffin. Although these cables were not so easily effected by moisture, and were a great deal better than our present-day cables in every respect, their size was against them and the "cotton insulated cable" was doomed. In this day, when the idea does not seem to be "how good," but "how cheap," can this cable be made up and still do its work, we shall undoubtedly see a 1,000 pair cable before the year is gone. Of course all the subway is built with 3¼ in. ducts, that being standard size, and the 600 pair, 22 gauge cable of today just fills it up, so that any larger cable which may be put on the market must have smaller gauge wires so as not to bring the diameter of the cable over the 3 in. limit.

PLACING THE CABLE

Upon the completion of the underground conduit, the next operation is the placing of the cable. This is accomplished by first "rodding" the ducts, the rods drawing in the "pulling line," and the line pulling in the cable. The operation of "rodding" consists of pushing short wooden rods, 3 ft. in length, with a screw connection on each end, into the ducts, one after another. When the first one is in the duct another rod is screwed into it and pushed in. The rods are attached until the first one appears in the manhole at the opposite end of the section. A ⅜ in. stranded wire pulling rope is attached to the last rod and thereby drawn through the ducts as the rods are drawn ahead and uncoupled. An iron bar is then placed through the center hole of the cable reel, a jack is placed at each end of the bar and the reel elevated clear of the ground, and in the location shown in Fig. 1. The pulling rope is then passed around the drum of some sort of a capstan, winch or windlass, which is then turned by hand or by mechanical means until all of the line is pulled through and the cable is placed in position in the ducts.

When the cable has been pulled into the ducts or "placed," it is usually tested for trouble. The various kinds of cable troubles are shown in Fig. 2. The only tests which are made on dead sections are the tests for "opens," "crosses" and "grounds." These tests are all made with the aid of a headphone and battery. The first operation in making any of these tests is to strip the armor off of the cable for about 8 in. at each end, being extremely careful that the wires are not cut or broken off or the insulation broken at the edge of the sheath. The former will cause "opens" and the latter "grounds."

TESTING FOR OPENS

In testing for "opens" the headphone and battery are connected in series, as in Fig. 4, and this arrangement is maintained throughout the test. The receiver lead *B* is grounded to the cable sheath. The wires at the far end of the section are "bunched" by stripping off about 2 in. of the insulation and tying all the bare ends together with a piece of copper wire. This wire is then fastened to the sheath, thereby grounding all of the wires in the cable and making our test possible. The individual wires in the manhole from which we intend to make our test, are then cleaned or kept separate from one another while we touch each individual wire with our "search." A click in the receiver should be heard if the wire is O.K. and if no click is obtained we know that the wire is open.

The circuit of this test is shown in Fig. 4, the current passing through the receiver, the sheath, the strap wire to the bunch and thus to our individual wire, the circuit being finally closed when contact is made between the "search" and the cable wires.

CROSS TEST

This test is very similar to the "open" test, but, instead of "grounding" the bunched cable wires, at the far end of the section, the strap is attached to lead *B*, as shown in Fig. 5, and the section is tested from this end. The lead *A* is then touched to the cable wires, one at a time, as they are removed from the bench. No sound should be heard in the receiver when these wires are touched, although the induction is often responsible for a pretty stiff tap on the diaphragm of the receiver and the amateur splicer should not be mislead by it. If the click in the receiver is really caused by the closing of the test circuit

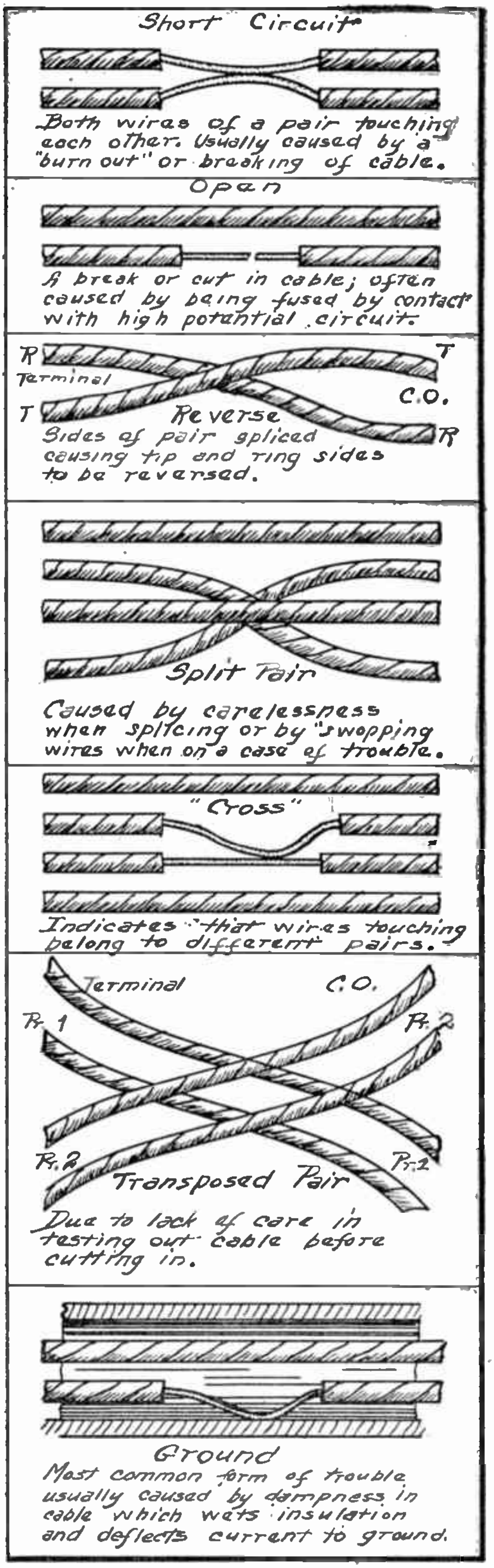


Fig. 2 Various cases of cable trouble

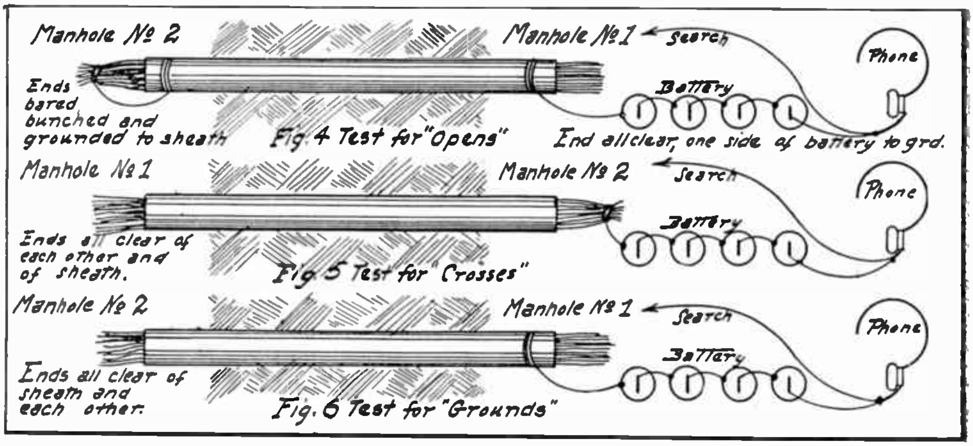


Fig. 4 Test for "Opens"

Fig. 5 Test for "Crosses"

Fig. 6 Test for "Grounds"

it is proof that the wire is "crossed," and it should be kept apart until the test is completed. Upon the completion of the "cross test" these marked wires should be tested against each other, against the ground and against the bunch of cable wires until the other side of the cross is located. Tests are then made from the other end of the section and in this way the trouble is located at both ends of the section and tagged.

GROUND TEST

The "ground test," as shown in Fig. 6, is practically identical with the "cross" test, but the lead wire is attached to the cable sheath instead of to the bunch, and the individual wires are tested against the sheath instead of each other.

If any amount of trouble appears it is always advisable to await instruction from the splicing or supervising foreman before splicing the cable up, as it is often considered good practice to draw in a new section of cable instead of splicing up the bad section and thereby losing several pair of wires for the total length of the cable, or going to the expense of clearing the trouble in the section.

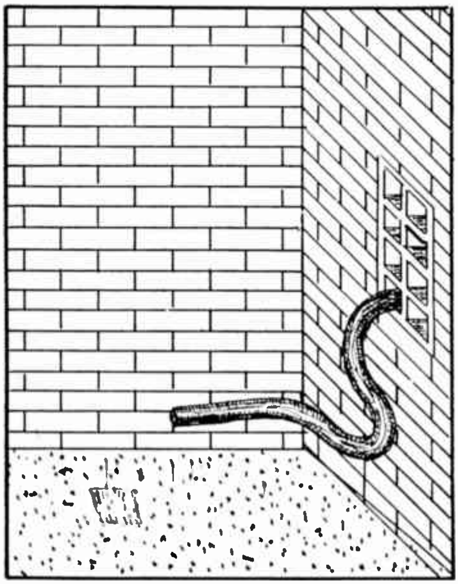


FIG. 7 One end of cable set up.

SETTING UP

After the sections of cable have been tested for trouble the ends, in the manhole, are placed in position for splicing or "set up." An idea of the proper manner of setting up a cable may be obtained from Fig. 7, which shows one end only.

SPLICING

Upon completion of the "set up," the actual operation of splicing is begun, the sheath being first removed back as far as it is desired to work upon the wires. A strip of cotton tape is forced between the cable wires and the sheath to prevent the rough edge from injuring the insulation of the wires. Fig. 8 shows a completed splice and will give a pretty good idea of the work needed to accomplish a good-looking job.

The insulation of the cable wires consists of a single wrapping of thin paper around each wire for telephone work, while a rubber and cotton braid

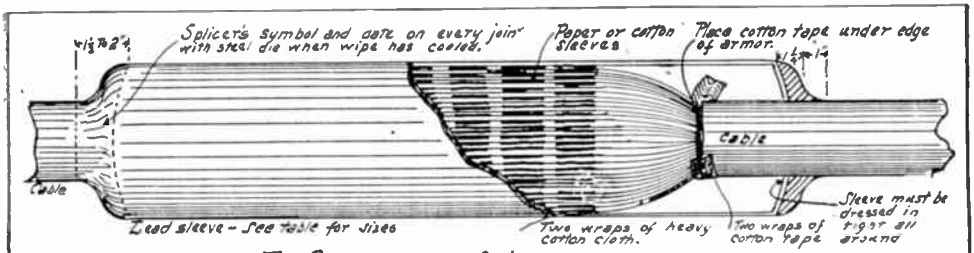


Fig. 8 Completed Splice

is used for telegraph, fire alarm, light and power cables.

After the tape is placed under the sheath the cable is "boiled out" with boiling paraffin, which is poured on at the end nearest the sheath and run out toward the end. The paraffin is used to drive out any moisture which may have collected; to keep out, to a large extent, any moisture which may be in the vicinity of the cable while open; to make the insulation "peel" off of the wires easier; to prevent, or at least check, the paper insulation from unfurling. From the foregoing statement it may be readily seen that if the paraffin were poured on from the outer end toward the sheath it would drive the moisture ahead of it under the sheath and thereby spoil the entire section of cable by throwing in a moisture ground. After the ends are dried out, a lead sleeve, of the dimensions given in the table, Fig. 11, is then slipped over one end of the cable and allowed to hang on the sheath, the ends first being filed, or scraped, bright and rubbed with stearine or tallow.

The cable wires are next laid back as shown in Fig. 9.

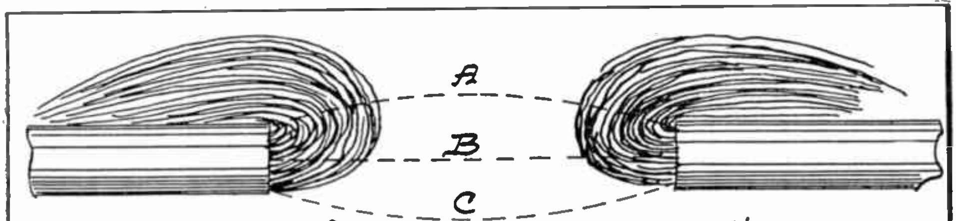


Fig. 9 Showing ends ready for splicing.

TYING THE WIRES

The cable wires are now ready to be tied, only one pair at a time being removed from the bunch and tied together, color for color, allowing enough fullness at the rear and bottom of the splice so that the finished splice will be symmetrical. *A* shows the back of the proposed splice, *B* the center, and *AC* the completed outline. The method

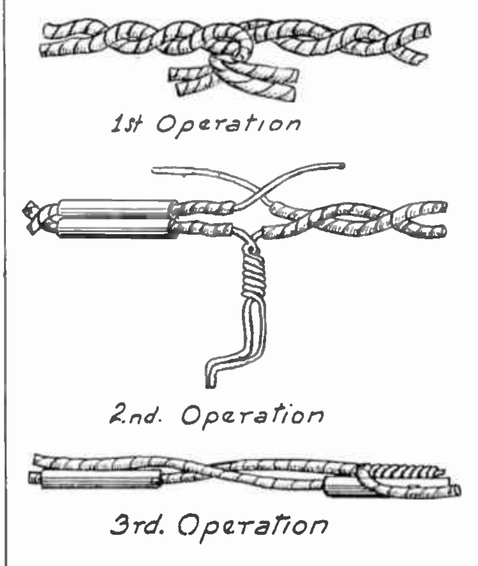


Fig. 10 Making Twisted Joints

Size	No. 19 Gauge Cotton Sleeves Length	Diameter	No. 22 Gauge Cotton Sleeves Length	Diameter
50 Pair	18 in.	2 in.	18 in.	1½ in.
100 "	20 "	2½ "	18 "	2 "
150 "	20 "	3 "	18 "	2½ "
200 "	20 "	3½ "	20 "	2¾ "
300 "	20 "	4 "	20 "	3 "
400 "			20 "	3½ "
500 "			20 "	4 "
600 "			20 "	4½ "

Sleeves for Straight Splices

When paper sleeves are used on cables larger than 300 pair, allow ½" more on diameter of the sleeve than that given in the table.

Fig. 11

Fig. 12 Location of Pasters on Joint.

of tying and slipping on the cotton sleeves is shown in Fig. 10.

After all of the wires are tied, or spliced, the splice is again boiled out, wrapped with heavy muslin, which has previously been rolled into rolls about 30 ft. long and 3 in. wide, boiled out again, and then the lead sleeve is slipped over the splice and dressed in to meet the cable, as shown in Fig. 12, which also illustrates the position in which the pasters are placed before wiping the joint. The pasters are intended to make a square end to the wipe and also serve as a marker to the man who is wiping. Great care must be taken to get the wiping solder hot enough, and extreme caution must be exercised so that the sleeve or sheath is not melted from the heat of the solder. A "frozen" or "plastered" joint is considered enough justification for a splicer's dismissal from any up-to-date telephone company's employ, as the joint is likely to be submerged in water at any moment, and if it is not absolutely tight and perfect, a few drops of water are liable to enter the splice, necessitating a hurried call for the galvanometer man, and maybe the calling out of the cable gang in the middle of the night to pull in a new section of cable; and then a couple of good splicers are more than likely to get stuck for a twenty-four, thirty-six or forty-eight hour trick, thus causing a considerable expense, which is inexcusable. Therefore, learn to wipe. The only way to learn is to get some short piece of cable and sleeving, a solder pot, furnace, ladle, some metal, make a wiping and catching cloth and go to it.

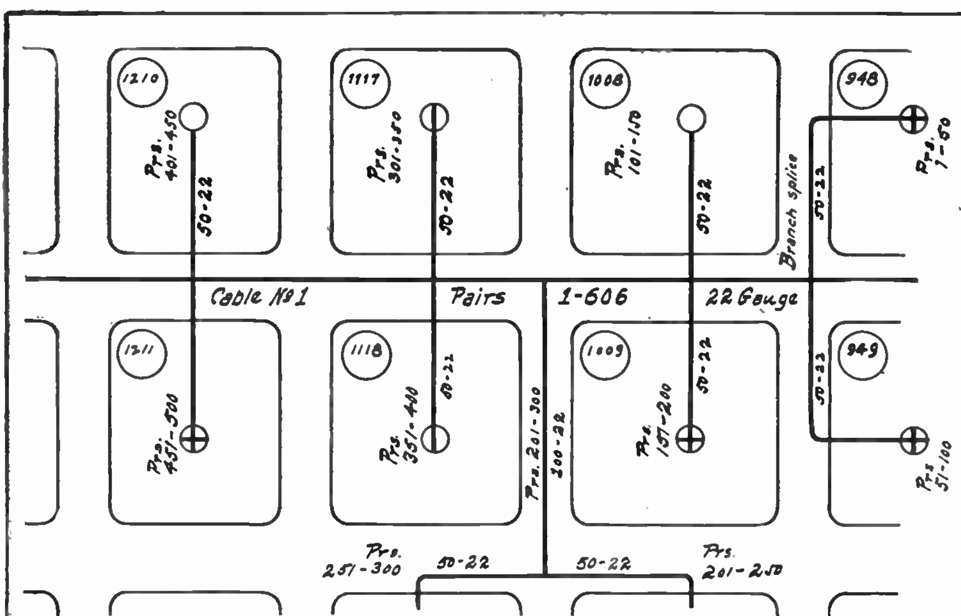


Fig. 13

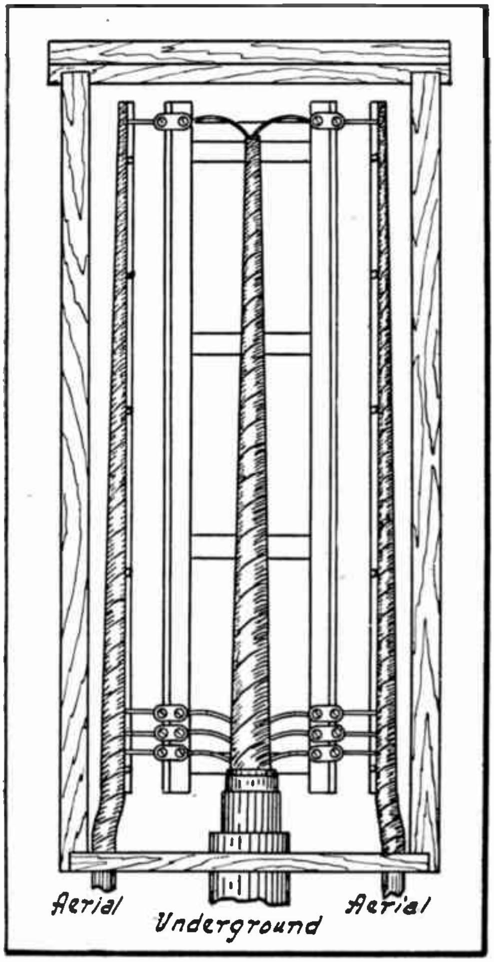


Fig 14 Cross Connected Cable Box

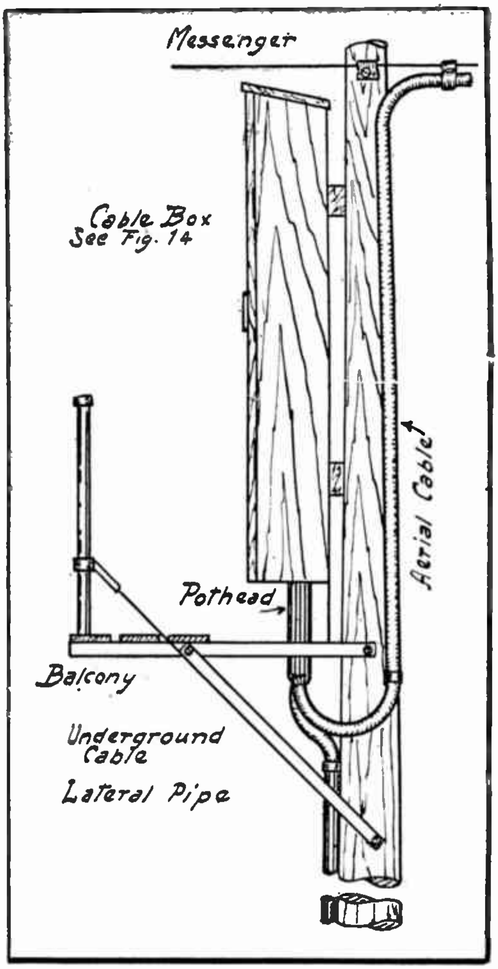


Fig. 15 Cable Box on Pole

BRANCH SPLICE

A branch splice is one which has at least three cables coming out of one sleeve and is used anywhere where stubs are to be taken out of a cable or where terminals are to be cut into the cable.

DUCT SPLICE

A duct splice is one which must be made of such a size that it may be pulled right into the ducts upon completion. This, naturally, requires a long sleeve, sometimes as long as 4 ft. The duct splice is generally used when a section of cable is not long enough and two pieces must be spliced together.

BLOCK CABLE CONSTRUCTION

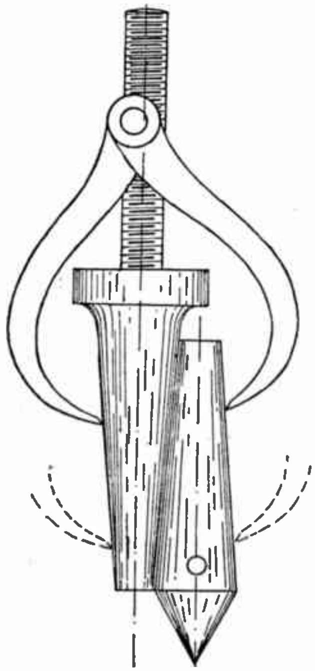
The latest practice in underground cable construction is shown in Fig. 13, in the plan of which each block in the city is given a number and is known by that number on all records, etc.

These blocks are fed by a main underground cable, a 600 pair, 22 gauge, being used for illustration, and from which the various taps or branches are run into each block as shown, the subsidiary cables usually being 30, 50 or 75 pair. The style of box to be placed on the pole is designated by the circle, one line ⊖ meaning a straight-connected, or solid box, while two lines ⊗ denotes a cross box, one which is equipped for an aerial cable as in Fig. 14. Fig. 15 shows a cross connected box on a pole.

The Turning of Tapers

F. M. T. REILLY

I found it necessary to turn out a mandrel to fit the socket of my lathe, during which I wished to test the angle of taper to see whether it coincided with that of the centers. The rough sketch



illustrates the quick and simple method used. If the two tapers are exactly alike the distance shown between the calipers is the same at all points. This will doubtless prove a useful hint, since it is not usually known.—*Model Engineer*.

Sparks from an Emery Wheel

J. F. RALLI

It is a well-known fact that the color of the sparks from a piece of metal, whether produced by electrical or mechanical means, is in a great measure characteristic of the metal in question. The fact is of service to the mechanic: it enables him to judge the kind of iron or steel of which his tools are made as they are being ground on an emery wheel.

The sparks from cast iron are dull red in color, and remain close to the wheel. Tungsten steel and self-hardening tool steel also produce dull red sparks, bearing a close resemblance to those of cast iron in point of color, but formed in thick showers. Mild steel gives a bright yellow spark, in striking contrast to the preceding; it also flies off much further from the wheel. Wrought-iron sparks behave in a similar manner and are thrown off some considerable distance. They are dull red like cast-iron. The observation of these sparks is always a simple—and sometimes the handiest—method of distinguishing between tool steels.

Belt Lacing

WILLIAM DOWNES

I am engineer at a large coffin and casket factory where a great many fast-running woodworking machines are in use, and where the belts have very severe usage and all of the belts are laced with wire lacing, which practically makes an endless belt and makes the machines run as smooth as possible.

There are three grades of wire for belt lacing, No. 1 for wide, heavy belts; No. 2 for medium width double, and No. 3 for small and single belts. The holes in the belts should be only sufficiently large for the wire to pass through nicely. The holes for light belts should be punched about ¼ in. from the end

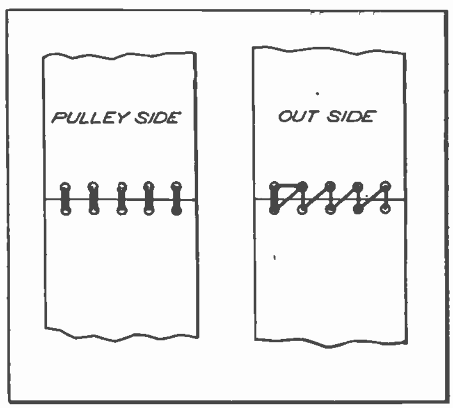


FIG. 1. METHOD OF LACING WITH WIRE

and about ½ in. apart; for heavy belts the holes should be punched about ⅜ in. from the ends and about 10 holes to 4 in. width of belt.

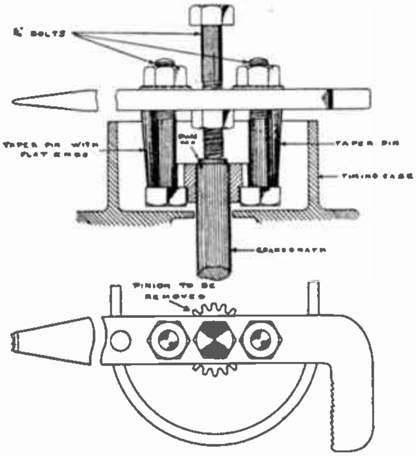
In cutting the wire so as not to have any waste, for single belts, use seven times the width of the belt for the lacing. Thus, if the belt is 7 in. wide, 49 in. of wire would be required. For double belts, the length of wire required is eight times the width of the belt. In commencing to lace a belt see that the holes come opposite each other. If the belt is very wide, requiring, say, 40 holes, cut the wire in two parts and commence at the tenth hole and work both ways, pulling the wire tight with a pair of pliers from the end of the wire, being careful that the wire does not get crossed. To fasten the wire, all that has to be done is to cross over on the top side and pass through hole to the pulley side, pull up tight and cut off within ¼ in. of the belt and turn down. When the lacing is finished, get a smooth hammer and pound down the lacing until it is imbedded into the leather and you will have as fine an endless belt as anyone would wish to see.

On my main belt there are two joints, all laced with wire lacing and two of the joints have been running for upwards of five years. The other joint is the one that I cut when I want to take up the slack. It is a very heavy double leather belt, 18 in. wide, 65 ft. long, running from a 96 in. pulley to one of 32 in. diameter.—*Practical Engineer.*

Removing an Obstinate Timing Wheel

C. R. E. POPE

A "jig" which may be of use to other motor cyclists in similar circumstances is herewith described. I had to remove a pinion on the crankshaft of my engine



that was particularly tightly fixed in place, and also very inaccessible, being at the bottom of timing case, as shown. It will be seen that the metal behind the pinion is very thin, thus preventing the use of this part as an "anvil" to hold the pinion against while driving out the shaft. I had not a "wheel drawer," or any like appliance at hand, but on looking around I found the handle of a pipe wrench, with a very convenient number of holes in line. Three 5/16 in. bolts and nuts, two taper pins, with the ends filed flat—to prevent the bolts "splaying"—and a small piece of brass completed the outfit, and on slipping the two outer bolts' heads under the edge of the pinion, and screwing down the center one, meanwhile holding its nut with a spanner, the pinion came off quite nicely. I might add that the pinion shaft had been riveted over, and was very tight in consequence, even after removing the burr.

The chemist has saved Paris from a water famine. The experiments of filtration and chemical sterilization of the water of the river Marne have yielded excellent results. By means of filtration and treatment with hypochloride of soda 30,000 cu.m. of potable water have been turned on for the use of Parisians, and this supply, added to 300,000 cu.m. of spring water, and 60,000 cu.m. of Seine water, filtered at the Ivry reservoir, will suffice for the present needs of the French capital.

A newly-made magistrate was gravely absorbed in a formidable document. Raising his keen eyes, he said to the man who stood patiently awaiting the award of justice

"Officer, what is this man charged with?"

"Bigotry, your worship. He's got three wives."

The new J.P. rested his elbows on the desk and placed his finger tips together. "Officer," he said, somewhat sternly, "what is the use of all this education, all these evening schools, all the technical classes, and what not? Please remember, in any future like case, that a man who has married three wives has not committed bigotry, but trigonometry. Proceed."—*St. Paul Dispatch.*

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 the letter, and only three questions may be sent 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 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.

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.

1672. **Small Dynamo.** R. A. L., U.S.S. *Minnesota*, asks for data for small shunt dynamo generating 5 amperes at 5 volts while running at a speed of 500 revolutions per minute. Ans.—Your machine will necessarily be expensive for its output, as you desire so low a speed. We can do no better than to refer you to Mr. Houghton's articles in the February and March, 1911, numbers for the description of an excellent little machine which may meet with your requirements if you substitute No. 20 enameled wire for the No. 18 d.c.c. as specified for the armature. The field winding may remain the same. Some difficulty may be experienced in making the machine build up at such low speed, and in such an event, we would suggest the usual "coaxing" method with a few cells of battery, or it may be necessary separately to excite the fields.

1673. **Wavemeter.** J. G. A., Honolulu, H.I., asks if we can mention publications covering the Siebert wavemeter. Ans.—We can find no accurate data on this type of wavemeter, and would refer you to the Patent Office as the only probable place where a description of same may be obtained if it is patented.

1674. **Kites for Aerial.** E. H. K., Richmond, Va., asks: (1) The sending range of a 1 in. coil. (2) How to amalgamate battery zincs. (3) What kind of kites to use to suspend an aerial and how made. (4) Are ferron and silicon deprived of their sensitiveness by holding with solder in a cup? Ans.—(1) We must decline to give such an estimate as it would be a mere guess. (2) Dip the zincs in dilute sulphuric acid to clean them; then scrub mercury over surface with a toothbrush. (3) Box or cellular tetrahedral kites. The publishers of this magazine can furnish you with suitable publications covering the construction of these. (4) Yes, too much heat injures it.

1675. **Armature Winding.** S. G., Trinidad, Col., asks: (1) If there is not an error in the description of the armature winding of the 75-watt dynamo given in the last March issue. (2) What is the size of wire, of which a sample is sent? (3) Would this wire serve as the secondary of an induction coil for giving ½ in. to 1 in. sparks, and if so, what should be some of the general dimensions of the structure? Ans.—(1) Yes, and you have been a very careful reader to detect the mistake. On page 184, column 2, 21st line from bottom, it should read "terminals in 8." (2) The size is No. 27 B.& S., and this is too large for an induction coil. However, general dimensions for a coil of the output you propose would be: Length of core, 7 in. diameter, ¾ in. primary winding, two layers of No. 16; secondary, ¾ lb. of No. 36; condenser, 60 sheets, 4 x 4 in. (3) You can do no better than to follow many of the directions given in the February and March issues of the magazine, in regard to the 6 in. coil. For a coil of your size, you would not need to divide the secondary into more than four sections. A dynamo does not operate an induction coil as well as batteries. The reason is that the former has considerable self-induction in its armature winding. This quality prevents the current building up as quickly as desirable when the contact is made. A battery is free from such hindrances, and can supply its current as determined by the conditions of the exterior circuit only. You could use storage cells charged by a dynamo.

1676. **Wireless Connections.** L. C. P., West Newbury, Mass., sends us a diagram of connections used in his receiving set and asks our opinion on the hookup. Ans.—You are using a very poor diagram, and it is doubtful if it will work properly at all. The battery rheostat is of no use with the silicon detector, and both this and the battery should be discarded and your set connected as follows: Connect aerial lead to one sliding contact of your tuner; to the other slide of the tuner connect one terminal of your detector; the other terminal of your detector goes to the fixed condenser, and from the opposite side of the fixed condenser to the binding post at one end of the winding on the tuner. This post also connects with ground. The telephones are bridged around the fixed condenser as shown.

1677. **Alternating Currents.** I. H. S., Siegfried, Pa., asks: (1) What is meant by "single phase," "two-phase," and "three-phase" currents? (2) What is the advantage derived from the use of such currents? (3) Is it possible to operate motors by wireless electricity? (4) In making the 75-watt rotary converter described in the April and May, 1910, issues of *Electrician and Mechanic*, could a smaller number of armature slots be used? (5) What is the difference between "magnet" and "annunciator" wire? Ans.—

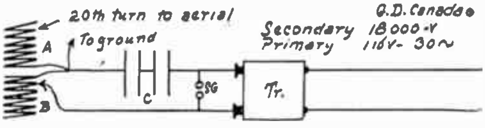
(1) The idea can be clearly obtained by conceiving an ordinary ring-wound armature, as adapted for direct currents; if the winding be tapped at two opposite points and led to two insulated rings, and the armature be rotated under the influence of a two-pole field magnet, single-phase alternating currents will flow in the external circuit that may be provided. If two other taps be provided, equidistant from these first, and two more rings be added, a second single-phase circuit will be available. The combination of these two circuits, involving the use of the four wires, will give two-phase currents. Because these connection points are a quarter-circumference apart, the scheme is also often denoted as "quarter-phase." With three equidistant points connected to three rings, and three external wires, three-phase currents will flow. Of course the external circuits, or apparatus, must be properly designed and wired to utilize the successive alternating currents in a symmetrical manner. (2) The principal advantages of alternating currents over direct lie in the fact that the voltage can be much higher than any commutator could withstand, therefore much greater distances can be reached in the transmission system. (3) No. (4) Not well, —it would be better to have more rather than less. (5) "Magnet" wire has a thin covering of cotton threads, in single, double or triple layers. It is the sort of wire to use on dynamo armatures and field magnets, in which it is important to get the largest amount of copper in a given space. "Annunciator" wire has a heavy covering of threads, soaked in paraffin, and is intended for bell wiring and the like. Magnet wire is annealed, and therefore more easily bent than the other.

1678. **Thermo-Generators.** R. B. T., Jamestown, N.Y., asks several questions regarding the sort and permanency of the connections between the different parts. Ans.—The questions expose the weak points inherent in this sort of electric generators. Joints that are soldered have less electrical resistance than those that merely are clamped together. In order to get an appreciable electromotive force a very large number of elements must be connected in series, and the accumulated resistance of the numerous connections is considerable. Besides requiring some skill in the soldering, the result of one's work is not entirely satisfactory in the end, for the influence of the current and the heat at the one end destroys the intimacy of the bond. Occasionally there is mention in the magazines of the day of some new or large thermo-generator, but the reader is advised to regard them as highly expensive and meagre sources of electrical energy. A single dry cell will often outdo quite a ponderous construction of the thermo sort.

1679. **Voltmeter and Ammeter.** C. P. H., Linwood, N.J., asks: (1) How to change a 0.95 volt instrument to one having a scale 0.125, and a 0.250 ammeter to one of 0.50 extent. (2) Can a voltmeter and ammeter be left permanently in a wireless telegraph set, or should they be switched into circuit only when a reading is desired? (3) Will 18 x 24 in. window glass, with thin sheet copper plates, answer for a condenser for a 3 kw. wireless installation, provided transformer oil is used for extra insulation? Ans.—(1) A 125-volt instrument should have the scale extend to 150 division on the scale. For this purpose, the total resistance of the instrument must be increased in the proportion of 150 to 95. If there is a card somewhere in the case stating what the present resistance is, you can readily order a suitable resistance, or "multiplier," as it is often called, from almost any instrument maker, that will have the desired extra number of ohms. With a Wheatstone bridge, you could measure the resistance yourself. For the ammeter, you would need to increase the resistance of the "shunt" five times. If this part of the instrument is external, and happens to be so made as to allow four-fifths of the cross-section to be disconnected—cut or filed away—you will get approximately the right resistance, but the final adjustment should be made in comparison with some correct instrument. The Weston Electrical Instrument Company is located in Newark, and we would advise you to correspond with them in reference to both meters. (2) If they are of the "switchboard" type, they can be left in circuit, but if of the "laboratory" pattern, it is preferable to have the voltmeter open-circuited and the ammeter short-circuited except when taking readings. If you have in mind the antenna current, only an instrument of the "hot-wire" type is appropriate, and for economy of power, this may well usually be short-circuited. (3) If you have sufficient margin of glass beyond the copper, the insulation should suffice. Can you not use tin-foil in place of copper?

1680. **Wireless Station.** H. C. T., Ludlow, Vt., writes as follows: (1) I hear a certain wireless station both at night and in the daytime whose name I can't make out. It has a very high-pitched spark and takes about twice as much more tuning coil as Cape Cod. I use Continental code and do not make sense of its messages. What station is it? (2) What are some of the other high-pitched stations on this coast aside from Brant Rock? Ans.—(1) It would be impossible for us to say what this station might be, unless you could determine the approximate wave length. (2) See list of Wireless Stations of World given in this magazine several issues back.

1681. **Tuning.** Rev. G. D., Nicolet, P.Q., Canada, writes us as follows: I am puzzled with the tuning of my sending wireless station.



I am using two helices for loose coupling, each one having 20 turns of No. 8 wire and a diameter of 18 in., connected as per above diagram. The best tuning I can obtain is when I introduce only one turn of inductance of the helix *B*, using all the 20 turns of the helix *A*, in the antenna circuit. And it looks as if the tuning would be better if I could use more than 20 turns on the helix *A*. So I think that I cannot tune properly. The power used is about 1¼ kw.; antennæ, four wires 160 ft. long; capacity of condenser, about 0.04 m.f. Will you kindly advise me through the columns of *Electrician and Mechanic* what change is to be made, if any? Ans.—You are following the proper method of tuning, and it is evident that you require more inductance in your open oscillating circuit besides the helix *A*. It frequently happens that a very small amount of inductance in the closed oscillating circuit, such as one turn or even one-half a turn is all that is needed. You may also increase your efficiency by varying your coupling to a greater or less extent as described by Mr. Getz in his article on the use of the Wavemeter.

1682. **Transformer.** F. W. M., Kalamazoo, Mich., asks: (1) How far he can send with the ½ kw. transformer described in the September issue of this magazine. (2) If he can wind the transformer with No. 30 enameled wire instead of the No. 33 wire as specified. Ans.—(1) The sending distance would depend to a large extent upon your skill in tuning the instruments, the efficiency of the component parts of your set, the insulation of your aerial, the quality of your ground and the system you use, quite as much as upon the transformer itself. Why ask us "how far you can send with such and such a transformer," when we should have to guess at the values of the other important factors in the case in order to give you any estimate at all? The transformer is an efficient one and it will "send" as far as any other similarly rated one of equal efficiency. (2) If you will be content with a lower voltage from the secondary of the transformer, you may certainly use No. 30 wire.

1683. **Vibrator; Relay.** F. G., Howell, Mich., asks: (1) How he can make a relay from a pair of 2,000 ohm ringer magnets. (2) Where he can get a good vibrator for a large Ruhmkorff coil. (3) How many 8 c.p. lamps he can light in parallel on 4 volts of current, and how many 6-volt, 10 c.p. lamps can be lighted by means of a 6-volt storage battery. Ans.—(1) There are a number of ways and means to this end, and we believe that by merely explaining the principle of the relay, your own ingenuity will enable you to use the magnets as you wish. Briefly, the principle of operation is this: A freely moving armature, having a platinum contact point on one side of an extending arm, is pivoted in front of the magnets. An upright having an inverted "U" bend in its upper extremity carries two adjusting screws, one screw being tipped with platinum and the other with some insulating substance. The upright is so arranged on the base of the relay that its two adjusting screws control the amplitude of the armature, the extension of which plays between the adjusting screws of the upright. The screw with the platinum tip is usually placed on the magnet side of the armature, while the insulating tip is on the opposite side. From this you will see that when an exciting current is sent through the coils of the magnets, the armature will be drawn forward and contact will be made between the platinum on armature extension and that on the screw. As soon as the circuit is broken through the magnets, the armature will be drawn back against the insulating tip of the other screw (by means of a light spring) and the secondary contact is broken. (2) We would suggest that you write to Houghton & Curtis, Waltham, Mass., stating the size of your coil and the current you use. (3) This will depend upon the efficiency of the lamps and upon the source of current supply. What is the ampere-hour rating of your storage battery?

1684. **Transformer Rating.** H. C. McE., Ada, Ohio, asks our opinion on the efficiency and rating of an open core transformer of the following dimensions: rated at 1½ kw.; secondary, 10 lbs. No. 28 d.c.c. wound in ¼ in. pies 8 in. in diameter; primary, one layer No. 12 d.c.c. wire 30 in. long on core 36 in. long, 2 in. diameter; primary insulated by fiber tube from core, and secondary insulated from primary by ⅛ in. of empire cloth. Ans.—We would suggest that you either increase the diameter of the core to 3 in., having it 36 in. long, or else reduce the length to 24 in., making core 2½ in. in diameter. Unless the coil is to be used on direct current with an electrolytic interrupter it is a mistake to make the core too thin and long. Increase the number of layers in primary to 3 or 4 and use No. 10 wire in place of No. 12. We should say that you would need from 15 to 20 lbs. of No. 28, not necessarily double-covered wire, and advise you to keep the diameter of the pies down to not more than three times diameter of core. For insulation between primary and secondary use at least ½ in. of empire cloth or a micanite tube ⅜ in. thick, which would be much better. We strongly recommend the immersion of the complete coil in transil oil.

1685. **Induction Coil Difficulties.** K. J. B., Torrington, Conn., writes us that he is having trouble with a coil of his own construction, and asks us to offer suggestions. Ans.—While you carefully stated dimensions and specifications of the coil proper in your letter, you omitted that which is probably the most important part in cases of amateur construction, *i.e.*, the interrupter and condenser. Your coil appears to be quite well designed, and with the exception of the insulation between primary and secondary, we can suggest no radical improvements. We suggest a few layers of empire cloth between the tube on which secondary is wound and the primary. We presume your secondary sections are wound in even layers with a layer of paraffined paper between each two layers of wire, and if such is not the case we suggest that you rewind the coil. We are inclined to think that your trouble may rest in the condenser and interrupter, as you state that you can obtain only a 1/16 in. spark with 10 cells of dry battery. If you will write us more fully in regard to this adjunct to your coil we will endeavor to assist you. Show us by rough sketch your connections, state number and size of sheets of tin-foil in condenser and the type of interrupter you are using.

TRADE NOTES

A New Sending Condenser

A distinctively novel type of transmitting condenser is arousing much attention and comment among all classes of wireless workers. We refer to the molded condenser which is the subject of a patent application of Mr. Wm. J. Murdock, of Chelsea, Mass. So much has been written of the Leyden jar and glass-plate types of high potential condensers, that the average worker is not only acquainted with their good qualities, but in the majority of recent articles, he is informed of their inherent defects, and their lack of efficiency. Of all the faults which are laid at the door of the above-mentioned condensers, probably the most familiar are the effects of brushing and heating.

The molded condenser resembles the glass-plate type in so far as the metallic sheets are considered. That is to say, in its construction, the conductors are in sheet form, placed in the dielectric in precisely the same manner as in the case of the glass-plate condenser, with leads brought out for connections in the same way. But, of course, the dielectric being of a complex nature, and containing materials of high normal dielectric strength, the resulting electrical capacities are higher than would be the case with similar sizes of glass plates.

The plates of the molded condenser are prepared in somewhat the same fashion as the commonly-known method of building up a glass-plate condenser, but, when they are all assembled, the entire mass, slightly increased above normal temperature, is introduced into a properly shaped mold, wherein it is subjected to a tremendous pressure, which in itself serves not only to give a definite form to the finished condenser, but is also valuable from the electrical standpoint, since the great pressure forces the molecular structure into a most intimate association and increases the electrical value of the dielectric.

The finished condenser presents itself as a smooth, almost polished, tough, rectangular solid, measuring 1 in. in thickness, by 5½ in. in width, by 6½ in. in length. The capacity of the finished section is roughly estimated at .00146 mf.

The condenser may be seen to possess, apart from its special electrical qualities, the advantages of practical unbreakability, of extreme compactness, and of certain durability. By unbreakability is suggested the physical strength. For example, the dropping of a section of the condenser upon a floor, means no damage to the condenser. Some idea of the compactness of condenser equipment possible with it may be obtained by the brief suggestion that 28 sections, used in a 3 kw. station, occupy but one-fourth of the space required for a glass-plate set. The durability is certain, since through the lack of brush, which with the sheet imbedded construction is practically impossible, the heating is minimized and a long life is assured.

It will be seen, therefore, that there are intrinsic qualities which are commendable. The original condensers, subject to severe tests, have safely withstood voltages ranging from 15,000 to 50,000 from transformers of all sizes and types from ¼ to 5 kw., without puncturing. They have been worked for long periods without showing an appreciable heat increase. They have been worked in small capacity combinations without showing a brush.

As we go to press, we receive notification that the Brookline factory of the Holtzer-Cabot Electric Co. was partly destroyed by fire on the evening of October 6th. While there will doubtless be some delays in filling orders now on hand, the company advises us that a considerable proportion of the machinery has remained intact, the principal damage having been done by water, and that an immediate return to regular work by the full force of employees is anticipated.

ELECTRICAL ASSISTANT

November 22, 1911

The United States Civil Service Commission announces an examination on November 22, 1911, to secure eligibles from which to make certification to fill vacancies as they may occur in the position of electrical assistant in the Signal Service at Large, War Department, and vacancies requiring similar qualifications as they may occur in any branch of the service, unless it shall be decided in the interest of the service to fill such vacancies by reinstatement, transfer, or promotion.

The salary of electrical assistants in the Signal Service at Large, is $1,080 per annum.

The examination will consist of the subjects mentioned below, weighted as indicated:

Subjects	*Weights*
1. Practical questions in electrical science	20
2. Practical questions in construction and installation of electrical instruments	30
3. Training, experience and fitness	50
Total	100

Applicants should be familiar with the practical side of electricity as applied to telegraph, telephone and kindred engineering, and should be familiar with the equipment and methods of installation of telephones, storage batteries, motor generators, auxiliary power switchboards, telephone switchboards, wire and wireless telegraph apparatus.

Persons who have had power experience only are not qualified for this position and will not be admitted to the examination.

Electrical assistants in the Signal Service at Large have no permanent location, but are transferred from place to place as the needs of the service require.

Applicants who fail to show that they have had sufficient training and experience to entitle them to a rating of at least 70 in that subject will not be admitted to the examination.

All statements relating to training, experience, and fitness are subject to verification.

Age limit, twenty years or over on the date of the examination.

Applicants may be examined at any place at which this examination is held, regardless of their place of residence; but under a recent act of Congress only those who are examined in the state or territory in which they reside and show that they have been actually domiciled in such state or territory for at least one year previous to the examination, will be eligible for appointment to a position in the apportioned service in Washington, D.C.

This examination is open to all citizens of the United States who comply with the requirements.

This announcement contains all information which is communicated to applicants regarding the scope of the examination, the vacancy or vacancies to be filled, and the qualifications required.

Applicants should at once apply to the United States Civil Service Commission, Washington, D.C., for Form 1312. No application will be accepted unless properly executed and filed with the Commission at Washington. In applying for this examination the exact title as given at the head of this announcement should be used in the application.

As examination papers are shipped direct from the Commission to the places of examination, it is necessary that applications be received in ample time to arrange for the examination desired at the place indicated by the applicant. The Commission will therefore arrange to examine any applicant whose application is received in time to permit the shipment of the necessary papers.

Issued October 3, 1911.

BOOK REVIEWS

The Slide Rule. By Frank C. Hinckley and William W. Ramsay, State Inspectors of Boilers and Examiners of Engineers for the Commonwealth of Massachusetts. Boston, New England Engineer, 1910. Price, $1.25.

A really useful contribution on a highly important subject. This book is a simple but extremely comprehensive treatise intended primarily for those who have heretofore been unable to use the slide rule. It has been designed with particular reference to the needs of boiler inspectors, engineers and mechanics, and contains some illustrative examples showing the adaptability of the slide rule to problems in steam engineering.

The book explains in simple language how the person of ordinary intelligence may make use of this valuable mathematical instrument without being obliged to know anything whatever of arithmetical or geometrical progressions or of the principle of logarithms.

The latter part of the book contains a treatise on logarithms and also an explanation of the principle of the slide rule. The method of finding sines and cosines, tangents and cotangents is fully covered, but no attempt is made to explain trigonometry. A distinctive feature of the book is that its contents apply to any of the well-known slide rules now on the market without reference to any particular make. In our opinion, this work should fill a long-felt want in the field of non-technical literature.

ORDER YOUR MAGAZINES FROM THIS PAGE

For the convenience of readers who wish to subscribe to more than one magazine we have arranged this page, which contains a list of the leading general, photographic, and mechanical magazines of the United States. It saves you time, money, and trouble to order all your magazines at one time from a reputable house, which can always be reached to adjust complaints. Do not pay your money to unknown solicitors, but send your orders to us. Subscriptions may begin at any time, need not all be sent to one address or begin at the same time, and may be either new or renewal, unless otherwise specified. Remit by postal money-order. If personal check is used, add 10 cents for collection. Periodicals sent to Canada and foreign countries cost more to cover the postage. Always ascertain from us the proper rates for such subscriptions.

If you do not find the periodicals you want listed on this sheet, write to us for terms. We will duplicate the prices quoted by any reliable agency on any periodical or combination.

DIRECTIONS

From the list below select your magazines, add their class numbers and multiply by five — the result is the cost in dollars and cents. For instance: —

Class Number:	ELECTRICIAN AND MECHANIC	24
" "	AMERICAN PHOTOGRAPHY .	24
" "	EVERYBODY'S	23
		Cost
		71 x 5 = $3.55

Class No.	Publication
30	Abel's Photographic Weekly
30	Adventure
53	Aeronautics
27	Ainslee's
20	All Story Magazine
17	American Boy
55	American Homes & Gardens
50	American Homes & Gardens (new)
80	Amer. Machinist (w)
20	Amer. Machinist (m)
23	American Magazine
24	Amer. Photography
20	American Motherhood
20	Argosy
45	Automobile
17	Auto. Dealer & Rep'r
16	Black Cat
27	Blue Book
17	Boys' Magazine
20	Building Age
30	Bulletin of Photog.
17	Camera (Until Jan. 1, 1912)
22	Camera (After Jan. 1, 1912)
20	Camera Craft
17	Camera Craft (new)
170	Camera Work
20	Cavalier
80	Century
20	Cosmopolitan
70	Country Life in America
53	Craftsman
35	Current Literature
21	Delineator
12	Designer
37	Dress
20	Electrical World (m)
60	Electrical World (w)
24	Electrician and Mechanic
28	Electric Journal
17	Electrocraft
23	Etude (For music lovers)
23	Everybody's
12	Everyday Housekpg
23	Field and Stream
47	Forest and Stream
20	Foundry
23	Garden Magazine
16	Gas Engine
16	Gas Power
8	Gas Review
20	Good Housekeeping
23	Hampton-Columbian
20	Harper's Bazar
70	Harper's Magazine
70	Harper's Weekly
12	Home Needlework
50	House & Garden
23	Housekeeper
10	Housewife
35	Independent
100	Iron Age (w)
40	Iron Age-Hardware
8	Ladies' World
90	Life
35	Lippincott's
60	Literary Digest
17	Little Folks (new)
30	Manual Training Mag.
9	McCall's Magazine
23	McClure's Magazine
40	Metal Worker
23	Metropolitan
60	Model Engineer & Electrician
17	Modern Electrics
12	Modern Priscilla
10	Mothers' Magazine
60	Motor
40	Motor Boat
60	Motor Boating
18	Motor Cycle Illustr'ed
15	Motor Print
23	Musician
17	National Sportsman
70	North Amer. Review
24	Outdoor Life
50	Outing
60	Outlook
25	Overland Monthly
22	Pacific Monthly
23	Pearson's Magazine
24	Photo Era
20	Photographic News
27	Photographic Times
50	Photo Miniature
23	Physical Culture
17	Pictorial Review
23	Pictorial Rev. (2 yrs.)
17	Popular Electricity (Until Jan. 1, 1912)
25	Popular Electricity (After Jan. 1, 1912)
60	Popular Magazine
9	Poultry Herald
9	Poultry Keeper
7	Poultry Success
17	Practical Engineer
33	Printers' Ink
20	Railroad Man's Mag.
40	Recreation
23	Red Book
35	Review of Reviews
60	St. Nicholas
40	St. Nicholas (new)
55	Scientific American
50	Scientific Amer. (new)
20	Scrap Book
60	Scribner's
23	Short Stories
45	Smart Set
30	Strand
50	Suburban Life
17	Success
22	Sunset
40	System
23	Technical World
35	Travel
27	Violinist
9	Violin World
70	Vogue
47	Wilson's Photo. Mag.
23	Woman's Home Com.
37	World's Work
35	World To-day
23	Yachting

The following magazines are sold only at the full subscription price and are never clubbed.

Ladies' Home Jrl.	$1.50
Munsey's	1.00
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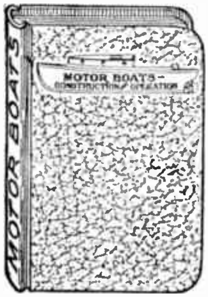

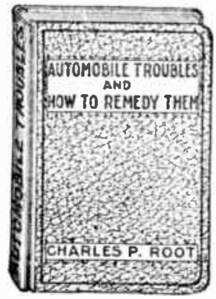

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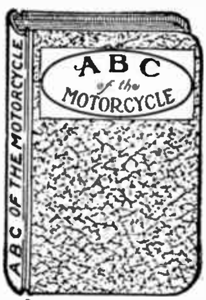

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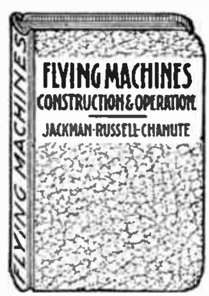

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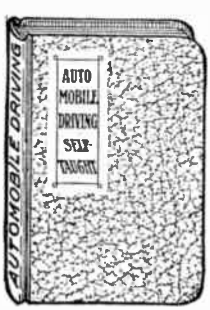

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