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THE ODDEST ELECTRIC LOCOMOTIVES

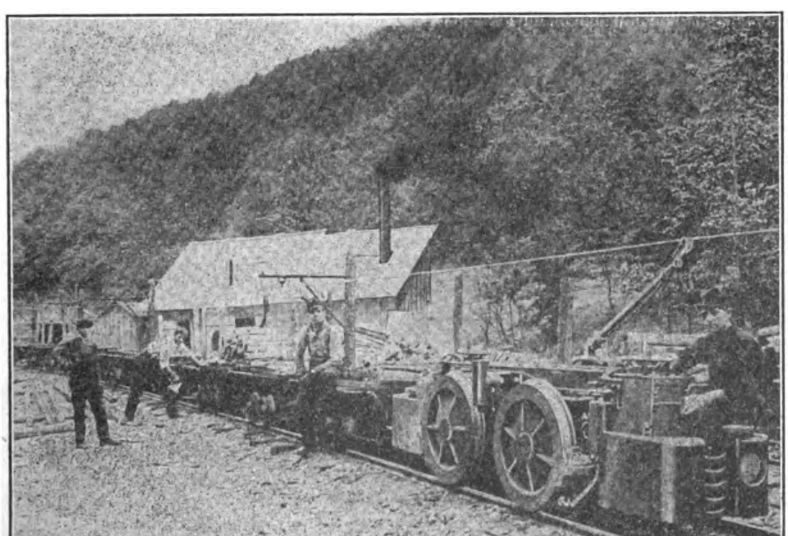
GEORGE FREDERIC STRATTON

One of the oddest designs of electric locomotives is designated the Crab; and while the name is perhaps somewhat descriptive of its flat and squatty appearance, it does no justice to its movements. The "Octopus" would be a more denoting term.

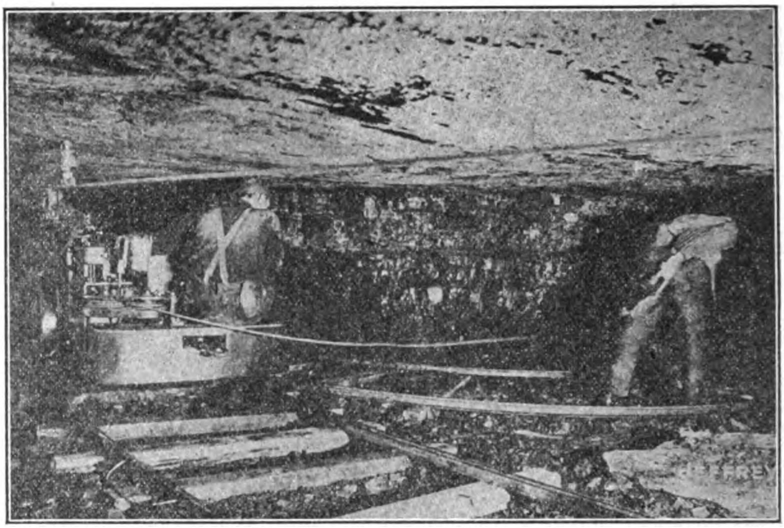
Gliding into the black entries of coal mines and halting at a crevice in the wall, from which issues the dull ring of distant pick and shovel, and through which may be seen tiny points of light from the miners' lamps, the Crab sends a flexible searching tentacle in for 200 or 300 ft., withdrawing it presently with a car of coal in its grasp. First on one side and then on the other it moves along, feeling into the holes, and never failing to secure its prey. Finally, with a dozen or more cars in its wake, it proceeds triumphantly to the shaft or outlet, and delivers its booty into the insatiable maws of the crusher.

These crabs operate by trolley conductors. They run through the main entries of the mine, but for various economic reasons they are not usually run up into the working faces. Accordingly, each machine is furnished with an electrically-operated drum upon which is carried 300 or 400 ft. of steel cable.

There are several methods of operating this locomotive to advantage, the choice depending upon the system of mining in use. With the double entry system, the locomotive usually hauls a trip of empty cars into one entry and drops them off at the rooms where they are required. Returning on the other entry it stops in front of each room where a loaded car is ready. The trip rider then drags the cable into the room, attaches



Coal Locomotive in use at Bingham Mines, Utah



A 5-ton Coal Locomotive in a Coal Mine

its end to the car and signals the motorman, who starts the crab motor and pulls the car out to the entry track. The locomotive then pulls it to the next room or leaves it standing until as many cars have been drawn from the rooms as are required to make up a trip. Then it pushes them together, and they are coupled up and hauled to the shaft or mine entrance. On the return trip the empty cars are distributed in the entry from which the loads have just been removed, and the locomotive gathers the loaded cars from the entry which was supplied with empties on the preceding trip.

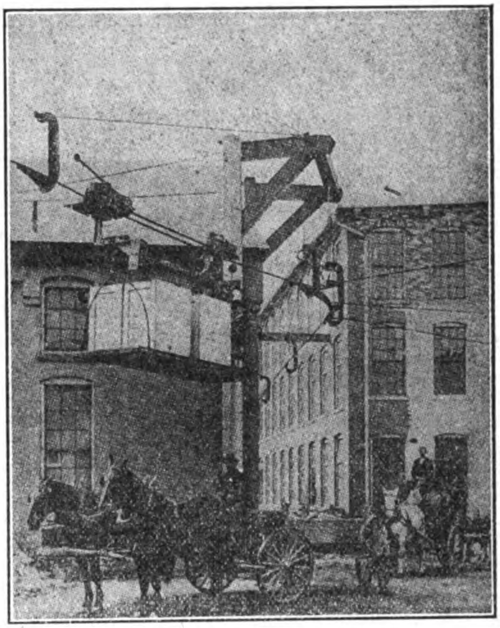
Where the single entry system is used, the locomotive runs in with a train of empties. Stopping successively in front of the rooms in which loaded cars are ready, it hauls out each car to the entry track and pushes it ahead to the next room, dropping off an empty to replace each loaded car taken out. When all empties have been distributed, it then proceeds to the mine entrance with the loaded cars. By either of these methods, a locomotive can gather from 75 to 200 cars per day, depending upon local conditions.

Another type of electric mine locomotive is known as the rack-rail. It is used in mines where the grades are very steep, and, as its name indicates, depends for its tractive power upon a driving sprocket wheel which engages a rack-rail bolted to the ties. Frequently this rack-rail is used as a current conductor instead of the overhead wiring and the trolleys. The locomotive can also be used in the ordinary way, without the rack-rail, whenever level stretches are reached.

Rack-rail locomotives are made in powers of from 50 to 200 h.p.; and in every case are equipped with unusually powerful brakes for controlling cars on heavy grades. They are also furnished with reels upon which are wound several hundred feet of conducting cable, through which the motors can obtain current while working up into rooms where no permanent conductors are installed.

Mining operations, however, comprise but a small percentage of the great variety of uses for electric locomotives. Like compressed air engines, they are especially valuable in yards and factories and on wharves, where the steam locomotive would be prohibited on account of fire risk. For these purposes electric locomotives are designed to operate by trolley system or by storage battery, or by a combination of both; the batteries being so designed as to run the locomotive for from one to two days on a single charge.

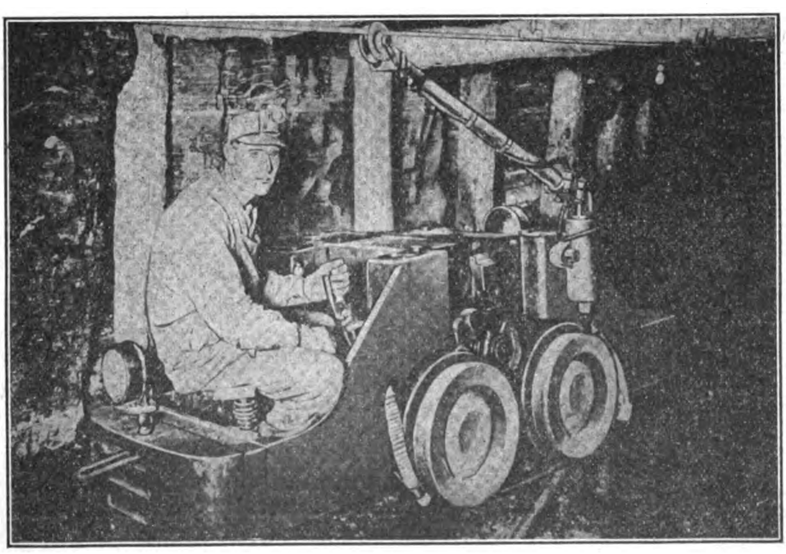
These engines are made in sizes of 2½ tons up to 60 tons. Of course, for regular railroad work very much heavier machines are built; but that is another story. The variety of these electric locomotives is as numerous as the uses to which they are put. Some are built very low to facilitate entrance into low storage warehouses or basements. Some are equipped with hoisting devices to pick up and carry weights but little less than their own. Some are designed solely for hauling cars—others are a combination of car and locomotive, operating as a single unit. They are of course more flexible in their scope of operation than the ordinary steam locomotive. The combination trolley and storage battery engine will dart along under a trolley wire, switch off onto a temporary track, using its own battery power, then, returning to the trolley track, will, while doing its work, absorb juice from the wire to keep its batteries fully charged. Such equipment on great construction operations—dams, bridges and reservoirs—is almost ideal. They are short, compact, set so low and are under such excellent control that stunts may be done with them on curves and grades which make them almost as flexible as the Telpher.



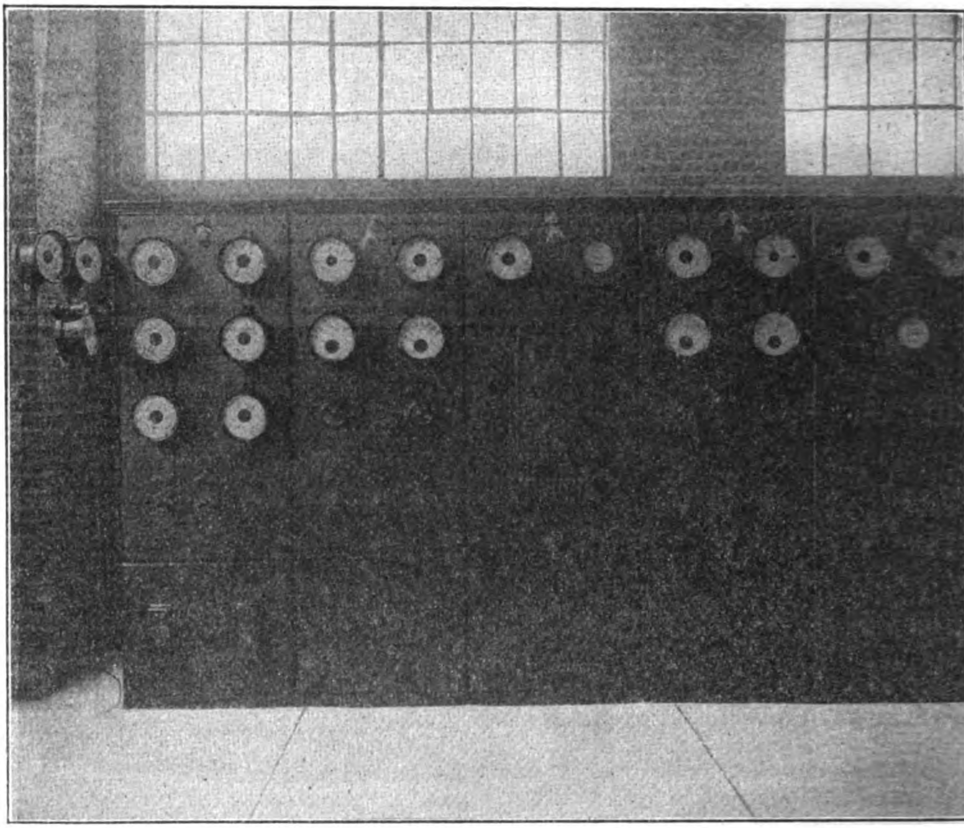
Telpher in use at the Arnold Print Works, North Adams, Mass. It operates among the various buildings, hoisting the load from the road or wagon and carrying it down the alleys and into the various floors of the building.

The Telpher is the tiniest locomotive built for work. It runs not upon the surface, but upon a single wire, suspended a few inches below another wire from which it takes its current. It hooks up a barrel of flour or a bale of dry-goods and runs with it, sometimes unattended, to some distant corner of yard or warehouse

Recently, a gasoline-electric tractor has been designed by Massachusetts engineers. This is called the Multiple-Unit-Road train, and is comprised of a tractor and two or more cars, each with a capacity of six to eight tons, and carrying its own electric motors, current for which is supplied by generators on the tractor, and driven by a 40 h.p. gas engine. The speed of this train is stated to be, with a 20-ton load, six miles per hour on a macadam road.



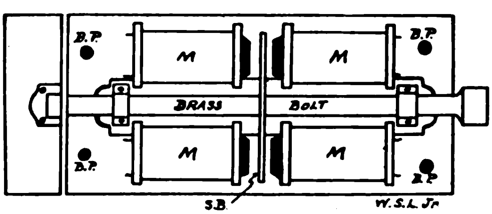
7½-ton Locomotive



The Switch Board in the New Hydro-electric Plant of the N.C. Electrical Power Co.

A SIMPLE ELECTRIC LOCK

W. S. LYLE, JR.



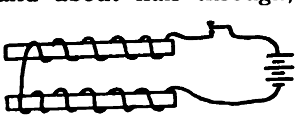
Top View of the Lock

Most electric locks of today are complicated or do not work satisfactorily.

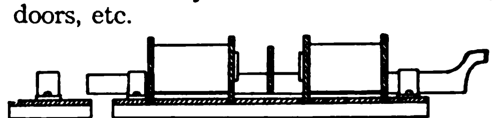
The lock described in this article is simple and very durable.

First purchase a brass push bolt for about 25 cents, then cut the bolt in the center and about half through, with a hack saw. Cut a piece of iron or steel to fit into this slot and long enough so that the magnets on each side of the bolt will attract the steel bar in the bolt, thus pulling it either backward or forwards.

This lock may be used for secret locks, doors, etc.



Connections.



The Lock Complete.

Emergency Magnifying Glass

HERBERT P. A. HOLDER

Take a piece of small wire or a plant stem and make a loop in the end about the size of a drop of water. In this loop place a drop of clear, pure water. This will serve admirably as a strong magnifying glass.

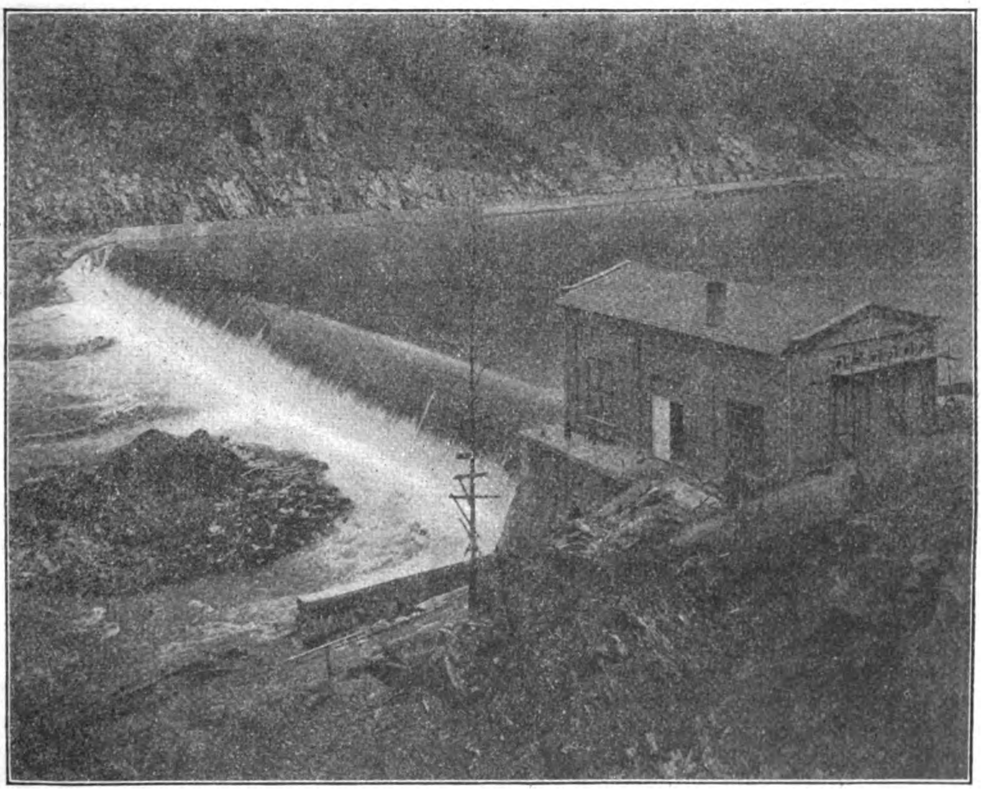
A NEW HYDRO-ELECTRIC PLANT

N. BUCKNER

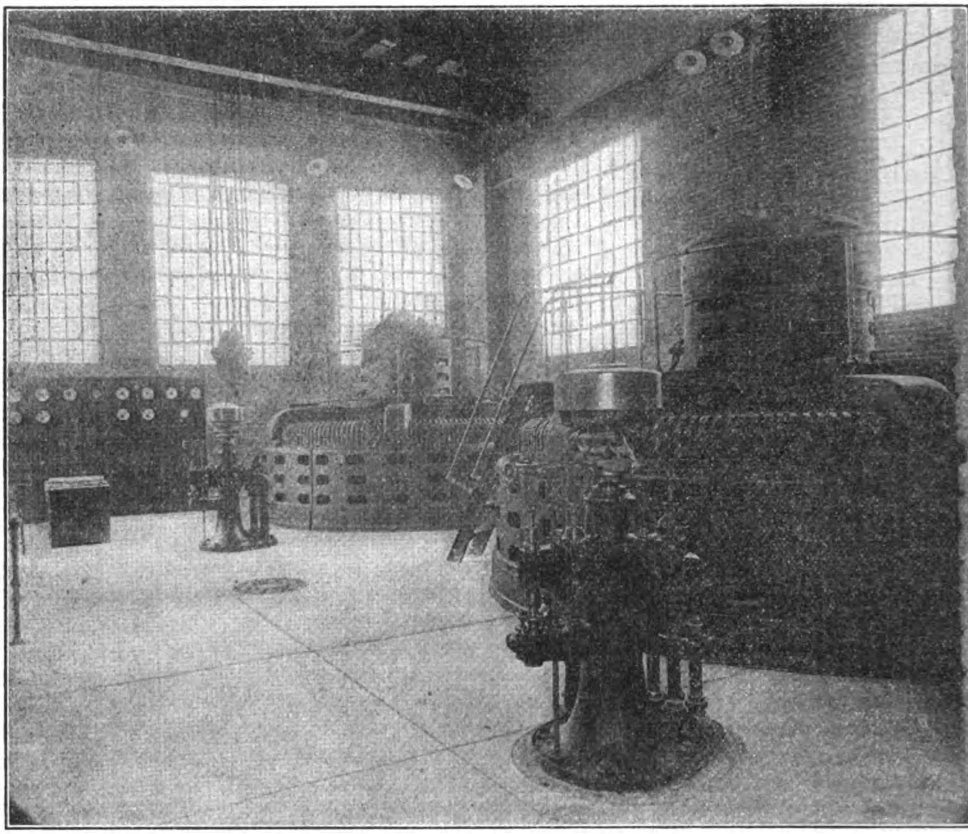
The third hydro-electric plant of the North Carolina Electrical Power Company of Asheville, N.C., located on the French Broad River 25 miles northwest of Asheville, which has been in the course of construction for the past two years, has just been completed and put into service. Normal capacity of the plant is 5,000 h.p. The entire plant represents in round figures an expenditure of $500,000, and to construct same it was necessary to raise and rebuild 2½ miles of the track of the Southern Railway which skirts the river at that point. The track at the dam was raised 20 ft. higher than the old roadbed, the total excavation amounting to about 60,000 cu. yds., 80 percent of which was solid granite. The change in roadbed alone cost $75,000, required one year to complete, and all work was done without interference with traffic, there being operated over this line an average of 30 to 40 trains per day.

The dam is 540 ft. long, 30 ft. high, 43 ft. 9 in. thick at the base, and 11 ft. at the top. It is built of cyclopian concrete, the large stones in some instances approximating 5 cu. yds. Approximately 22,000 barrels of cement were used in construction of dam, foundation of power plant and retaining wall for the protection of the roadbed. The downstream face of the dam is curved in such a manner as to insure the water always clinging to the surface and preventing the formation of a vacuum under the falling sheet, since it is generally conceded by engineers that a vacuum on the down stream side is responsible for the trembling often felt in the vicinity of overfall dams.

There are two 7 ft. mud gates in the dam next to the power house, which are operated by hydraulic cylinders and are opened and closed by an electrically-driven pump in the power house. The gates and cylinders are entirely submerged.



Looking North; New Hydro-electric Plant of the N.C. Electrical Power Co. It is located on the French Broad River, near Asheville, N.C.



The Generator Room

The four penstock gates are among the largest cast iron gates made; each gate covers a clear opening of 18 ft. x 7 ft. 3 in. and weighs 13 tons. They are operated in pairs by an electric motor.

The power house, 40 x 76 ft., fireproof throughout, is built of concrete to the floor line, and brick from that point up. Windows are of steel and prismatic glass. From floor to eaves is 31 ft.; from bottom of foundation to comb of roof is 100 ft. A 50-ton electrically-operated traveling crane extends the entire length of the building.

The equipment consists of two 1,875 kw. Westinghouse alternating current generators, 6,600 volts, 3-phase, 60-cycle, 133 revolutions per minute, each directly coupled to two turbines made by the I. P. Morris Co. The units are vertical, with the exciters located on top of the generators. The current, generated at 6,600 volts, is stepped up to 66,000 volts for transmission. The entire control of the plant is from the switchboard, all gates, switches, motors and valves being electrically operated.

Duplicate power lines have been built on private right of way, one on the west side, the other on the east side of the river, to plant No. 2 of this Company, six miles northwest of Asheville, where there is a sub-station for distributing the power to Asheville, Canton and other places.

The other two hydro-electric plants owned by this company develop 4,000 h.p., all of which has been utilized in Asheville. This new plant has been made necessary by the increased demand in Asheville and surrounding territory for additional light and power.

This plant was designed by Charles E. Waddell, member American Society Civil Engineers, Asheville, North Carolina. Capt. W. T. Weaver is President of the Company and Charles Folsom, resident engineer.

METHOD FOR OBTAINING THE EFFICIENCY AND LOSSES OF DYNAMOS AND MOTORS

A. SPRUNG, E.E.
(*Associate Member A.I.E.E.*)

A direct-current dynamo can be operated as a motor, and conversely a motor can be operated as a dynamo. In the dynamo the mechanical energy of the prime mover is turned into electrical energy, and in the motor, the electrical energy is consumed in the production of rotation of the motor armature. The revolving of this motor armature furnishes the necessary mechanical energy available at the shaft. In either of the above cases the energy is produced with losses. These losses are found in the machine itself under any condition of running whatsoever. By machine is meant either the dynamo or the motor.

It is understood from the laws of nature that the amount of work obtained from any mechanical device must be to a certain extent smaller than the amount of energy put into this device in order to obtain the desired work output. This difference of output and input is credited to the energy losses of the device. In other words, the losses cause the output of a machine to be less than the input. Then the amount of work obtained from the machine divided by the amount of work put into the machine is called the efficiency. By means of efficiency the amount of losses is readily determinable. Efficiency=work output÷work input.

This is true for both the dynamo and the motor, and is more clearly expressed as follows:

Motor Efficiency=Mechanical Output÷ Mechanical output + losses

Dynamo Efficiency=Electrical Output÷ Electrical Output + losses.

It is evident from the above that the output + losses = input. If not for the losses the output would equal the input, which in practice is impossible. Motor efficiency can be obtained also as in the following formula:

Motor Efficiency=Electrical input— losses÷Electrical input.

To determine the efficiency in practice, it is necessary to solve the above equations experimentally. This can be done by two methods.

First, by determining the actual input and output of the machine, and second, by determining either the input or the output of the machine including the energy lost in the machine.

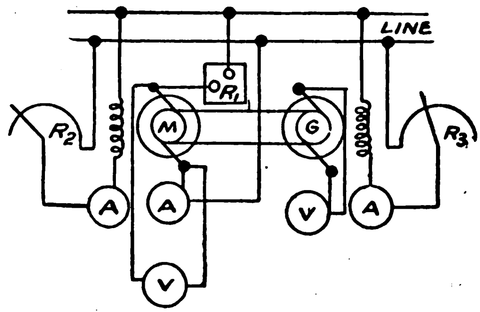


Diagram of Connections

The accompanying diagram shows the method of connecting for making up the test.

METHOD OF TESTING

In the first case, to determine the input and output directly, an actual load test is necessary. A friction brake load is generally used on motors, and a resistance lamp load is used on dynamos. The above method has its disadvantages in that it is extremely difficult to take accurate mechanical measurements at the brake. The amount of power consumed during the test is wasteful and the total losses only can be ascertained by this method. This does not help the operator in determining just where most of his losses are located.

On the other hand, if the test is made by determining the losses of the machine at no load, the above disadvantages are overcome and we can thereby determine the efficiency at any load, together with a location of various losses.

The losses in an electric machine can be described as follows:

1. Copper losses (C^2R); these losses are found in the armature and field coils.

In order to overcome the resistance a certain amount of energy must be sacrificed or lost in dissipated heat. This energy can be expressed in watts. Hence the watts consumed equals volt drop x current, but volt drop equals CR, then watts or energy loss equals $C \times C \times R = C^2R$ loss.

2. Iron losses chiefly found in armature core due to hysteresis and eddy currents.

3. Mechanical losses—these are caused by friction in bearings, brush friction and windage or air resistance.

The copper loss can be easily determined just by merely measuring the ohmic resistance of the armature and field winding, by the drop of potential method. Knowing *R*, the resistance, the copper loss for any current would then be the square of current times *R*.

The copper losses depend upon the magnetic flux and upon the speed. In shunt machines the losses are approximately constant, since the magnetic flux is constant with a constant field current. The speed will generally keep constant at all loads.

The mechanical losses depend entirely upon the speed. In direct connected machines the bearing friction is constant, whereas in belt drives the friction is a function of a tensity of the belt.

The iron losses and mechanical losses can be assumed constant at all loads, having the same value at full load as at no load. The losses can then be measured by finding the amount of power necessary to run the machine, as a motor at no load. By noting the amount of current in the armature and field the copper loss (C^2R loss) can be deducted from the total losses, at no load, and the resulting losses will be iron and mechanical losses.

SAVED BY THE MINE TELEPHONE

The public at large has already for some time past appreciated what great reason they have to be grateful for the invention of the telephone; but there are today two miners in Kansas who are more than grateful. They owe their lives to it.

These two miners, or "shot-firers," to be exact, are employed by the Girard Coal Company in a mine at Radley, Kan. The mines of this company have recently all been equipped with Western Electric Company mine telephones, and, according to the rules of the Coal Company, the shot-firers must report to the night engineer, by means of the telephone, the progress of their work as they go through the mine lighting the shots. This enables the engineer to know where his men are, so that if he does not hear from them at certain intervals, a rescue party is sent down.

One evening, after the miners had left, the shot-firers went down as usual to fire the shots which would bring down the coal for removal during the next day. The two men had just entered a refuge hole and one was in the act of ringing the engineer to tell him they had lighted the shots in that particular entry, when an explosion occurred. The force of the explosion was so strong that it blew in the back end of the refuge hole, and the shot-firer did not even get to talk, but was immediately overcome by the after-damp. His partner, who was with him, was likewise overcome. The night engineer, knowing that this was the station from which they should next report, immediately tried to call them, but was unable to get any response and started the distress whistle. In fifteen minutes after the explosion had occurred, a rescue party was in this refuge hole and had the two shot-firers out working upon them, and succeeded in resuscitating them. A little later it would undoubtedly have been impossible to revive them.

There is an employers' liability law in some states, which compels the operator to pay a considerable sum for loss of life or personal injury. The fact that the telephone very often prevents accidents and assists in quick rescue work, saves the operator a great amount of money. In the Girard Company's mines, there were three severe explosions during the winter, but not one of the Western Electric mine telephones was injured, nor was service interrupted.

The business section of the town of Nacozari, Mexico, owes its existence today to the bravery of the Mexican engineer of a burning train in which there were two cars of dynamite. While the train was standing at the depot in the center of the town a blaze was discovered in a box car adjoining one of the cars of dynamite. The engineer, Jesus Garcia, rushed to his engine and pulled the train out of the town. Less than a mile out the dynamite exploded, blowing the engineer to atoms.

THE FUTURE, PRESENT AND PAST OF ELECTROPLATING

CHARLES H. PROCTOR

The future of electroplating, like that of other commercial enterprises, will depend upon the progress made in the art by individuals or by the concerted action or co-operation of men who understand the essential details of its chemical, electrical and mechanical requirements. These will be so interwoven as to create the standard of efficiency that will be necessary for the successful electroplater to attain. Electroplating is so closely identified with commercial enterprises and progress that to keep in line with such advances will require more careful thinking and studying in the electrical, chemical and commercial manipulations than has fallen to the lot of the foreman plater heretofore. For years the art has remained practically dormant chemically. Very little has been accomplished since the days of Elkington, Becquerel, Heeren, Roseleur, Von Leutchenberg, Neidinger and others whose methods and formulas have remained practically standard up to the present time.

But a new era lies in the future. On every hand it is gratifying to note that electrochemists and metallurgists, who have devoted the product of their brains to the mining industries for years past, are now turning their thoughts to the greater possibilities of the electro-deposition of metals. Not only of metals on metals, but also on many non-conducting surfaces, such as wood, plaster, etc., thus obtaining a finish having the appearance of solid metal, combined with extreme lightness of weight and low cost of production. New fields are constantly being opened up for intelligent workmen, so that instead of electroplaters being in less demand in the future, it will be found that there will not be sufficient number of thoroughly experienced men to draw upon to fill positions that will be created by new enterprises. So it behooves the younger generation who expect to take up the art of electroplating in the future to make a thorough study of chemistry and electricity. Adding to these arts such mechanical skill as he possesses, the plater of the future will then be able, with his superior knowledge, to successfully cope with any difficulty that may present itself.

PROGRESS IN RECENT YEARS

The present of electroplating is upon a satisfactory basis, so much has been accomplished in a mechanical way in the past decade. Mechanical plating tanks and barrels of almost endless variety have been put on the market. Mechanical polishing and burnishing methods, that brought forth economical results in manipulations, have saved considerable money in the cost of production, which has heretofore been almost prohibitive in the finishing of small articles. By the application of mechanical electroplating much has been learned that heretofore has not been thoroughly understood. Constant friction by agitation caused greater internal resistance and necessitated denser solutions and greater voltage to produce results as satisfactory as those secured from the still solutions formerly employed. Electro-galvanizing and mechanical plating requiring greater voltages have brought forth the three-wire system. The dynamo developed for this purpose affords a range of from five to ten volts, making the energy created satisfactory for still solutions requiring up to five volts, and for mechanical solutions needing up to ten volts. Such dynamos are replacing the older types because of their particular advantage in developing the high and low voltages required.

The platers of the United States and Canada should feel highly gratified that they have been able to maintain a standard of finishes quite equal, if not superior, to those of any other country. Germany, France and Austria, however, have paid more attention to chemical detail. England has followed the lead of the United States, but pays more attention to the uniformity of deposit. Many finishes are produced in the above countries that are unknown in the United States, and *vice versa*. In the builders' and cabinet hardware industry the United States surpasses the world in the variety of its finishes and designs.

THE TRISALYTE SOLUTION

The introduction of "Trisalyte" for

solutions in the United States by the Roessler & Hasslacher Chemical Company will prove of much value to the plater. The composition of these tri-salts, being uniform in quality and perfectly balanced, will produce more satisfactory results in the various deposits than has been obtained in the past. Such solutions are prepared for electro-galvanizing, copper, brass, bronze, silver and gold-plating. These salts are used exclusively in Germany, and have been on the market there for several years. In France and Germany bright nickeling has been brought to a successful issue. If a polished surface is immersed in the bright nickel bath the deposit will remain bright even though plated for several hours, and will require no further polishing when removed from the bath.

The Sangamo ampere-hour meter will no doubt prove of great value in determining the actual amount of metal deposited in a given time, so that eventually a system of costs—so much desired—will be installed in the plating department: and, with the introduction of the Rojas method of electrochemical metal coloring the present status of electroplating can be considered as satisfactory.

PRINCIPLE STILL UNEXPLAINED

The past of electroplating must always be interwoven with the present and the future. The secret of precipitation has never been satisfactorily explained. The question is often asked: "What is electricity?" So the plater often wonders what causes those particles of metal to become so evenly distributed over the metal or metallized non-conductive surface, but he cannot explain why. The old myths of unsatisfactory deposits being due to too much sunshine, too much cloudy weather and a hundred and one other imaginative thoughts, have, like the myths of the middle ages, been explained by scientific study of cause and effect. Unfortunately, while many of the old concerns have modernized their mechanical productive departments, they have sadly neglected their plating department. The owners of such plants wonder why they do not produce the same results as their more modernly equipped competitors.

In many instances this neglect of introducing modern methods and equipment revert upon the plater to his disadvantage; his employer oftentimes thinking he is not as competent as the plater of a competing concern. Recently I paid a visit to one of these modern plants with a plating room linked with the past. The results being produced were unsatisfactory. Several thousand gallons of solutions, consisting of brass, copper, bronze and nickel, were in daily use. The brass deposit varied greatly in color, and was otherwise inferior. In looking over the plant for the probable cause of this variation in color my attention was immediately drawn to the absence of a voltmeter. It is a well-known fact that a uniform deposit from a number of solutions depends not only on the uniformity of the composition of the solutions, but also upon the uniformity of the voltage at the tank terminals, so that unless evenly balanced, the deposit will not be uniform.

Variation in voltage produces variation in color and a variation of internal resistance in the various tanks, and not the incompetency of the plater, is the primary cause of lack of uniformity of deposit.

BECOMING AN EXACT SCIENCE

Give the progressive plater modern methods and he will undoubtedly produce results. This does not only refer to one solution but to the results obtained from any number of solutions in action at the same time. Looking back more than a quarter of a century into the past of plating, one is amused at the ridiculous thoughts and ideas that entered into the mind of the plater as to the probable cause of the troubles he encountered.

The National Electroplaters' Association has been of untold mutual advantage to its members, producing results from exchange of thoughts, ideas and experiences. If Andrew Carnegie or some other great leader in the metal world could understand its requirements, there is no doubt their financial assistance would be forthcoming to maintain the art of electroplating in this country in the foremost ranks of the world. With a scientifically-equipped laboratory and competent men who are experts in their various lines, the solution of many problems could be accomplished and great results accrue, which would be of advantage not only to the individual plater, but to the country at large.—*The Metal Industry.*

MECHANICAL DRAWING

P. LEROY FLANSBURG L. BONVOULOIR

INTRODUCTION

It is quite apparent to anyone who considers the matter, that thought must always precede each intelligent act; it is therefore necessary that even the most simple of structures must be carefully conceived before it is built. Most persons find it at first extremely difficult to visualize or mentally conceive different physical bodies and their various shapes and relations, either while at rest or in motion. But it is possible to train the mind so that the faculty of visualizing will be developed and that is exactly the service performed by a course in mechanical drawing.

Mechanical drawing is primarily but a means of conveying ideas and the draughtsman should not only be able to make drawings which are both readable and workable, but should also be able to readily read such drawings as are made by other draughtsmen.

It is the purpose of this course to develop these various abilities. While the student may accomplish much by carefully following instructions, still, in mechanical drawing, as in nearly everything else, careful and intelligent criticism, especially at the beginning of the student's progress, will save him from forming many careless habits which he might find hard to overcome after they had once been formed. The authors, realizing this, will be glad to criticize any drawings which are sent in and will answer any questions which may bother the student who is taking this course, provided return postage is enclosed, and all the communications are addressed to the Mechanical Drawing Department of the *Electrician and Mechanic.*

In order that the student of mechanical drawing may do his best work, it is very important that he be supplied with a good serviceable set of instruments and certain necessary drawing materials. The man who does but a limited amount of draughting will, however, find little need for the more expensive outfits, and one of the less expensive sets will prove quite sufficient for all his needs. In the following paragraphs will be described the more important of the drawing materials.

THE DRAWING MATERIALS

1. *Drawing-Board.* — The board is generally made of well-seasoned pine, from ¾ to ⅞ in. thick, and for ordinary work, a board 17 x 22 in. in size will be found most convenient. Even though the board be well-seasoned, it has a tendency to warp, and, to prevent this, the maker usually places two cleats, either on the underside of the board or along its shorter edges (*AA*, Fig. 1). One of the shorter edges of the board (*B*, Fig. 1) is used as a working edge; and since the accuracy of the drawing is dependent upon the evenness of this edge, it is made a true plane. It is customary to place the working edge at the left hand, and for most work this is the only edge of

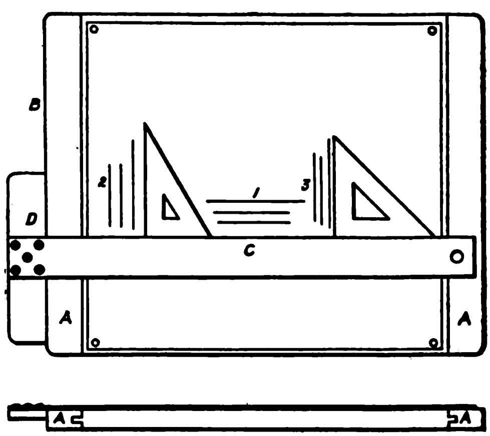


Fig. 1.

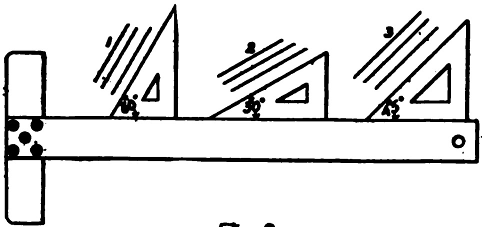


Fig. 2.

the board that need be used. Care should always be taken not to indent the working surface of the board.

2. *T-Square.*—The T-square consists of a blade (*C*, Fig. 1) and head (*D*, Fig. 1); the head being securely fastened to the blade by means of screws. Various woods are used for making the blade and head, pear-wood being the most common. However, on the better grade of T-squares, the blades are edged with either ebony or celluloid. Ordinarily the head is rigidly attached to the blade, so that the inner edge of the head is exactly at right angles with the upper edge of the blade. In some cases the blade is made movable so that it can be adjusted to any angle with reference to the head. In using the T-square, the inner edge of the head slides up and down the working edge of the board and should be held firmly against it with the left hand. Since the working edge of the board is a true plane, it is possible to draw parallel lines (1, Fig. 1), by sliding the T-square along this edge, and all horizontal lines are drawn in this manner. In drawing, only the upper edge of the blade should ever be used, and this edge must not be injured in any manner.

3. *Triangles.*—To draw straight lines other than horizontal lines, triangles are used. These are usually made either of wood or celluloid, are of various lengths and are about 1/32 in. thick. Since the celluloid triangles are transparent and easily cleaned, they are preferable to the wooden ones. Two triangles are used: one a 45 degree and the other a 60 degree. The 45 degree triangle has two 45 degree angles and a 90 degree angle, while the 60 degree triangle has a 60 degree, a 30 degree and a 90 degree angle. When using the triangles, they are placed against the upper edge of the T-square, and since each triangle has a right angle for one of its angles, it is easily possible to draw vertical lines (2 and 3, Fig. 1), that is, lines which are parallel to the working edge of the drawing-board.

In all mechanical drawing work, the light is allowed to fall upon the board from the upper left-hand corner and the triangles should be so placed that they do not cast shadows upon the lines which are being drawn. When moving the triangle from one position to another, hold the head of the T-square firmly against the working edge of the board with the left hand, and move the triangle with the right hand. When drawing a line, both triangle and T-square should be held with the left hand.

By the use of the T-square and the triangles, it is a simple matter to draw lines which make angles of 30 degrees, 45 degrees and 60 degrees with the horizontal (1, 2 and 3, Fig. 2). Since a line making 30 degrees with the horizontal makes 60 degrees with the vertical, one making 60 degrees with the horizontal makes 30 degrees with the vertical, and one making 45 degrees with the horizontal makes 45 degrees with the vertical, it is a simple matter to draw lines making any one of these angles with either the horizontal or the vertical.

By using both the 60 degree and the 45 degree triangles with the T-square, it is possible to draw lines which make angles of 15 degrees or 75 degrees with either the vertical or the horizontal. The method of drawing such lines is shown in Fig. 3 and 4. In Fig. 3, the edge of the 45 degree triangle makes an angle of 30 degrees plus 45 degrees (or 75 degrees) with the horizontal, and since lines making X degrees with the horizon-

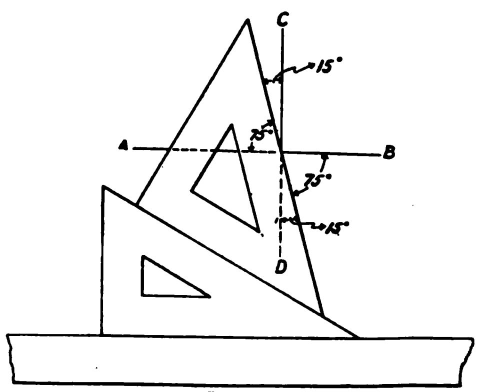


Fig. 3.

tal make (90—X) degrees with the vertical, the edge of the triangle makes an angle of (90—75) degrees or 15 degrees with the vertical. In Fig. 4, the edges of the 45 degree triangle make angles of 15 degrees with the horizontal and 75 degrees with the vertical.

When it is desired to draw parallel lines, other than those that are horizontal or vertical, it may be accomplished by means of two triangles. Place one triangle so that its long edge is quite near and exactly parallel to the given line, and holding the triangle firmly, place an edge of the second triangle against one of the shorter sides of the first. Now hold the second triangle firmly and slide the first either up or down along the edge of the second. It will thus be seen that the long edge of the first triangle will always move so that it is parallel to the original line. An example of this is shown in Fig. 5. *DE* is the given line

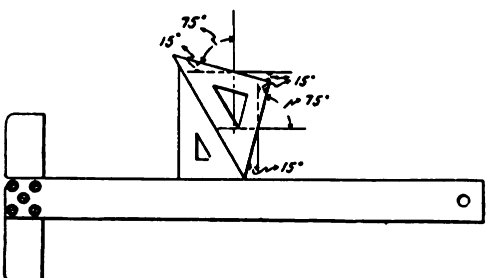


Fig. 4.

and it is desired to draw a line parallel to *DE* through some given point *K*. Triangle *A* is placed along line *DE* and triangle *B* is held against one of the edges of *A*. Then holding *B* firmly with one hand, *A* is slid along to position *A′* and the line *FG* is drawn through point *K*.

To draw a line perpendicular to a given line, the following method is used. Place one of the short edges of the 45 degree triangle against the line, and holding it firmly, place the long edge of the 60 degree triangle against the long edge of the 45 degree triangle. Now holding the 60 degree triangle firmly in place, slide the 45 degree triangle along the 60 degree until the other short edge of the 45 degree triangle intersects the original line at the desired point. Then a line drawn along this edge will be perpendicular to the given line at this point. In Fig. 6, the line *AB* is the given line and it is desired to erect a line perpen-

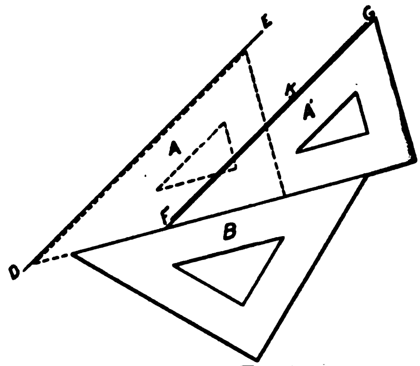


Fig. 5.

dicular to *AB* at point *K*. First place one of the short edges of triangle *E* along the line *AB* and place one of the long edges of triangle *F* along the long edge of triangle *E*. Now hold *F* firmly in place and slide *E* to position *E′*. When in this position, the other short edge of *E* is perpendicular to *AB* at point *K* and the line *CD* may now be drawn.

4. *Pencils and Penciling.*—It is much easier to learn to draw with a pencil, and finished pencil work will give more effective training in neatness than can be gained by inking-in the drawing. For these reasons, the student is advised to make all of the early exercises carefully finished pencil drawings. After one has gained both speed and accuracy with the pencil, the inking-in of the drawing will prove to be mere mechanical work. The pencils used should be ones having hard leads, and the ordinary writing pencil, being too soft, should never be used. The two grades of lead which are most commonly used by draughtsmen are the HHHH and the HHHHHH. In Fig. 7 is shown the proper manner of sharpening

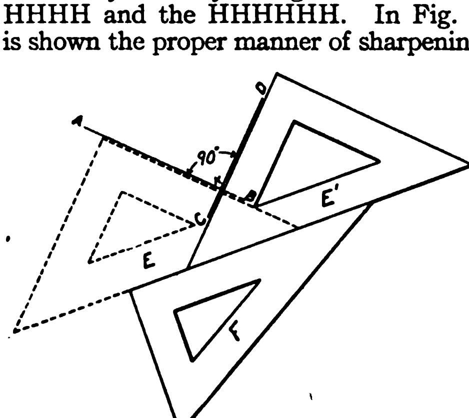


Fig. 6.

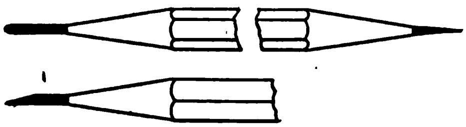


Fig. 7

the pencil leads. For ordinary line work an excellent point is made by cutting the lead clear across at an angle of about 30 degrees. As the outer skin of the pencil lead is much tougher than the center of the lead, such a point wears well. Also, it is a very quick way of sharpening the lead, since all that need be done to obtain such a point is to rub the lead upon a file, a piece of sand-paper or emery cloth. Generally the draughtsman will have a small piece of sand-paper or emery cloth fastened to a block of wood and will sharpen his pencils on this. The second point shown in Fig. 7 is an ordinary needle point, and this type of point is best for use in dimensioning drawings and for laying off distances. It is not only convenient but also good practice to have both ends of the pencil sharpened, one end having the chisel point and the other a needle point.

Be sure to keep the pencils well sharpened at all times, and when drawing hold the flat edge of the pencil against the straight edge. The pencil should be held vertically, and all lines drawn either from left to right or from bottom to top of the board.

All construction lines should be drawn fairly light, since it is therefore much easier to make any necessary corrections in the drawing.

5. *The Ink.*—The ink used for mechanical drawing is called India ink, and can be obtained either in stick form or in prepared form. Either form of ink will give a glistening, jet-black, waterproof line; but since the stick ink must be ground in water before it can be used, the prepared ink is preferable. One good kind of prepared ink is Higgins' Waterproof Drawing Ink. Red ink is much used for center lines and may be purchased already prepared. It is a much thinner ink than the India ink and will flow more freely, so that more care should be taken when using it, so as not to blur or blot the lines.

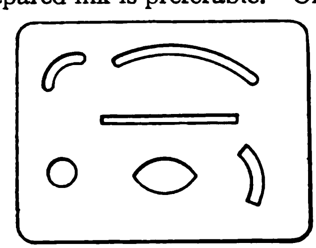


Fig. 8

6. *Paper and Tracing Cloth.*—For work that is to be traced, either the so-called Duplex paper or a Normal paper is generally preferred. They are very tough and will stand a large amount of erasing without showing any marks. They will also stand inking, but a hot-pressed paper is much better for this purpose and either Whatman's or some other reliable make should be used. Tracing paper is seldom used except in architectural work, tracing cloth being preferred on account of its toughness and lasting qualities. Both the dull side and the glazed side of the cloth are used, but the dull side has the advantage that it causes the ink to flow more freely and also it will not show erasures as much as the other side.

7. *Erasers.*—For erasing pencil lines use a pliable rubber eraser, and for cleaning a drawing or removing light pencil lines which show upon an inked-in drawing, use a kind of eraser known as art-gum. An eraser such as art-gum or sponge rubber will remove the light pencil lines without injuring the inked lines. For removing ink spots or erasing inked lines it is best to first use a scalpel, being careful not to scrape the surface of the paper any more than can be helped. Then finish erasing with a rubber eraser. The scalpel is a small knife, very well sharpened and of a form to facilitate erasing.

8. *Erasing Shields.*—Erasing shields are made of paper, cardboard, celluloid or metal and have slits or holes of various shapes and sizes cut out of them. Such a shield is shown in Fig. 8. When removing an ink spot or a small portion of an inked line, the shield is placed over the spot or line so that only the part to be erased is exposed.

(To be continued)

The real friend is the one who gives you pepper once in a while rather than sugar all the time.—Grizzly Pete.

THE INTIMATE THEATRE

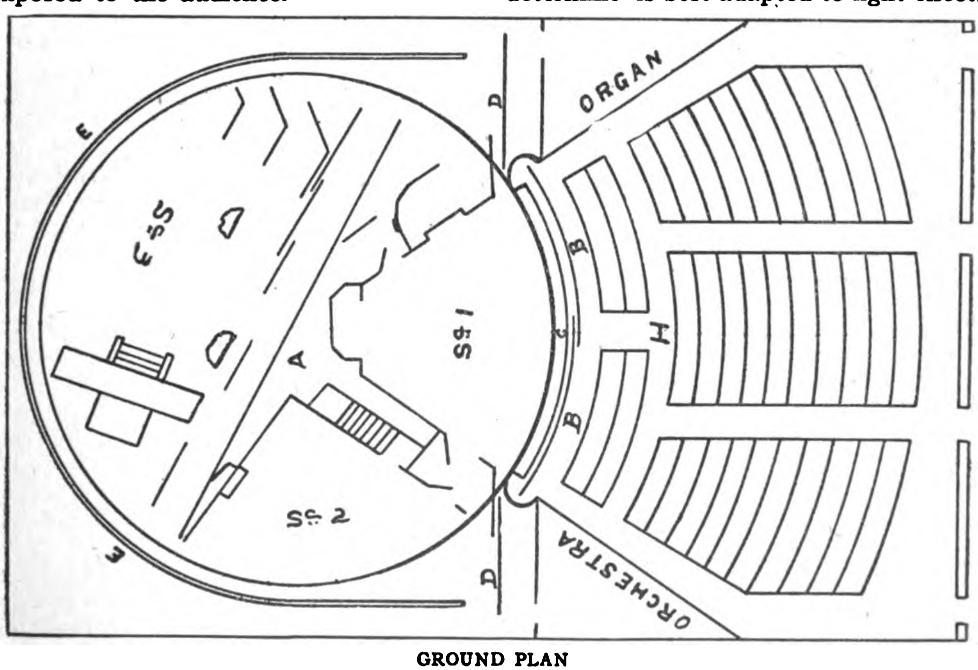
C. L. HAGEN

The Intimate Theatre is so termed because of the intimate relation of the audience and the stage. The revolving stage projects into the audience chamber, and is enclosed by the act curtain, just back of which are the footlights; while on each side, arranged vertically, are side lights, and overhead, the border or top lights. All of these lights are concealed, and the light is diffused onto the characters. This arrangement distributes the light equally, and removes the blinding effects of the light filaments upon the eyes of the actors, thus permitting them to see their audience.

An orchestra chamber is provided on one side of the proscenium arch, and an organ loft opposite. The top of the proscenium arch extends over the entire auditorium, returning down to the rear wall, forming an immense sounding board which will reflect sound waves to every part of the audience chamber and permits of a more efficient control of ventilation. The curtain is placed in front of the footlights to permit the stage director to properly light the picture before it is exposed to the audience.

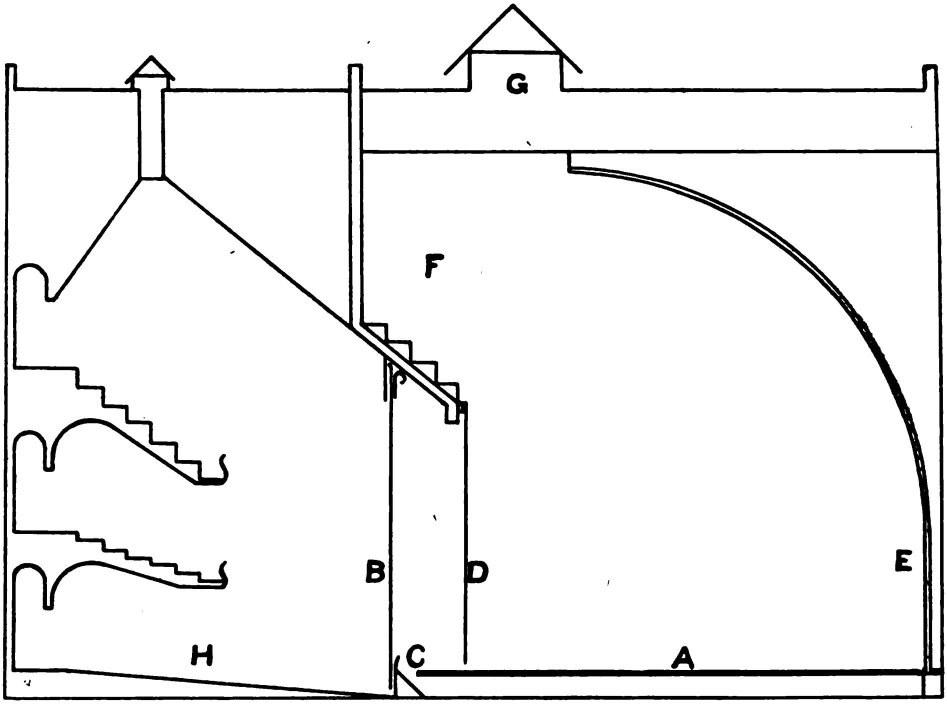
Stage floor coverings, carpets, etc., may be extended to the curtain so that the entire scene is in repose when shown. Movable fire walls separate the stage from the audience chamber, and are arranged as sliding doors suspended from the top and closed in from the sides. This permits the proscenium opening to be closed much quicker than if it were lowered from the top. It also removes the danger of such an enormous weight being suspended over the stage and which might be dropped or lowered upon actors who were trying to pacify an audience in a panic. There is also less danger of obstruction in this movement, as illustrated in the Iroquois Theatre fire. This arrangement also permits of the construction of a light chamber over the proscenium arch and by means of flying or swing bridges, lights and effects can be produced over any portion of the stage.

The Drehbohne, or revolving stage, is surrounded within the sight lines by a horizon wall with a sky dome, preferably of steel construction, rough plastered and of such color as experiments may determine is best adapted to light effects



GROUND PLAN

A. Revolving Stage or Drehbohne
B. Act Curtain
C. Footlights, Side Lights, Border Lights
D. Fire Wall Curtain
E. Circular Dome over Stage
H. Auditorium



LONGITUDINAL SECTION THROUGH CENTER

A. Revolving Stage or Drehbohne
B. Act Curtain
C. Footlights, Side Lights, Border Lights
D. Fire Wall Curtain
E. Circular Dome Stage
F. Chamber for Reflecting Lights and Light Effects
G. Ventilators
H. Auditorium

projected from the light chamber. In this manner the entire stage may be flooded with diffused light.

The background acts as a sounding board to project sound waves.

Beautiful effects may be obtained similar to those of the artist Mariano Fortuny of Venice, who has invented a new process of stage illumination which closely imitates the conditions of nature, and presents all objects in diffused light. Arc lamps are used exclusively, as their light corresponds in composition more closely with sunlight. The light is reflected by surfaces of cloth and thus is diffused. In order to produce the various tones observed in nature, the reflecting surfaces are composed of a number of strips, some of which serve for the production of colors, and others for the modification of the light by an admixture of black or white (white paper reflects 70 to 80 percent, black velvet 4/10 of 1 percent). Fortuny has illuminated a stage scene so perfectly that it was photographed without the use of other light and as clearly as though it had been out in the daylight.

The opportunity provided by the design of the Intimate Theatre permits of a revelation in stage lighting and dissolving stage pictures. The Drehbohne permits of a number of scenes being arranged upon it at one time, with no portion of them extending over—thus permitting scenes to be moved into position both rapidly and silently. Indefinite time may be expended in preparing scene pictures with that care and detail so desired by the director and artist, and with the knowledge that they will appear undisturbed and silently in their proper place in the play. And thus does the mechanical stage play its part in the advancement of the drama.

The forging and tempering of iron and steel can be greatly enhanced, according to recent experiments, by dipping the metal in fused salt. This dipping in salt is also well adapted for annealing steel without the oxidation of the surface.

THE HOME CRAFTSMAN

RALPH F. WINDOES

JARDINIERE STAND

Every home has a place for just such a stand as we here illustrate, so it should behoove every craftsman to make up such a stand. It presents a beautiful appearance when built up of quarter-sawed white oak and finished in one of the modern styles. The stock needed consists in the following pieces, planed and sanded to dimension:

4 pcs. $1\frac{3}{4}$ x $1\frac{3}{4}$ x 30 in. quarter-sawed oak
8 pcs. $\frac{7}{8}$ x 2 x 13 in. quarter-sawed oak
12 pcs. $\frac{3}{8}$ x 4 x $6\frac{1}{2}$ in. quarter-sawed oak
2 pcs. $\frac{7}{8}$ x 1 x 11 in. plain oak
1 pc. $\frac{7}{8}$ x 12 x 12 in. plain oak
Screws, filler, stain, wax, etc.

First, shape the legs and chamfer their top. They taper at the bottom, starting in the center and working down from $1\frac{7}{8}$ in. square to 1 in. square. Next, cut the tenons on the eight side stringers and fit them into mortises cut in the legs. These stringers should have grooves $\frac{1}{4}$ in. deep and $\frac{3}{8}$ in. wide cut into them to receive the side pieces. The craftsman can save himself considerable work if he has these grooves cut out at the mill. The side pieces are given in the bill as being 4 in. wide, but in reality they are $3\frac{2}{3}$ in. Of course this is an uncommon dimension, so the builder will be forced to divide an inch into three equal parts and take two of them, in order to get the accurate dimension. The star decoration on these pieces is shown in the detail. It should be laid out on two of the pieces adjoining each other. It represents two squares, the diagonals of which are 2 in. long. All of the lines are drawn at an angle of 45 degrees, therefore it would simplify the work if the T-bevel was set at this angle and the design drawn out with its help. An easy way to set the bevel for such an angle is by means of the steel square. Put the beam of the bevel against one edge of the square and set it so that the blade will pass through the same division on both the body and the tongue of the square, that is, through both 2 in., 3 in., or 4 in. marks. When the design has been cut out of one piece, this may be used as a pattern for the other pieces. After all are cut out and fitted, glue and clamp the parts together, being sure to insert the sides into the stringers before clamping, as it would be impossible to insert them after.

Allow ample time for the glue to set, then screw the two narrow strips of plain oak from the inside, onto two of the bottom stringers, keeping them flush at the bottom and parallel to each other. Onto these fit the bottom piece, which may also be screwed into place.

Scrape off any surplus glue in evidence, sand lightly and apply the finish as before described.

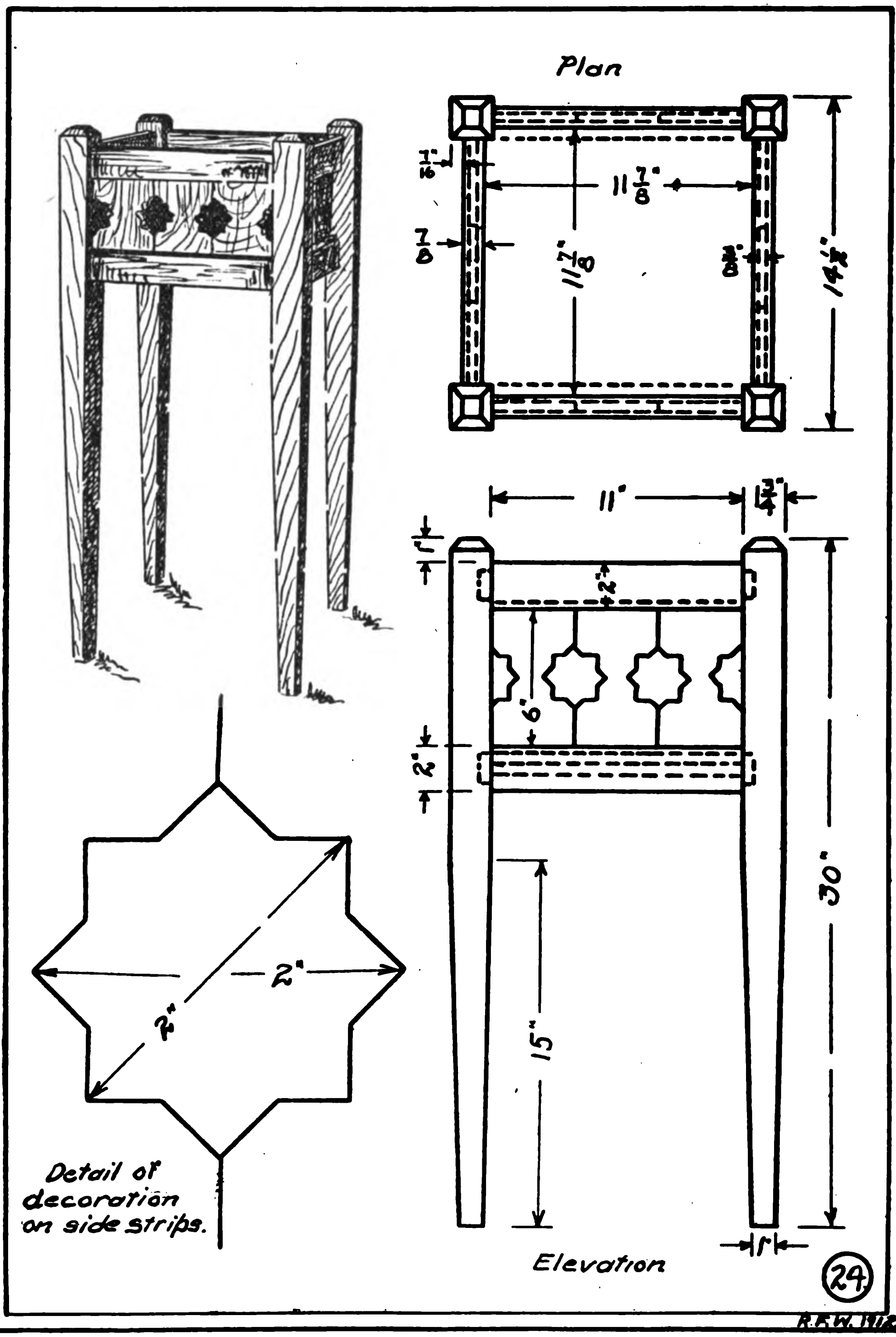
SCONCE

The sconce, illustrated on page 306, may be worked up in a number of ways, but the hammered method is preferable. It is a beautiful piece when finished in dull copper with the reflector highly polished. The materials needed for the hammered method consist in the following, while, if the etching is used it will take heavier and the piercing lighter, metal:

1 pc. copper No. 23 gauge, $8\frac{1}{2}$ x 13 in.
1 pc. copper No. 20 gauge, 2 x 2 in.
1 pc. copper No. 20 gauge, 2 x $4\frac{1}{2}$ in.
1 pc. copper No. 20 gauge $3\frac{7}{8}$ x $3\frac{7}{8}$ in.
Rivets, steel wool, lacquer.

First, make a complete, full-size drawing of the back on a piece of paper according to the dimensions given. The design shown is suggestive and should not be copied unless the craftsman thinks himself unable to originate a better one. If he does his own designing, he should not forget to plan a reflector directly back of his candle. Second, transfer this design with carbon paper to the large piece of metal, leaving $\frac{1}{2}$ in. all around outside of the cutting edges. Third, drill holes through this margin about $\frac{3}{4}$ in. apart and insert $\frac{3}{4}$ in. slim screws through these holes and into a thick softwood board. Fourth, with a 20-penny

-JARDINIERE STAND.-



common nail, the end of which has been slightly filed, stamp the background of the design in a manner similar to piercing, but *do not pierce through the metal.* This lowers the background and raises the design. Fifth, sharpen another nail to a blunt chisel edge and stamp along the border of the design and the background. Sixth, remove the metal from the board, cut away the surplus and file the edges. Seventh, polish the reflector with steel wool and lacquer the piece. A high polish can be given it with pumice stone and water. In any event use two or more coats of lacquer. Eighth, shape the bracket as shown and bend on the dotted lines, in each case bending a right-angle. Ninth, draw a circle on the 2 in. square piece and trim down to this line. With the ball pein of the hammer, pound a hole in the end of a piece of soft wood and form the little bowl in this depression, using the ball pein for all of this work. Tenth, draw the holder out full size on a piece of paper and transfer it to the remaining piece of metal. Cut it out to shape and bend it up on the dotted lines. The upper ends are shaped with the round nose pliers. Finally, rivet the bowl and holder to the bracket shelf and the latter to the back as illustrated. after giving each piece a coat of lacquer.

If the etched or pierced methods are used, the principal directions will still be the same.

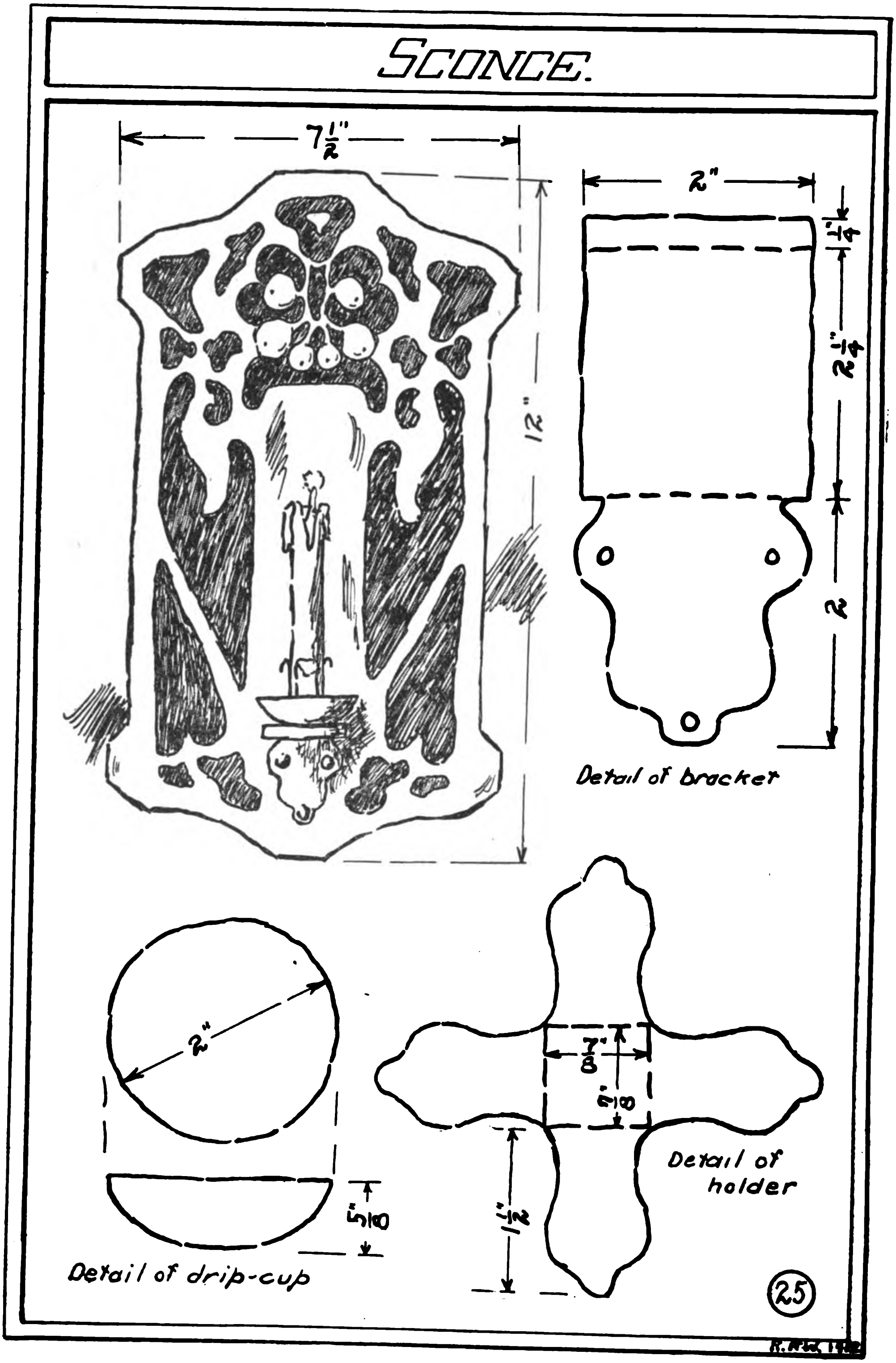
(*To be continued*)

KINKS FOR THE HOME CRAFTSMAN

Every woodworker discovers little short-cuts in his work which materially help him to attain rapidity and perfection. A number of these, from the writer's own experience and the experience of others, will be listed with the hope that they will be of some assistance to the amateur craftsman.

1. In measuring with a rule, always tip it on edge so that the dimension marks are adjacent to the piece being laid out, and in taking a series of dimensions, start from one point only; do not move the rule from one mark to the next.
2. For fine cabinet work, make all lines with a knife and the gauge, but never with a pencil.
3. In setting a gauge, do not rely upon the scale on the beam, but always test with the rule, the end of which can be placed against the head of the gauge, and the dimensions run to the spur.
4. Always tip a plane on its side when laying it on the bench so as not to dull the iron. For the same reason, always raise the plane from the work on the return stroke.
5. In planing end grain, never run the plane entirely across the end, but work from both edges toward the center of the piece. This prevents the splitting of corners.
6. In using an oil stone, there are three things to observe: (*a*) Use plenty of good oil. (*b*) Clean the stone well before putting it away. (*c*) Use the entire face of the stone, not merely the center. If these precautions are taken a stone should cut perfectly for years.
7. In sharpening plane irons and chisels, always rub on the bevel and never on the back, as this must be perfectly straight at all times to insure perfection in cutting.
8. In boring, never bore entirely through a piece, but reverse the piece and finish the hole from the other side after the worm penetrates.
9. Do not drive a screw into a board with a hammer, as its holding qualities will be greatly lessened.
10. Always drive nails and brads at an angle, as they will then hold more securely.
11. In sand-papering, always use a block if possible, as this will prevent rounding edges where they are not wanted.
12. Sand-paper should be used for cleaning and smoothing purposes only; do not depend upon it for doing the tool work.
13. Sand-papering should not be done across grain.

The old custom of leasing land to the highest bidder by the aid of a candle and pin is still being observed at Vadmouth, a village between Reading and Newburg, England. The candle is lighted and a pin stuck into it. Bids are then called for until the pin, owing to the softening of the candle, drops out.


SCONCE.
7 1/2"
12"
2"
1/4"
2 1/4"
2
Detail of bracket
2"
5/16
Detail of drip-cup
7/8"
5/8
1 1/2
Detail of holder
25
R.W.K. 1912

ENGINEERING LABORATORY PRACTICE—Part VI

The Measurement of Water by Means of Nozzles and Weirs

P. LE ROY FLANSBURG

It often happens that the engineer must know the exact amount of water which is flowing through a given pipe in a given time. When the quantity of water to be measured is small, the simplest and quickest method of procedure is to allow the water to flow from the pipe into a series of tanks known as weighing tanks. These tanks are mounted on platform scales and each tank is filled in succession; then, knowing the weight of the tank when empty, and also its weight when filled, it is a simple matter to determine the cubic feet of water or the gallons of water discharged from the pipe in a given period of time. But such a method is not practical when large quantities of water are to be measured, and the engineer then usually employs either a nozzle or a weir as a means of measuring the water.

The nozzle is but a modified form of the convergent tube with rounded corners, as shown in Fig. 1, and nozzles of this type are inserted in the sides of tanks. Usually, however, the length of the nozzle is three or four times its smallest diameter and it would more closely resemble the one shown in Fig. 2. Such nozzles are attached to the ends of pipes or hose.

By a rather complicated mathematical analysis (and also many experiments) it has been shown that the quantity of water Q, in cubic feet per second, discharged through a nozzle, is directly proportional to the area a of the nozzle, at its smallest cross-section, and also directly proportional to the square root of $2g$ times the head H, where g is the gravitational acceleration, equal to 32.2 ft. per second, per second, and H the pressure head. Expressing this relation mathematically, we have,

$$Q = a\sqrt{2gH}$$

This formula, however, does not take account of the angle of convergence of the nozzle or of the frictional resistance of its walls, and to correct for these two things we must write the formula as

$$Q = Ca\sqrt{2gH}$$

where C is a constant for the nozzle, determined experimentally and called the coefficient of discharge.

Suppose that we have a nozzle inserted in the side of a tank and that the distance from the level of the water in the tank to the center of the nozzle's mouth is 10 ft. Let the cross-sectional area of the nozzle at its mouth be 1 sq. in. Now weigh all of the water discharged through the nozzle during a test of 10 minutes and let it equal 102.6 cu. ft. This gives a value of Q equal to .171 cu. ft. per second.

If we assume a value of C equal to 1, then our formula becomes

$$Q = 1 \times \frac{1}{144} \times \sqrt{2 \times 32.2 \times 10} = .176 \text{ cu. ft. per sec.}$$

However, we found that the actual discharge was .171 cu. ft. per sec. There-

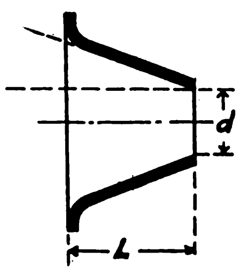


Fig. 1.

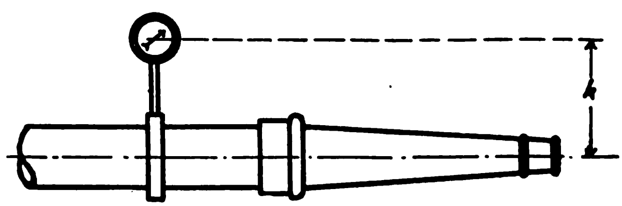


Fig. 2.

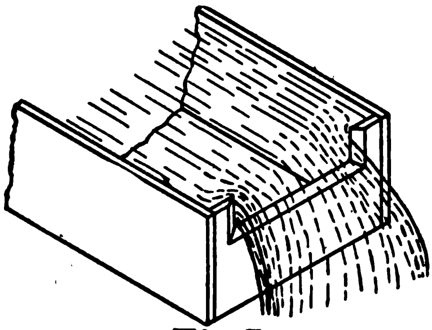


Fig. 3.

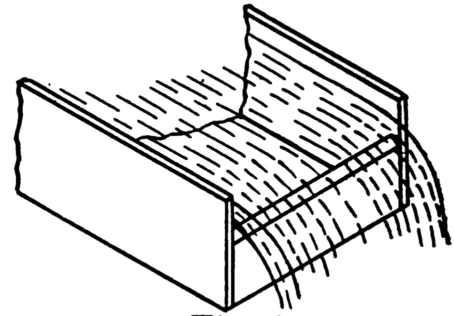


Fig. 4.

fore, we see that the actual coefficient of discharge is equal to,

$$\frac{.171}{.176}=0.97$$

and combining all constants we find that for this nozzle,

$$Q=.0541\sqrt{H}$$

Therefore, after once calibrating the nozzle, all that need be done to compute the number of cubic feet of water discharged per second is to make a measurement of H and substitute in the formula.

It is important, however, to remember that H must be measured to the level of the smallest cross-section of the nozzle.

When a nozzle is not sufficient to handle all of the water discharged (as when measuring the quantity of water flowing past a given point in a stream) a weir is often made use of.

A weir is simply a long rectangular box having one of its short sides so cut that it resembles the ones shown in Fig. 3 and Fig. 4. This weir box is placed with its beveled edges on the down-stream side, and so arranged that the water from the stream will flow through it. By a process of mathematical deductions (and also by many experiments) it has been found that the quantity of water discharged through a weir, can be expressed by the formula,

$$Q=\tfrac{2}{3}Cb\sqrt{2gh^3}\text{ cu. ft. per sec.}$$

where C is the coefficient of discharge of the weir, b the width of the weir in feet, h the distance (expressed in feet) between the level of the water in the stream and the upper edge or crest of the weir. C has been determined experimentally for different types of weirs and will average about 0.62 for weirs having rectangular openings. To secure accurate results, the distance h should be measured to thousandths of a foot.

In making measurements of this kind a hook-gauge like the one shown in Fig. 5, is employed. This gauge consists of a graduated rod having a hook on its lower end and fastened by means of a nut and screw to a fixed arm. The rod may be raised or lowered by turning the nut. A vernier is fastened to the rod and passes over a a scale, thus making it possible to make readings of a thousandth of a foot. A pipe is led from the weir box to the hook-gauge can and thus the water will stand at the same level in the can as it is in the weir box. To use the gauge the zero reading of the water level must first be taken. Let the water in the weir box be exactly level with the crest of the weir and turn the nut on the hook-gauge rod until the point of the hook is just at the surface of the water in the can. Then read the height of the hook-gauge by means of the scale. After the test has started the water in the hook-gauge can will rise until it is at the level of the water passing over the weir. Take another reading of the hook-gauge (again bringing the point of the hook up to the surface of the water in the can) and the difference between this reading and the zero reading will give the exact value of h.

The following is a test performed by the author to determine the coefficient of discharge for a given nozzle and given weir.

TEST ON NOZZLE AND WEIR

The test was for the purpose of determining the coefficient of discharge for an "Underwriter's Fire Nozzle," and a "Trapezoidal Weir." The method followed in performing the experiment consisted in measuring the volume of water discharged in a given time, the pressure at which the water from the nozzle was discharged and the height of the water above the weir.

In order to know the pressure of the water in the pipe, a piezometer ring was placed around the pipe and to this a gauge was attached. This gauge was read every two minutes for ten minutes and the amount of water discharged was measured in large measuring tanks.

The general sketch of the apparatus is shown in Fig. 6.

DATA

Diam. of nozzle ....1.25 in.
Diam. of piezometer............1.75 in.
Height of center of gauge above
center of nozzle................5 in.
Length of weir crest...............15 in.
Vol. of water...............391.3 cu. ft.
Nozzle gauge reading...........37.25 lb.
Hook gauge reading.............7.87 in.
Zero reading of hook-gauge = 4.30 in.

CALCULATION OF RESULTS

The formula for finding the coefficient of discharge is,

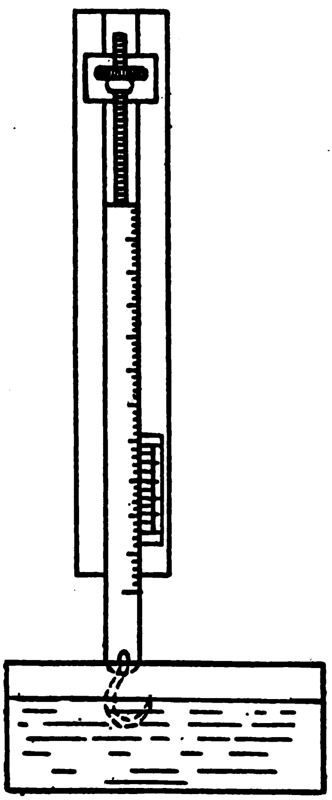


Fig. 5.

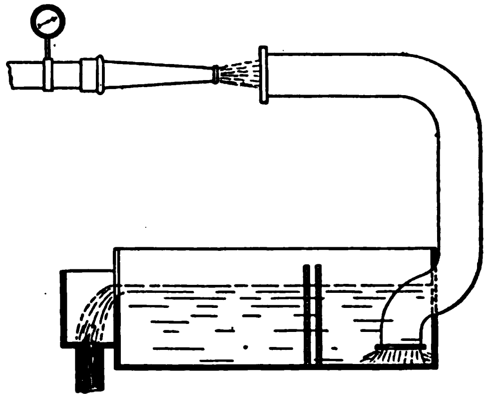


Fig. 6.

$$Q=\frac{0.4374Cd^2}{\sqrt{1-C^2\left(\frac{d}{D}\right)^4}}\sqrt{h_1}$$

where Q = discharge in cu. ft. per sec.
C = coef. of discharge
d = diameter of nozzle
D = diameter of piezometer
h_1 = total head

When using this formula the size of the piezometer and of the nozzle, together with the height of the center of the gauge above the center of the pipe, must be known.

The formula used for finding the coef. of discharge of the weir was,

$$Q=CLH^{\frac{3}{2}}$$

where Q = discharge in cu. ft. of water per sec.
C = coef. of discharge
L = length of crest
H = height of water flowing over weir

Weir.

$$7.87''-4.30''=3.57''$$

$$Q=CLH^{\frac{3}{2}} \qquad C=\frac{Q}{LH^{\frac{3}{2}}}$$

Q = cu. ft. H_2O per sec.
C = coef. of discharge.
L = length of crest in ft.
H = head on weir in ft.

$$C=\frac{\frac{391.3}{600}}{\frac{15}{12}\times\left(\frac{3.57}{12}\right)^{\frac{3}{2}}}$$

$$C=\frac{0.653}{1.25\times .162}=3.23$$

Nozzle.

$$\frac{5}{12} \times \frac{62.3}{144} = .018 \text{ lb.} \left\{ \begin{array}{l} \text{Corr. for height of} \\ \text{center of gauge above} \\ \text{center of nozzle.} \end{array} \right.$$

$$P_1 = 37.25 + 0.18 = 37.43 \text{ lbs.}$$

$$h_1 = \frac{37.43 \times 144}{62.3} = 86.7 \text{ ft.}$$

$$Q = \frac{0.04374\ Cd^2 \sqrt{h_1}}{\sqrt{1 - C^2 \left(\frac{d}{D}\right)^4}}$$

$$\frac{\sqrt{1 - C^2 \left(\frac{d}{D}\right)^4}}{C} = \frac{0.04374\, d^2 \sqrt{h_1}}{0.653}$$

$$1 - C^2 \left(\tfrac{5}{7}\right)^4 = (9.75)^2 C^2$$

$$C^2 = \frac{1}{1.21} = .828$$

$$1 - 0.26c^2 = .95c^2$$

$$C = 0.915$$

$$\text{Total head at piezometer.} = 86.7 + \frac{\left\{ \dfrac{\frac{391}{600}}{\frac{\pi 1.75^2}{4.144}} \right\}^2}{2g} = 86.7 + 23.5 = 110.2 \text{ ft.}$$

Total head = pressure head + velocity head.

$$V = \frac{Q}{A}$$

$$\text{head due to velocity} = h_2 = \frac{V^2}{2g}$$

RESULTS

Coef. of weir........................3.23
Coef. of nozzle.....................0.915
Total head at piezometer.......110.2 ft.

CUTTING RUBBER WITH A WET KNIFE

W. E. MOREY

Some years ago the writer was employed in a paper mill in Vermont, and one day saw the machine tender cutting some heavy rubber which covers one of the rolls at the "wet" end of the machine. After every stroke of the knife he would wet the blade in his mouth. Being asked the reason, he explained that it made it cut easier, and then told the following story: A certain firm of rubber manufacturers were experimenting with a new mixture of rubber and were observing the utmost secrecy regarding its composition, with a view to protecting same when a satisfactory mixture had been found.

One day a visitor wormed his way into the works on some plausible excuse or other, and was looking about with apparent indifference and that lack of close observation which characterizes the merely curious.

He was apparently a minister, being of a benevolent mien, with a long black coat of a clerical cut and a white tie. As he came to where some of the finished rubber lay he asked if he could have a piece to use as an eraser and as he looked anything but the technical expert he was told that he might have a piece.

Taking out his knife he took up a piece of the heavy sheet and wet his knife to cut it off. Instantly the man in charge snatched away the sample sheet and with no gentle hand spun the clerical-looking gentleman around with the words: "You get out, and quick, too, You know altogether too much about rubber for us. Now go!" He went.

Although the shark and the octopus share about equally the reputation for being the greatest enemies to mankind in the sea, a much worse creature than either shark or octopus is the devil-fish—a large ray that is common in the warm waters of the Atlantic. The fish grows to a weight of a ton and a half, and besides formidable teeth, is armed with a horrible barbed and poisoned spike in the tail. It has often been known to attack boats. Another nasty customer is the green moray of Bermuda, which resembles a conger eel in form, but is of a very savage nature. The swordfish, sought for its oil and flesh, especially along the Atlantic coast of the United States, is another dangerous creature. Swordfish are harpooned in the same manner in which whales used to be killed. Quiet enough until attacked, the swordfish then seems to go raving mad and fights with unmatched ferocity.

THE USE OF CONCRETE ON THE FARM *

INTRODUCTION

With the rapid decrease of our timber supply and the resulting increase in the price of lumber, there has come a necessary demand for a new building material. Nowhere has this demand been felt more keenly than on the American farm, where lumber has till now been practically the only building material. On account, however, of the farmer's nearness to the timber itself, he has been the last to feel the full effect of the shortage.

A building material has been discovered in concrete that in many instances has proved to be far superior to lumber, brick, or building stones on account of its durability, economy, and safety from fire loss. Moreover, it can very often be used at the most convenient time by the farmer himself with a little assistance.

SELECTION OF MATERIALS

Frequently cement users have made costly mistakes by not informing themselves properly, before starting their work, concerning the correct methods of making good concrete. For this purpose the following materials are necessary: (1) cement; (2) sand; (3) gravel or crushed stone; and (4) water.

Cement is therefore only one part of a concrete mixture. A far greater proportion of sand and gravel than cement is required. The quantity of cement to be used and the strength of the concrete depend entirely on the quality and size of the sand and gravel, and it is of the utmost importance that these be of the right kind. With an equal amount of cement a far stronger concrete may be made, if the sand and gravel are of the proper size and correctly proportioned. It is sometimes thought that any kind of soil of a sandy nature, mixed with a small percentage of cement, will make concrete, but this idea is incorrect.

As a guide in the selection of the proper materials, especially sand and gravel, the following suggestions should be observed:

CEMENT

Portland cement is a manufactured product, the principal value of which is its ability to adhere to the various materials used in masonry construction. Most of the American brands of Portland cement are made under the careful supervision of the manufacturer, w[illegible] has his reputation at stake. They have to meet the requirements of a fixed standard which has been, after years of experimenting, adopted by the American Society for Testing Materials and the American Society of Civil Engineers. Guarantees should be obtained from the dealer or manufacturer that the Portland cement furnished meets this standard.

On adding water to the dry cement it becomes a soft, sticky paste, and will remain so for about one-half hour, after which it begins to harden or "set." To disturb the concrete after this initial set has started means a decided loss in strength, while to disturb it after the set is well under way means to destroy the concrete. It should, therefore, be remembered that Portland cement concrete must be placed in position within 20 or 30 minutes from the time it is first wet.

There are also several other minor considerations to be observed. First, the binding power of Portland cement is lessened by exposing the concrete to a hot sun during the first four or five days after it has been placed in position. Then, a green cement mixture, which can be easily frozen at a temperature below 32 degrees Fahrenheit, should be protected from such an exposure. Freezing does not materially affect the binding quality of good Portland cement, provided the concerte does not freeze until after placing, and is not subjected to any load until after it has been thawed out and allowed to "set" in the usual way. It is safest to avoid mixing on days when the temperature is below the freezing point, that is, 32 degrees Fahrenheit. In no case should fresh manure be placed over very green concrete to protect it from freezing, because this will soil the surface of the concrete.

Portland cement is shipped in paper bags, cloth sacks, or wooden barrels. The second means is, for the average user, the best, and, while the manufacturers charge more for this kind of a package, they allow a rebate for the return of the empty bags.

* U. S. Department of Agriculture. Farmers' Bulletin, 41.

Fig. 1. Method of Screening Sand from Gravel

Cement is manufactured in twenty-five states in the United States and can be obtained easily in all sections of the country. Of the various kinds of cements made, Portland cement is without question the best.

Cement must be kept in a dry place. It absorbs moisture from the atmosphere with great readiness and, when kept in a damp place, soon becomes lumpy or even a solid mass. In this condition it is useless and should be thrown away. But lumps caused by pressure in the storehouse must not be mistaken for cement that has been wet and has then formed into lumps. Lumps caused by pressure are easily broken and the cement is perfectly good.

In storing cement wooden blocks should be placed on the floor and covered with boards. The cement should then be piled on the boards and the pile covered with canvas or a piece of roofing paper.

SAND

In the selection of sand the greatest care should be used, and critical attention should be given to its quality, for sand contributes from one-third to one-half of the amount of the materials used in making concrete.

Sand may be considered as including all grains and small pebbles that will pass through a wire screen with ¼ in. meshes, while gravel in general is the pebbles and stones retained upon such a screen.

The sand should be clean, coarse, and if possible, free from loam, clay and vegetable matter. It was proved in an actual test made by a United States government expert that an exceedingly fine sand required seven times the amount of cement required by coarser sand retained on a 20-mesh screen, without increasing the strength of the concrete.

Sand from the same bank usually varies largely in different places in the bank, and, as sand of such fineness that over 50 percent of the bulk of the sand will pass through a 40-mesh screen is generally unfit for concrete work, it may become necessary to screen out this very fine sand by means of a 40-mesh wire screen. A 40-mesh screen means a screen with 40 holes to the lineal inch of screen surface. The screen should be placed in an upright position at an angle of about 45 degrees. The screening should be done at the pit, in order that only the material actually used may be hauled.

Sand with the grains of nearly uniform size does not give as great strength as sand with grains of various sizes. By testing concrete made from coarse and fine sand of one size of grains, it will be found that the coarse sand gives the stronger concrete. The strength and hardness of the grains of sand are of much importance; and a sand which shows the slightest tendency to dissolve or soften when soaked in water for an hour should be discarded.

The coarseness of the sand can be felt, or can be determined by a screen, and the vegetable matter can be seen, but the amount of clay or loam can not be decided in either of these ways. Four inches of sand should be put in a pint preserving jar, and when the jar has been filled with clear water to within an inch of the top, the lid should be fastened on and the jar shaken vigorously for 10 minutes. The jar should then be rested upright and the contents allowed to settle. The sand will settle in the bottom with the clay and the loam on top, and the water above them. If more than ½ in. of clay or loam shows, the sand should be rejected or washed. The difference in color and fineness shows clearly the line of division between the clay or loam and the sand.

If the sand must be washed, the simplest way is to build a loose board platform from 10 to 15 ft. long, with one end 12 in. higher than the other. On the lower end and on the sides an edge 2 x 6 in. should be nailed to hold the sand. The sand should be spread over the platform in a layer 3 or 4 in. thick and washed with a ¾ in. garden hose. The washing should be started at the high end and the water allowed to run through the sand and over the 2 x 6 in. piece at the bottom. A small quantity of clay or loam does not injure the sand, but any amount over 10 percent should be washed out.

GRAVEL

The largest part of concrete is the gravel or crushed stone. This should be clean; that is, free from loam, clay, or vegetable matter. The best results are obtained from a mixture of sizes graded from the smallest, which is retained on a ¼ in. screen, to the larger ones that will pass a 1½ in. ring.

For heavy foundation and abutment work, larger-sized pebbles and stones might be used; while for reinforced concrete work pebbles larger than those passing a 1 in. ring should not be used.

If crushed stone and screenings are used, the same care in selecting the sizes must be exercised as in selecting the gravel. In ordering from the crusher plant, the sizes of the stone and screenings should be specified in the order. The crusher dust should always be removed.

Sometimes bank or creek gravel, which will answer the purpose of sand and gravel combined, can be obtained, and it is frequently used on the farm and in small jobs of concrete work just as it comes from the pit or creek. Occasionally this gravel contains nearly the right proportions of sand and gravel, but in the majority of sand pits and gravel banks there is a great variation in the sizes of the grains and pebbles or gravel, and in the quantities of each. This is due to the fact that all the deposits are formed in seams or pockets that make it impossible to secure anything like uniformity. Therefore, to get the best and cheapest concrete, it is advisable to screen the sand and gravel and to remix them in the correct proportions.

Experienced contractors have found that it is not only necessary but economical to pay laborers as much as $2.00 per day to screen the bank material twice, in order to obtain the sand and gravel. First, a ¼ in. screen should be used to keep out the gravel, and then the material which has passed through this screen should be screened again over a 40-mesh screen for the sand. All material which passes through this 40-mesh screen should be rejected.

By knowing exactly the proportions of sand and gravel, the exact amount of cement to obtain the desired strength can be determined. Enough cement can be saved to balance the additional pay given to the laborers for screening the sand and gravel.

Dirty gravel can usually be observed without further test, and can be washed in the same way as dirty sand.

WATER

The water used for concrete should be clean and free from strong acids and alkalis.

MANUFACTURE OF CONCRETE

PROPORTIONS

Concrete is a manufactured stone formed by mixing cement, sand, and

Table I.—*Quantities of materials and the resulting amount of concrete for a two-bag batch*

Kinds of concrete mixture	Proportions by parts: Cement	Sand	Stone or Gravel	Materials: Cement (bags)	Sand (cubic feet)	Stone or gravel (cubic feet)	Concrete (cubic feet)	Sizes of measuring boxes (inside measurements): Sand	Stone or gravel	Water for medium wet mixture (gallons)
1:2:4	1	2	4	2	3¾	7½	8¼	2 x 2 ft. x 11¼ in.	2 x 4 ft. x 11¼ in.	10
1:2½:5	1	2½	5	2	4¾	9¼	10	2 x 2 ft. 6 in. x 11¼ in.	2 ft. x 6 in. x 4 ft. x 11¼ in.	12½

stone or gravel (*i.e.*, pebbles) together with water. Various amounts of each are used, according to the use to which the concrete is to be put. The mixture in which all the spaces or voids between the stones or gravel are filled with sand and all the spaces between the sand are filled with cement is the ideal mixture. This mixture is rarely obtained, since the voids in each load of gravel and sand vary slightly, and in order to be absolutely safe, a little more sand and cement than will just fill the voids are used. The following illustration (Fig. 2) shows the relative amounts of these various materials for a certain amount of 1:2:4 concrete. It will be noticed that the amount of concrete is only slightly greater than the amount of stone or gravel.

Table I shows the amount of stone, sand and cement used in the various grades of concrete work. The proportions are always measured by volume. A 1:2:4 mixture means one part of cement, twice as much sand, and four times as much stone or gravel, so that the whole mixture consists of seven parts. A 1:2½:5 mixture means one part of cement, two and one-half times as much sand, and five times as much stone or gravel, so that the whole mixture consists of eight and one-half parts.

MEASURING BOXES

It should be noticed that the dimensions given for the measuring boxes for sand and stone or gravel are inside measurements. These boxes are made with straight sides of any kind of rough boards and have no top or bottom.

AMOUNT OF WATER

The amount of water given is only approximated. The amount given in Table I should be used for the first batch; if it is too wet for the use desired, the amount should be reduced, while if it is too dry, the amount should be increased. A bucket should always be used in measuring the amount of water, as this secures uniform results.

VARIATIONS IN MIXTURE

If the sand is very fine, the cement should be increased from 10 to 15 percent.

When the mixture does not have a uniform color, but looks streaky, it has not been fully mixed.

If the mixture does not work well, and the sand and cement do not fill the voids in the stone, the percentage of stone should be reduced slightly, but the concrete should first be properly mixed. Concrete that is poorly mixed may present features that are entirely eliminated by turning it over once or twice more.

METHOD OF MEASURING QUANTITIES

One barrel of Portland cement holds practically 4 cu. ft., or 4 bags of cement. Sand and stone or gravel are measured loose in the boxes and should not be packed. A 2-bag batch of concrete requires 2 bags of cement, while the amount of sand and stone or gravel is measured as shown in Table I. For a 4-bag batch, twice as much sand and stone or gravel and 4 bags of cement should be used.

DETERMINATION OF QUANTITIES

The number of cubic feet of concrete that will be required for the work in question should first be calculated. By multiplying this number by the number under the proper column, as shown in Table II below, the amount of cement, sand, and stone or gravel can be found.

Table II

Quantities of materials in 1 cu. ft. of Concrete

Mixture of Concrete	Cement by bbls.	Sand by cu. yds.	Stone or Gravel by cu. yds.
1:2:4	0.058	0.0163	0.0326
1:2½:5	.048	.0176	.0352

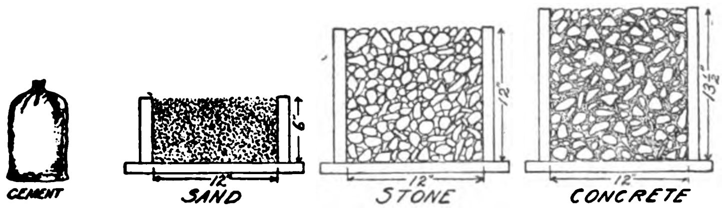


Fig. 2. Required Quantities of Cement, Sand and Stone or Gravel for a 1:2:4 Concrete Mixture and the Resulting Quantity of Concrete

Example.—Let us suppose that the work consists of a concrete silo requiring in all 935 cu. ft. of concrete, of which 750 cu. ft. are to be 1:2:4 concrete, and 185 cu. ft. are to be 1:2½:5 concrete. Enough sand and cement are also needed to paint the silo inside and outside, amounting in all to 400 sq. yds. of surface with a 1:1 mixture of sand and cement. One cubic foot of 1:1 mortar paints about 15 sq. yds. of surface and requires 0.1856 barrel of cement and 0.0263 cu. yd. of sand. The problem thus works out as follows:

Cement:

	Bbls.
For the 750 cu. ft. of 1:2:4 concrete (750 x 0.058)	43.5
For the 185 cu. ft. of 1:2½:5 concrete (185 x 0.048)	8.9
For painting (400÷15 x 0.1856)	4.9
Total amount of cement	57.3

Sand:

	Cu. yds.
For 750 cu. ft. of 1:2:4 concrete (750 x 0.0163)	12.23
For 185 cu. ft. of 1:2½:5 concrete (185 x 0.0176)	3.26
For painting (400÷15 x 0.0263)	.70
Total amount of sand	16.19

Stone or gravel:

For 750 cu. ft. of 1:2:4 concrete (750 x 0.0326)	24.5
For 185 cu. ft. of 1:2½:5 concrete (185 x 0.0352)	6.5
Total amount of stone or gravel	31.0

Thus the necessary quantities of materials are about 57½ bbls. of Portland cement, about 16¼ cu. yds. of sand, and 31 cu. yds. of stone or gravel. It is always wise to order two or three extra barrels of cement if the dealer is at considerable distance, as this avoids any possible trouble that a shortage might cause.

In case a natural mixture of bank sand and gravel is used, the following table should be consulted for the quantities of the mixture:

(*To be continued in the June issue*)

[*Editor's Note.*—This article, upon the "Use of Concrete," will be complete in three instalments, and in the June issue the equipment necessary for the mixing of concrete and the different methods employed will be quite fully and clearly described. It is hoped that this series of articles may prove of much practical benefit to such of our readers who have any concrete work which they wish done.]

Table III

Quantities of materials and the resulting amount of concrete for a two-bag batch, using a natural mixture of bank sand and gravel

Kind of concrete mixture	Proportions by parts: Cement	Proportions by parts: Natural mixture of sand and gravel	Materials: Cement (bags)	Materials: Natural mixture of sand and gravel (cubic ft.)	Concrete (cubic ft.)	Sizes of measuring boxes, mixture of sand and gravel	Water for medium wet mixture (gallons)
1:4	1	4	2	7½	8½	2 x 4 ft. x 11½ in.	10
1:5	1	6	2	9½	10	2 ft. 6 in. x 4 ft. x 11½ in.	12½

NEXT FEW YEARS WILL ECLIPSE ALL AGES IN INVENTION

EDWARD B. MOORE
(*Commissioner of Patents*)

The age of invention has just begun to dawn. The accomplishments of the last half-century, while marvelous almost beyond conception, will not begin to compare with what will be done in the next half-century.

I base this conclusion upon a definite knowledge of what is being done at present and an appreciation of the great world scope that invention is assuming. There is no evidence of a waning of inventive genius, while greater stores of knowledge, better-trained hands, and both these in vastly greater numbers, are being brought to bear in the field of invention.

The number of patents applied for and the number granted at the patent office last year were greater than at any time in its history. With the increased number there is no decrease in the individual importance, but merely an evidence of increased industrial activity that demands the articles patented.

There are periods of activity and depression along certain lines of industrial art. Some years ago we had ten men at work on bicycles alone, while now one man devotes but half his time to them. Eight men formerly worked on reapers, while they are so nearly perfected that but three are so engaged.

This does not mean, however, that any line of machinery is ever made so perfect that no further inventions will follow, for there are as many patents issued today for the improvement of plows as at any time in the history of the world, and the plow in the form of a forked stick was among the first tools invented. There are, however, certain lines of great activity at present and in the near future.

Electricity offers an unlimited field, and the number of patents bearing upon it is without end, while the flying machine is but beginning to show its possibilities. Wireless telegraph and telephone are just being heard from, while at any time a great basic principle, like that of the Bell telephone, may be discovered that will open up new vistas.

The inventor of today is a different man from the long-haired, erratic genius of a generation ago. He is in nearly all cases an inventor by profession, trained in the best technical schools and devoting his life to the creation of new things. He is, above all, a practical man of affairs.

The people of the United States have gained more than any other nation from their inventions. These have enabled them to enter the markets of the world and force out competition in many grades of machinery. The patent laws of this country have been a greater protection to the inventor than have those of any of the other nations and are being widely adopted.

Treaties for the protection of patents are being universally adopted. Such treaties are now being arranged by the state department with China and all the nations of South America. Japan is but just finding that her people have the same inventive mind that is shown in America.

The awakening of new minds and new nations is going to bring on renewed activity and competition, and matters will go forward at a still greater rate. World's fairs have done much to make this activity world-wide, and the promise is that our children will live in a world that we would not recognize.—*Chicago Journal.*

Concrete in Freezing Weather

In the construction of dams for Huronian Company's power development in Canada, a large part of the concrete work in dams, and also in power-house foundations, was done in winter, with the temperature varying from a few degrees of frost to 15 degrees below zero, and on several occasions much lower. No difficulty was found in securing good concrete work, the only precaution taken being to heat the mixing water by turning a ¾ in. steam pipe into the water barrel supplying the mixer, and, during the process of mixing, to use a jet of live steam in the mixer, keeping the cylinder closed by wooden coverings during the process of mixing. No attempt was made to heat sand or stone. In all the winter work care was taken to use only cement which would attain its initial set in not more than 65 minutes.—*Engineering Contracting.*

THE TESLA STEAM TURBINE

The Rotary Heat Motor Reduced to its Simplest Terms

FELIX J. KOCH

Nikola Tesla, whose reputation must, naturally, stand upon the contributions he made in electrical engineering when the art was yet in its comparative infancy, is by training and choice a mechanical engineer, with a strong leaning to that branch of it which is covered by the term "steam engineering." For several years he has devoted much of his time to improvements in thermo-dynamic conversion, and the result of his theories and practical experiments is to be found in an entirely new form of prime movers shown in operation at some plants in New York.

The basic principle which determined Tesla's investigations was the well-known fact that when a fluid (steam, gas or water) is used as a vehicle of energy, the highest possible economy can be obtained only when the changes in velocity and directions of the movement of the fluid are made as gradual and easy as possible. In the present forms of turbines in which the energy is transmitted by pressure, re-action or impact, as in the De Laval, Parsons, and Curtiss types, more or less sudden changes, both of speed and direction, are involved, with consequent shocks, vibrations and destructive eddies. Furthermore, the introduction of pistons, blades, buskets, and intercepting devices of this general class, into the path of the fluid involves much delicate and difficult mechanical construction which adds greatly to the cost both of production and maintenance.

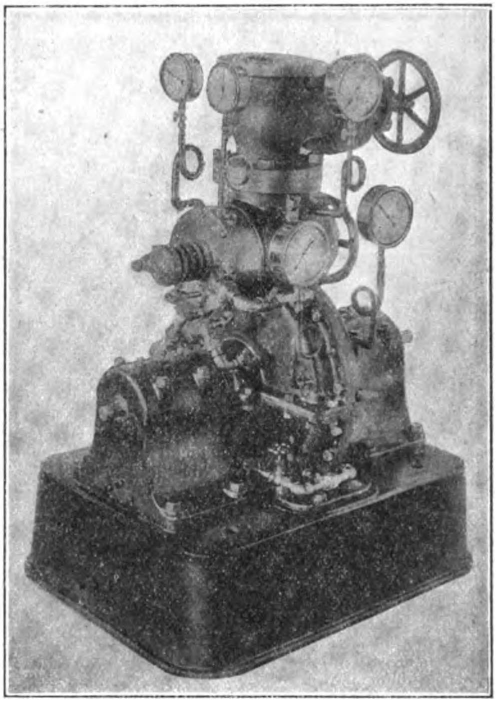


Fig. 1

A 200 h.p. High-Pressure Turbine

This view shows one complete high-pressure unit with the steam throttle above and below it. Note the compactness of the turbine and the many gauges used during the tests.

The theoretically perfect turbine would be one in which the fluid was so controlled from the inlet to the exhaust that its energy was delivered to the driving shaft with the least possible losses due to the mechanical means employed. The mechanically perfect turbine would be one which combined simplicity and cheapness of construction, durability, ease and rapidity of repairs, and a small ratio of weight and space occupied to the power delivered on the shaft. Mr. Tesla maintains that in the turbine which forms the subject of this article, he has carried the steam and gas motor a long step forward toward the maximum attainable efficiency, both theoretical and mechanical. That these claims are well founded is shown by the fact that in the plant where Mr. Tesla carried out his experiments, he is securing an output of 200 h.p. from a single-stage steam turbine with atmospheric exhaust, weighing less than 2 lbs. per h.p., which is contained within a space measuring 2 x 3 ft., by 2 ft. in height, and which accomplishes these results with a thermal fall of only 130 B.t.u., that is, about one third of the total drop available. Furthermore, considered from the mechanical standpoint, the turbine is astonishingly simple and economical in construction, and by the very nature of its construction should prove to possess such durability and freedom from wear and breakdown as to place it, in these respects, far in advance of any type of steam or gas motor of the present day.

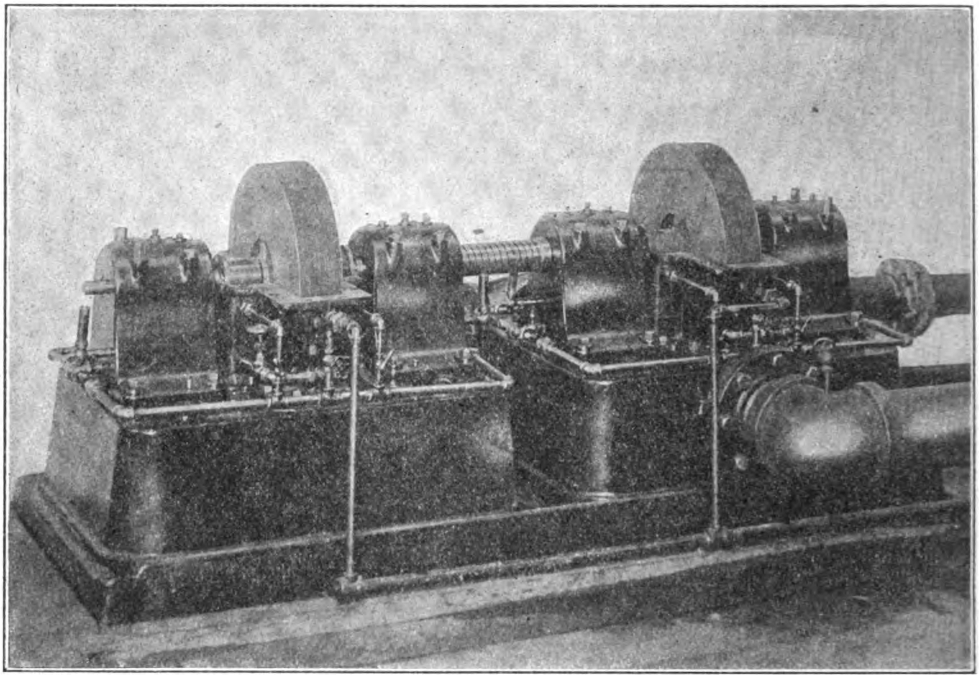


Fig. 2

The Tesla Testing Plant at the Edison Waterside Station

The top half of the casings is removed, showing the two rotors. Each rotor consists of 25 discs, 1/32 in. thick, by 18 in. in diameter. The steam enters at the periphery and flows in spiral paths to the exhaust at the center of the discs. The driving turbine is to the left, the brake turbine to the right, and between them is a torsion spring. The steam inlets are on opposite sides of the two rotors; the driving rotor moving clockwise. The torsion of the spring is automatically shown by beams of light and mirrors, and the horse-power is read off a scale. At 9,000 revolutions per minute, with 125 lbs. at the throttle and free exhaust, this turbine develops 200 h.p. It weighs 2 lbs. per horse-power.

Briefly stated, Tesla's steam motor consists of a set of flat steel discs mounted on a shaft and rotating within a casing, the steam entering with high velocity at the periphery of the discs, flowing between them in free spiral paths and finally escaping through exhaust ports at their center. Instead of developing the energy of the steam by pressure, reaction, or impact on a series of blades or vanes, Tesla depends upon the fluid properties of adhesion and viscosity—the attraction of the steam to the faces of the discs and the resistance of its particles to molecular separation combining in transmitting the velocity energy of the motive fluid to the plates and the shaft.

By reference to the accompanying photographs, it will be seen that the turbine has a rotor, which in the present case consists of 25 flat steel discs, 1/32 in. in thickness, of hardened and carefully tempered steel. The rotor as assembled is 3½ in. wide on the face, by 18 in. in diameter, and when the turbine is running at its maximum working velocity, the material is never under a tensile stress exceeding 50,000 lbs. per square inch. The rotor is mounted in a casing which is provided with two inlet nozzles, for use in running direct and for reversing. Openings are cut out at the central portion of the discs, and these communicate directly with exhaust ports formed in the side of the casing.

In operation, the steam or gas, as the case may be, is directed on the periphery of the discs through the nozzle (which may be diverging, straight or converging) where more or less of its expansive energy is converted into velocity energy. When the machine is at rest the radial and tangential forces due to the pressure and velocity of the steam cause it to travel in a rather short curved path toward the central exhaust opening, as indicated by the full black line in the accompanying diagram; but, as the discs commence to rotate and their speed increases, the steam travels in spiral paths, the length of which increases until in the case of the present turbine, the particles of the fluid complete a number of turns around the shaft before reaching the exhaust, covering in the meantime a lineal path some 12 to 16 ft. in length. During its progress from inlet to exhaust, the velocity and pressure of the steam are reduced until it leaves the exhaust at 1 or 2 lbs. gauge pressure.

The resistance to the passage of the steam or gas between adjoining plates is approximately proportionate to the square of the relative speed, which is at maximum toward the center of the discs and is equal to the tangential velocity of the steam. Hence the resistance to radial escape is very great, being furthermore enhanced by the centrifugal force acting outwardly. One of the most desirable elements in a perfected turbine is that of reversibility, and we are all familiar with the many and frequently cumbersome means which have been employed to secure this end. It will be seen that this turbine is admirably adapted for reversing, since its effect can be secured by merely closing the right-hand valve and opening that on the left.

It is evident that the principles of this turbine are equally applicable, by slight modifications of design, for its use as a pump.

In conclusion it should be noted that although the experimental plant develops 200 h.p. with 125 lbs. at the supply pipe, and free exhaust, it could show an output of 300 h.p. with the full pressure of the Edison supply circuit. Furthermore, Mr. Tesla states that if it were compounded and the exhaust were led to a low pressure unit, carrying about three times the number of discs contained in the high pressure element, with connection to a condenser affording 28½ to 29 in. of vacuum, the results obtained in the present high-pressure machine indicate that the compound unit would give an output of 600 h.p. without great increase of dimensions. This estimate is very conservative.

The testing plant consists of two identical turbines connected by a carefully calibrated torsion spring, the machine to the left being the driving element, the other the brake. In the brake element the steam is delivered to the blades in a direction opposite to that of the rotation of the discs. Fastened to the shaft of the brake turbine is a hollow pulley provided with two diametrically opposite narrow slots and an incandescent lamp placed inside close to the rim. As the pulley rotates two flashes of light pass out of the same, and by means of reflecting mirrors and lenses they are carried around the plant and fall upon two rotating glass mirrors placed back to back on the shaft of the driving turbine so that the center line of the silver coatings coincides with the axis of the shaft. The mirrors are so set that when there is no torsion on the spring, the light beams produce a luminous spot stationary at the zero of the scale. But as soon as load is put on, the beam is deflected through an angle which indicates directly the torsion. The scale and spring are so proportioned and adjusted that the horse-power can be read directly from the deflections noted. The indications of this device are very accurate and have shown that when the turbine is running at 9,000 revolutions under an inlet pressure of 125 lbs. to the square inch, and with free exhaust, 200 brake h.p. are developed. The consumption under these conditions of maximum of output is 38 lbs. of saturated steam per h.p. per hour—a very high efficiency when we consider that the heat-drop, measured by thermometers, is only 130 B.t.u., and that the energy transformation is effected in one stage. Since three times the number of heat units are available in a modern plant with superheat and high vacuum, the above means a consumption of less than 12 lbs. per h.p. hour in such turbines adapted to take up the full drop. Under certain conditions, however, very high thermal efficiencies have been obtained, which demonstrate that in large machines based on this principle, in which a very small slip can be secured, the steam consumption will be much lower and should, Mr. Tesla states, approximate the theoretical minimum, thus resulting in a nearly frictionless turbine transmitting almost the entire expansive energy of the steam to the shaft.

THE MAKING OF DINNER GONGS

GEO. F. RHEAD

The art of making ornamental objects in iron-work, so long as it is kept within certain limits, is one that should forcibly appeal to the ambitious home-worker, but in suggesting its addition to the number of home-crafts, we do not at all mean to imply a resetting of our old friend, "The Village Blacksmith," and wield the hammer, and attempt to forge, without a properly constituted workshop.

There are, however, some simple forms of metal work that require no especial outfit—no forge is required, and while the productions may be correctly termed wrought iron, they do not come under the category of the heavy work of the blacksmith.

To turn out useful objects for the home in metal-work, the amateur craftsman requires only a knowledge of soldering, riveting, and simple repoussé. If the worker is familiar with these three processes, and possesses the necessary tools to accomplish them, there are a large number of articles of the home, both useful and artistic, which he will find infinite pleasure in making. He will probably be happier in the construction of objects of utility in the home, than merely be "decorating." Fretwork, poker-work, chip-carving, etc., are all excellent pastimes, but structural wood and metal craft is work of a higher order.

In this enlightened age, we are all of us fond of good ornament, as it adds interest to construction, but the construction of an article for the mere sake of displaying some hand-work upon it is a plan not to be recommended. The utilitarian principle should be the first consideration—it is no use whatever ornamenting anything, and by doing so, lessening its practical value. Very often this is done, but with what a sad result—we have a door handle that one cannot properly grasp, because of its awkward shape, over-projecting surfaces that come constantly in one's way, and a host of devices such as wall pockets, racks, etc., that serve little real purpose than exhibit some handwork upon them. It is therefore always well that the repoussé worker can make simple objects in wrought metal, so that he may execute his work throughout. A fret-worker, or carver, has to have a knowledge of structural woodwork, so that he may employ his talent to the enrichment of objects of use.

Among the articles of the home of considerable utility comes the dinner-gong, which may be made to form a very attractive ornament, while being useful in no small degree. Those shown by our illustrations, Figs. 1 and 2, are examples where the utilitarian principle has been observed, no excrescences having been introduced in the design, the various

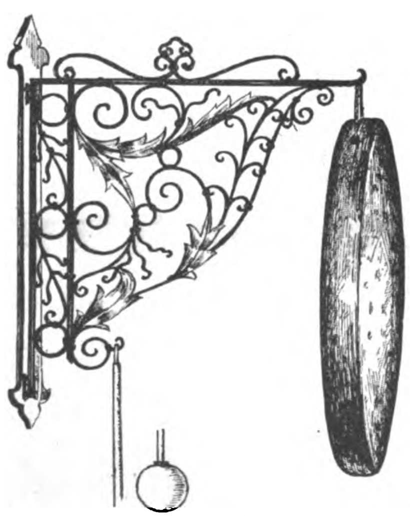


Fig. 1

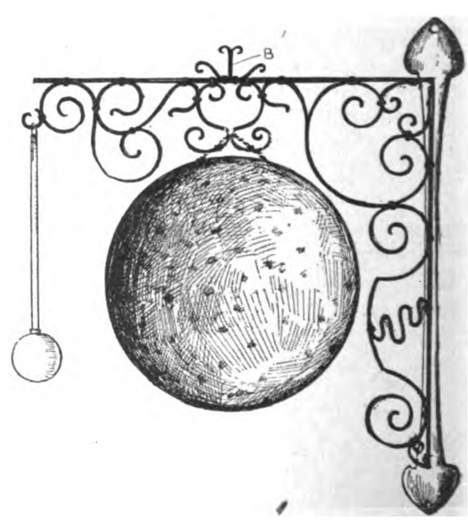
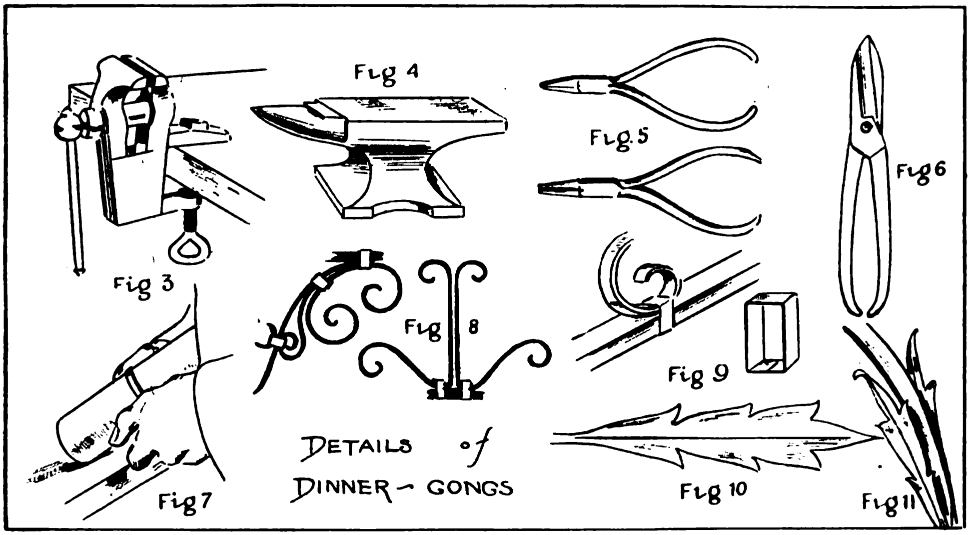


Fig. 2



parts merely holding the article together, and making a complete and serviceable article. The making is so straightforward and simple that the veriest amateur may fetch out his tool-box without the least fear, for success in the act of forming curves in thin strip-iron comes easily after a little practice.

The designs illustrated are made up of thin strips of iron, copper or brass, ¼ to ½ in. in width. In the case of design, Fig. 1, the scroll work is further enriched by a few polished pieces cut out of thin brass or copper, preferably soldered in position. The angle-pieces of both articles should be of thicker metal than the rest—about ½ in. x ⅛ in., while the back may be a flat piece of wood, polished, or a piece of beaten copper.

Let us now turn to practical considerations, and see what is necessary as stock-in-trade for anyone wishing to carry out such simple designs as these.

First of all, one should work it on a good solid table, with a deal top, such as a kitchen table, standing firm and steady on its legs. A vise screwed to the edge at one corner of this would be found useful, as would also a small anvil, Figs. 3 and 4; but these are not altogether indispensable. What are absolutely necessary are two pairs of pliers, one flat-nosed and the other round, Fig. 5; a pair of cutting shears will also be requisite for cutting the strips into the required lengths, Fig. 6.

SETTING OUT THE PATTERN

The design is first of all drawn the full size of execution, either upon a piece of board direct, or upon cartridge paper pasted down upon the working table. In this sketch, all the curves have to be accurately produced, and all portions that touch clearly indicated, or difficulties will crop up later which will not be easy to remedy. A piece of string is then carefully and accurately laid over any given line in this drawing, and indicates the length of iron strip necessary for that portion. It is a convenient method to cut off all the pieces at one time, keeping them labelled with letters showing their place on the design. The strips are then bent up, guided by the preliminary drawing; the angle piece first, which is of the thicker metal, followed by the longest curves, these latter being most truly formed by bending over a piece of a wooden roller for a start, Fig. 7. A number of these, of various sizes, will be found useful. All the small curves are bent up by means of the pliers alone, guided by the working drawing. Fig. 7 shows two details, marked *A* and *B* in the sketches, Figs. 1 and 2, and illustrates the method of fixing the sections with collars, all the joints being made by means of these collars (one being shown separately in Fig. 9) and the ends forced together to form a secure hold, by means of the closing pliers.

It is well to fix the different portions of the work together at first only temporarily, by means of wire twisted round the strips, at or near the places where the future ties or clamps are to go. This allows modification and alteration as the work proceeds.

Fig. 9 shows the pattern for a leaf cut from thin sheet brass or copper, ten of these being required, two being inserted opposite one another on each side of the bracket. They are neatly soldered on, and the ends bent to produce a varied effect, Fig. 10. In the case of Fig. 2, the design consists of scroll work alone, but a few foliated ornaments might be included if desired.

Ordinary 12 in. Burnese gongs may be very often picked up very cheaply indeed, from second-hand stores, and bought new they entail very little more expense. They are made of a specially-tempered metal that sound better than those made from copper. The gong-stick, the end of which is of wood, is muffled with leather, and hung from any convenient portion of the bracket.

On the completion of the work, if it is of wrought iron, it requires a finishing coat of black, not too dull or too shiny. Berlin black, which dries with an artistic egg-shell gloss, being perhaps the best substance for the purpose. If any of our readers have acquired the art of gilding, we can also strongly advise this method of finishing off their work. It is effectual as a preservation against rust, and is, in reality, a method largely adopted by many of our best metal workers.

RULES FOR THE CHAUFFEUR

An English motorist has compiled the following rules for his own driver for town driving, says *Automobile Topics:*

If there is a doubt whether you can "get through," don't try. Remember, if any accident occurs it is a discredit, and a bad job for someone.

Don't go too quickly near the pavement, in case a deaf person, or one engaged in other thoughts, steps off into your track. When passing a tram, face on, toot loudly, to provide for a person walking across from behind the tram, who might be bewildered by the confusion. Go too slowly rather than too quickly. If you make an error, make it on the safe side.

Always remember that any useless revolutions of the engine—that is, when the engine is running light, are so many moments less life to its existence. It is an unnecessary cost of petrol, lubricating oil, and wear and tear—a noise, a discomfort, and an irritation to people and mechanism.

A revolution saved is a revolution gained. There is an economic, a durable, and a pleasant speed to an engine, just the same as there is to a living person; a speed at which a person can walk and run without destroying the tissues or over-exerting the muscles of the system, so with the piston of an engine.

And an engine working the car, and running light, is under two distinct differences. Working, the car has the fly-wheel power of the car; it is "backed" by a ton in motion with itself, and it is thus held "steady." Running light, it has no staying power; it has no one-ton fly-wheel. Therefore, before declutching, throttle down your engine. Before starting your engine, throttle down. Before starting your car, throttle down to the extent that the engine will easily "take hold."

Never draw up with your brake if you can do so without; it is a penny wasted on tires every time you do so. Withdraw your clutch in anticipation of the place to stop at, and just bring the "stand still" with the brake. It is an act of bad driving to rush up to a stopping place and then apply the brakes—

Because it scares the people about, and the people inside may think perhaps the brakes won't act; because it savors of a wish to draw attention and give an impression of ability, which is not becoming; because it costs as much in tires to stop by brake power as it does to start with the same quickness. In the case of starting or quick acceleration, the engine is the motive power. In the case of slowing down suddenly by fierce brake power, the momentum (of, say, 1½ tons) is the motive power, and the brakes are the retarding power. In both cases the tires in contact with the road surface have to communicate the power, and they depreciate accordingly—

Because the power of retarding is transmitted through the gears and reduces the life of the mechanical parts.

NEW AND SECOND-HAND MACHINERY

H. W. H. STILLWELL

There seems to be a universal second-hand craze in this country, and it is on the increase There is no particular risk in purchasing second-hand machinery tools and shop equipment if ordinary caution is used by the purchaser, but, experience should be hand in hand with the caution, as paint and putty sometimes cover a multitude of mechanical sins. Perhaps there is no class of articles which are doctored up as much or made as pleasing to the eye as second-hand machinery and the unwary, inexperienced purchaser is easily drawn into the trap and repents in sack cloth and ashes for a long time thereafter.

In purchasing material of this sort, if the dealer is a man of known integrity and enough of a mechanic to know the actual value of the material which he is handling, there is little risk in buying from him. It is seldom that the honest dealer and the practical mechanic are combined. Machine sales, which are common in many districts, should be avoided, unless the purchaser, or he who desires to purchase, be a very good judge of machinery. I would not have the readers believe from what I have just stated that all machinery sales are fakes, or that the goods offered in these sales are all junk, as such is far from the case. There are many times when exceptional bargains can be secured where some shop for any good reason is about to be sold out at bankrupt sale, or for other good causes. There is much material disposed of in this manner, which is as good and often better than some new machinery would be, but, as before said, there is a great risk unless you know your ground.

There are many small concerns which have a very limited amount of capital and must count every cent expended; to these, good second-hand equipment is a great boon. There are also many amateurs who own a small workshop and have a second-hand lathe or other tool which may or may not be all they hoped it to be when purchased. It is to the inexperienced class that this warning is dedicated.

The writer knows of several concerns operating plants of considerable size who make a practice of using their machinery until it is only fit for junk and the scrap heap, and then patching, painting and puttying it up until it looks like new to the inexperienced and selling it for a good price. These concerns have an excellent up-to-date shop equipment and are better able to keep it in this condition by imposing their cast-offs upon the guileless public. Experienced mechanics when in the market for machinery never consider anything which is known to have come from these concerns.

One shop known to the writer is second-hand from the foundation to the roof, even the bricks in the walls are mostly second-hand, I have been informed, and the machinery equipment is entirely second-hand. The machine shop equipment is a varied assortment, a sort of patchwork of all makes of machinery, and few, indeed, are those which are worth the space they occupy. The management of this shop consider themselves very keen and economical in their operations, but as none of them are mechanics enough to grind a cold chisel, this is not to be wondered at. A few years ago the business made it necessary to increase the size of a department devoted to drop-forging, and another drop hammer was required. One of the heads of the company took it upon himself, he being a country storekeeper before he invested in the manufacturing line, to visit a well-known eastern firm which had been advertising second-hand machinery. This man was advised to send one of his best men to look the goods over, but he poo-pooed the idea, and said that he knew what he was at. The purchase was made and the drop hammer, in due time, was run in on the railroad siding, and, after much trouble, was taken from the car. The base of the hammer weighed six tons without the columns and head. When the hammer was placed in position in the forge room, it was found that the columns were not parallel, and that they were wider at the bottom than at the top; it was impossible to line up any drop dies for anything like accurate work, so the head was taken off and the columns removed to the machine room, where they were placed on the planer and the job given to an old man who was better at giving the directions than performing the work. Many weeks were consumed in planing the columns and several other parts; then it was found necessary to make a new shoe in the base as the old one was cracked. When all this was completed, new boxes had to be made for the head, and when the columns were set in place, the slots in their base, by which they were secured to the hammer base, were not long enough to close the columns in on the hammer. These slots were therefore made longer and the columns again set in place; all seemed to be fairly good until the hammer was started, when it was found that the workman who had planed the columns had not set them properly, and that they were too wide at the top and too narrow at the bottom; just the reverse of the original trouble. A drop hammer should be a little more free at the top of the stroke, and should fit the ways fairly snug at the bottom; but in this case, the hammer would stick and stop when about 12 in. from the die when the columns were bolted tight. The time taken to get things in this condition was something like six weeks from the time the machine was received. If this time be figured at the average rate of wages for the time of the men employed in connection with these various repairs, and the cost of the materials figured, and the result added to the original cost of the machine, it is soon discovered that the company would have been money in pocket if they had purchased a new hammer, or allowed one of their best mechanics do the purchasing. There is an old saying that "a burned baby keeps away from the fire," but the baby in question has done many things as bad as this since the above took place, and is constantly burning his and the company's fingers and their pocket-books as well.

A short time ago, a small manufacturer wanted an additional boiler for his shop, and, visiting one of these dealers with a questionable reputation, he selected one which had been coal-tarred inside and out, and looked as good as new. He complimented himself upon getting such a good boiler and so "dirt cheap." When it was placed upon its mountings, and the pressure run up to about 60 lbs., it leaked like a sieve. He had it closed down and the seams calked and poured in a lot of rye flour. A soup formed inside, a combination of coal tar and rye flour, and this soon found its way into the cylinders of the engines; and after weeks of this sort of thing, he ordered it all blown out, and hired a good man who was well experienced to look it over. The result was a great amount of patching and repairing; and the cost of those repairs, added to the original cost, would have purchased a good boiler, and he would have been saved the vexatious outlay of money and patience. At small cost this man could have hired a practical man to have accompanied him to make the purchase and thereby saved no end of annoyance.

There is one great advantage in purchasing new machinery or anything else, if the article is good and made by well-known manufacturers, there is a reasonable guarantee accompanying the article, and if for any reason it should not prove satisfactory, due to poor workmanship or defective materials, the makers will replace parts or the whole free of charge.

There is another point too little taken into consideration, and that is the proper handling of new or even good second-hand machinery. There are good and bad mechanics everywhere, and every shop has a good supply of the latter, if not the former, and even if the company starts out with a good equipment and employs many of these unskilled or careless men, it is only a question of time before the machinery, which should, with proper care, have given many years of good and efficient service, will be reduced to a lot of scrap.

An article devoted to the slip-shod methods as employed by some of the self-termed mechanics would be mighty interesting, but a good-sized book would be required, and possibly the good effects would be very slight. It is to be hoped that if any of the readers are about to purchase anything in the line of second-hand shop appliances, that they will profit by this article and save themselves no end of trouble and annoyance, to say nothing of the money.

Don't envy the man who is riding around in an auto until you know how big his mortgage is.

METAL DRILLING. Part I

Drill-Making, Tempering and Using

M. COLE

There are two principal classes of metal drills: the Cylindrical and the Spear-Headed. In the cylindrical drill the body of the drill is the full size of the hole to be bored, the body acting as a guide to keep the point of the drill in its right place, so that a hole bored by a cylindrical drill is quite straight. In the older forms two flats or grooves were cut in the body of the drill to allow the drillings to escape. The twist drill is another form of this, and has two spiral grooves instead of the straight ones, these bringing the drillings to the surface. The twist drill is certainly the best shape for getting through the work well and quickly, but it has its drawbacks, as it cannot be ground except by special appliances, and any attempt to do so by hand spoils the drill. Another difficulty is that unless run very true it jams, and if small, breaks. To these drawbacks must be added a much higher price, so that unless used in a good lathe or true running drilling machine, the other styles are preferable.

SPEAR-HEADED DRILLS

This is the ordinary shape of metal drills, and until comparatively recent years the only one. The body of shank, of such size that it fits the chuck or drilling machine, is narrowed down to form a neck, then widened and flattened to a head, all that part that goes into the deepest hole to be drilled being smaller than the width of the point. Good well-made drills are so cheap that it is hardly worth while to make them, though so much is to be learned by making a drill that the time is well spent.

Selecting the Material.—Drills, like other cutting tools, should be made from the best tool steel, and it is not dear, but it often happens that a drill is wanted, and no tool steel is to be had. It should be remembered that any metal, if properly shaped, will cut any other piece of metal not harder than itself. Old files or other tools of good quality steel may be used for drills. In most of the manufacturing districts old mill spindles can be bought very cheaply. They vary from 6 to 24 in. long, and proportionate thickness, are perfectly straight, so that if the end is worked into a spear head and a length cut off, a drill can be very quickly made; but they are a very mild steel and should not be used if the proper stuff is to be had. Steel varies in the amount of carbon it contains, some being as low as ½ percent, others up to 1½ or more, and the quality suitable for a razor would not do for a drill.

Shaping the Drill.— The spear-head drill is of three parts: the head, or cutting part; the body, or shank, being the part held in the chuck or socket of the drilling machine; and the tapered neck connecting the two others. The head, the most important part, as it does the work is usually 90 degrees angle, and should be tapered at the point according to the size of drill; ⅛ in. for 1 in. The neck is the part just above the head and is smaller than the hole the drill will bore. If the neck, as far as it penetrates, were the size of the hole, the drill would be cylindrical. The body or shank is the part that fits the chuck or socket of the drilling machine by which motion is imparted to the drill, and may be either square, cylindrical or taper.

Square body is required only when the drill is used in a joiner's brace, a very convenient method when lathe or drilling machine is not handy; but a large hole should not be attempted, not larger than ⅝ in. brass, or ⅜ in. in iron. If required larger, the hole should be opened out with a reamer used in a brace.

CYLINDRICAL

This is the most useful form for the body of a drill when used with a self-centering chuck or in the socket of a drilling machine; but in the latter case a flat must be filed or ground on it so that it may be tightened with a set screw. This is the old style, and from its shape difficult to get a drill to run accurately. If the drill is an exact fit to the socket, the ordinary treatment and occasional knocks would soon make it difficult to insert, and if forced in, impossible to remove; for this reason a little play is allowed with the result that it is not concentric.

Taper.—The body, or that part of it that is inserted in the socket, is tapered, and the socket itself is bored of an equal taper. This gives the best of all fits, and is used in the best makes of twist drills.

HARDENING AND TEMPERING

Steel may be hammered more than iron, but with light quick blows, gradually with less force as it gets cooler, and not with much force after it has lost its redness. It must not be heated higher than a blood-red heat, and care must be taken that the fire is clean and free from sulphur fumes, coke being preferable to coal. A length of iron pipe may be used in the fire to keep the tool clean while heating. Steel is improved by hammering at the right heat, but spoiled if hammered at too low a heat. Frequent heating also spoils it. Sharp angles must be avoided, as that is where cracks usually start.

Tempering the Drill.—For some reason that has never been explained, when a piece of steel is heated to redness and quickly cooled, it is hardened, so much so that it will break like glass if dropped on a stone; but if the same piece of steel is then re-heated to a lower heat than before, and cooled, it is no longer so brittle, but more or less springy, being then tempered. If it were not for its brittleness, a drill that is dead hard would be the ideal one for cutting, as it would keep its edge. As it is, we are compelled to use a tempered drill, which, though less hard, is tough enough to stand working. Steel changes color with the degree of heat to which it is subjected, but it should be remembered that while the degree of temper denoted by a certain color is always the same for the same quality of steel (provided it has previously been equally hardened) the same color would show various degrees of temper for different qualities of steel. Again, color does not prove steel to be tempered. If a piece of soft steel be heated to straw color and quenched, it will not have the same temper as if it had previously been hardened. The color is caused by a thin film of oxide. (See Table A.)

Process of Tempering.—Heat the tool to blood-red when looked at in a dark corner, then dip in cold water, holding the drill perfectly straight, point downwards, keep there till cold; it will then be quite hard and brittle; now clean up one of the surfaces of the head with a flat stone, and reheat till it shows the desired color; at once dip in water and hold there till cold, keeping the tool perfectly straight; it is then ready for grinding. It is as well to rub the surface that is to show the color with a piece of stone while hot, to clean it.

Hardening and Tempering at one operation.—Grind a smooth place on the body of the drill, and another on the head, heat to red, and then dip the head and half of neck till the body shows light blue color, lift out of the water and hold till the heat of the body of drill spreads to the head and shows the right color, say, light straw, then quench the whole drill. Once in the water a tool must not be lifted out till cold. The steel is white when dead hard and cold. A good process of tempering much used is to heat the tool in a clear fire and while hot rub on some commorr yellow soap, then heat to cherry red, and quench off in some common petroleum. Keep away from the fumes. Everyone thinks his own method of tempering the best. Below are opinions of practical men on the best way to do it. They are all useful, though contradictory:

"Boil the water before using."

"Spray the water on the drill."

"Use water heated to 100 degrees F."

"Put a little oil on the surface."

"Put plenty of salt in the water."

"Use pure, clean water quite cold."

"Keep the drill perfectly still in the water."

"Move the drill gradually lower in the water till cold."

"Dip the head and hold 10 seconds before dipping the remainder."

Good work has been done by all the above methods, and they are all the best way, according to those who use them. When reheating a small drill for temper-

TABLE A

Compiled 100 years ago and still unsurpassed.

430° F.	Paint Yellow	Lancets
450° F.	Pale Yellow	Razors
470° F.	Full Yellow	Penknives
490° F.	Brown	Scissors, cold chisels
510° F.	Brown, with purple spots	Axes and planes
530° F.	Purple	Shears and table-knives
550° F.	Light blue	Swords and watch-springs
560° F.	Full blue	Small saws
600° F.	Dark blue	Hand saws

ing, use a block of iron, large in proportion to the size of the drill, heat to redness, then lay the drill on it, the head overhanging; the block will heat the drill. A very tough result is got by "blazing off," not so useful for drilling, but very useful where it is necessary to have a drill that will spring rather than break. After heating drill, dip in cold oil to harden it, then put the oily drill in the fire till it blazes up; allow to blaze till the right color is reached, then quench off. When tempering a spring allow to blaze till burned out, then dip in water. When large quantities of articles are to be tempered they are often done in an oil bath, which can be kept at the required temperature by a thermometer. Linseed oil boils at 600 degrees F., and mercurial thermometers can be had graduated to 600 degrees, which is much higher than is required for tempering.

Grinding is a very important part of drill making. The small cutting edge is the part that does the work, and the most elaborate lathe, chuck, drilling machine, etc., is only a means of moving the unseen and often forgotten cutting edge. The usual angle for a drill is 90 degrees. When required for cutting very hard metal or glass, the angle is smaller, while for thin metal a much larger angle is used, sometimes nearly straight. The object of grinding a drill is to give it a cutting edge, so that if one side is ground away more than the other, only one side will cut, and the drill will only be doing half its work; a little clearance must be given, but only enough to prevent any part except the cutting edge pressing on the work, so grind away only a little more than the depth the drill is intended to cut. A 100th of an inch is a good cut for drill of moderate size. If too much is ground away, the edge is weakened and breaks. When a drill is properly ground the drillings should come away in curls; in one badly ground or dull they are only scrapings. There is one part of the drill that does no work, viz.: the point. A great deal of the power put into the drill is used in forcing the point into the metal. This is even more marked in twist drills. Many devices have been tried to get over this difficulty. If a small leading hole, say 1/8 in. for drills up to 1/2 in., is first bored, the drill may be run at double the speed that could otherwise be used with it.

A grindstone is the safest to grind drills with, but it must be kept true, and not allowed to wear into irregular shapes, as many grindstones do. An emery wheel does the work much quicker and runs truer, but there is always the danger of burning the edge of the drill, unless it is kept flooded with water; merely wet is not enough to ensure safety. It is worth while to finish off with an oilstone, the superior edge being worth the extra trouble.

Testing the Drill.—To see if correctly ground, run the drill very slowly so as to drill into a bit of brass, and watch if both sides cut. If only one side cuts, the work will take twice as long to do and the drill be forced sideways; if small, the drill breaks; if large, the strain injures the chuck.

Drills ground by hand in the ordinary way are never accurate except by accident, so the greatest care should be used to get the error as small as possible.

Making Very Small Drills.—Drills can be obtained ready for use down to the smallest required by watch-makers. To make them it is best to use good steel wire; failing that, they may be made from needles—sewing-machine needles being the best, as they are well-shaped and only require a head making, the body being large enough to be held in a drill chuck. To soften: heat a large piece of iron to redness, lay the needle on it—it will soon reach the heat of the block—allow both to cool together, the larger the block the softer the needle will be. Now break or file off the point, and with one blow of a hammer spread the end to form a head. It will stand one knock, but repeated hammering will spoil it, file and dress to size, then to harden hold the drill with pliers, heat to redness in the flame of a tallow candle and instantly plunge the point in the tallow. It then only requires setting on an oil stone. Mercury may be used to quench the drill to get a very hard point.

MOST IMPORTANT.—If the head of a drill has been overheated, it should be cut off and a new head forged, as no good can be done with a burned drill.

(To be continued)

Thirst for Knowledge; knowledge is Power; power is Life, itself—the Sun-Center of your universe and never eclipsed.

HAND SCRAPING IN THE MACHINE SHOP

STUART K. HARLOW

Hand-scraping is that process of scraping a metallic surface, by the use of a hardened steel chisel, so as to obtain a smoother and more level surface than is otherwise possible in ordinary machine shop practice. It is an example of one of the many instances where hand-work far excels that performed by a machine.

The learner or apprentice first starts with a piece of cast iron that has been molded roughly to the dimensions of 3½ x 2 in. The sand from the mold that still clings to the bottom side in the deep hollows should be scraped out with the sharp tang end of a file. If the block is too thick, it should be tightly fixed in the shaper and planed down to within a 1-32 in. of the desired thickness, ¾ in. to ⅝ in.

The block is next fixed securely in a vise (fitted with copper jaws). Now proceed to bring first one side then the other to a smooth and level surface, as shown by test with a small steel square. When the sides and ends are filed square, turn the block and file the top surface till it is as nearly smooth and level as is possible to attain by hand filing. When the top is finished, the sides and ends only (not the top) should be brought to a high polish by the use of, first a coarse emery cloth, then the finest emery cloth, mounted on a stick for a handle.

The next operation is the most important, as it constitutes the first steps at hand-scraping. The smooth die-plate should be carefully covered with a very thin layer of red lead paint, rubbed on with the finger. The block is next laid face downwards upon the die-plate and is given a circular motion. When it is lifted from the die-plate, the face of the block is found to be marked by the red lead appearing only on the high spots of the metal. Now lock the block securely in the vise and proceed to apply the chisel scraper only on these high spots and in a series of short strokes, equal in length to the width of the scraping chisel. The scraper should be gripped firmly, with both hands, and held at the angle at which it cuts the best, and a great deal of pressure should be applied on the tool to make it take hold and cut. The first cut should be started at a 45-degree angle with the end. When the high spots have been gone over in this position, at this angle, it should be immediately reversed by stepping to the left-hand side of the vise and taking a cut directly across the others at an angle of 90 degrees. Now remove the block from the vise and mark the high spots again by rubbing it on the die-plate. When the face of the block is as nearly smooth as is practicable, it is shown by rubbing the block on the die-plate, when the whole surface is covered with red lead.

The final operation is to make a series of parallel cuts across the face (leaving a small space between each), parallel to the sides of the block. Then a second cut with the chisel is taken directly across the face from side to side and perpendicular to the other cut. A finishing cut is taken at an angle of 45 degrees in the remaining spaces, when the block is finished.

Encourage the Workers

Men need a word of encouragement now and then just as much as they need food. For as the food is to the body, so is encouragement to the mind and heart. A worker who is discouraged is not half a man. Fear of disfavor often holds back valuable information. Even the most liberal compensation cannot take the place of a word of appreciation and encouragement given in the right spirit at the right time. Men and women crave the assurance that their work is meeting with satisfaction. To withhold that assurance when it is due is not merely a poor business policy—it is an injustice. Part of the compensation of every worker is the satisfaction of knowing that he is accomplishing something, and to withhold that satisfaction is often more harmful than to hold back money duly earned. More and more must those in business recognize the human element in men and women, the part the heart plays in business. It is possible, of course, to say too much to a man, giving him an over-elated sense of his value, but the tendency seems rather in the other direction.

THE PLANIMETER

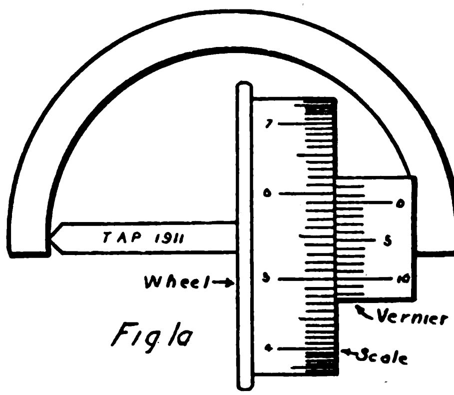
C. W. WEBBER AND T. C. FISHER

The object of this article is to describe the planimeter in its simplest form so that it may be understood by the general reader and by those who do not use the instrument but would like to know of its workings as a matter of general information.

The planimeter is an instrument by means of which the area of plane figures, no matter what their shape, can be measured easily and accurately. Its early history seems rather vague, it being thought that the first one appeared in Germany about the year 1814. The first one, however, of which we have record appeared in Paris in 1836.

There are four essential parts to the planimeter, namely: (1) polar arm; (2) tracer arm; (3) wheel; and (4) vernier. The relative positions of these parts are quite clearly shown in Fig. 1. The polar arm has a length of from 5 to 8 in., and a square cross section of about 3/16 in. on a side. At one end is a fixed needle-point with a weight directly above it. The material used in the construction of these parts is German silver, as that metal will not rust as iron or steel would under similar conditions of constant handling.

The tracer arm, like the polar arm, has a length of from 5 to 8 in. with the same cross section as before. To one end is fastened the tracer point, while near the other is the wheel. The tracer and polar arms are connected at their ends by means of a pivot. The wheel, another one of the essential parts, has a diameter of about 3/4 in. To it is attached a scale of less diameter which is divided into 100 equal parts. The wheel is mounted upon



steel bearings and is plated with nickel to prevent rust and injury due to use.

The vernier, which plays such an important part in the reading of the scale, is the invention of Pierre Vernier, from whom it takes its name. It is a device for reading easily and accurately a fraction of a scale division. The relative positions of the vernier, scale, and wheel are shown in Fig. 1a. Besides this use, the vernier is found on barometers, surveying instruments, and other appliances where accuracy of reading is required. In the case of the planimeter the vernier is mounted flush with the scale on the wheel, and is graduated into ten equal spaces for nine on the scale.

If we let

W = length of one wheel division

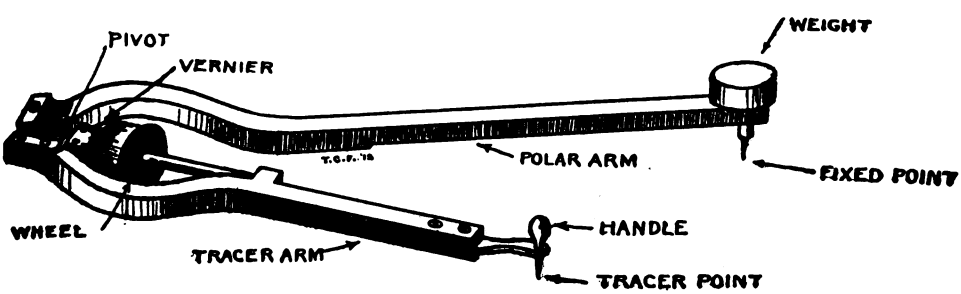
V = length of one vernier division

we have

$$10V = 9W$$
$$V = \frac{9}{10}W$$

that is, the length of one vernier division is 1/10 less than the length of a wheel division. In Fig. 2 let the zero of the

FIG. I



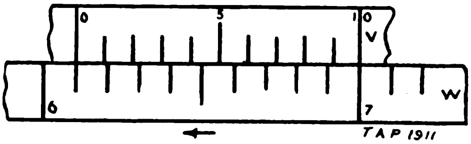


Fig. 2

vernier be the index. The reading as shown is 6.10; for the 0 of V coincides with 6.1. Let W slide by V in the direction of the arrow, and, since $V = {}^9\!/_{10}W$ when the first small division of V coincides with the second small division of W beyond 6, the zero of V will have moved 1/10 of a division of W. The reading would, therefore, be 6.1 plus 1/10 of .1, or 6.1 plus 0.01, which is equal to 6.11. To read the vernier, we look first for the index. In Fig. 3 it lies between 6.3 and 6.4. Looking along the vernier, we see that the fifth division coincides with a division on the wheel, meaning that the index has traveled 5/10 of the way between 6.3 and 6.4. Thus the reading is 6.35.

METHOD OF USE

Let the position be as shown in Fig. 4, it being desired to obtain the area of the figure. When the tracer is at the center of the area, a line from the fixed point a to the rim of the wheel makes a right angle with the tracer arm bc. Place the tracer point on the outline of the figure at point x, the intersection of the arc de with the outline. The radius of the arc is equal to ac. It is not necessary, however, to draw the arc, as x can be estimated nearly enough by eye. A slight indentation is made in the paper and a reading taken of the scale. Call this reading x. Now the outline is traced in a clockwise direction. The point should always be guided with the thumb and forefinger and the rest of the hand be steadied on the paper. When the indentation is again reached another reading is taken. Call this reading y. Then

$$y - x = \text{area of the figure.}$$

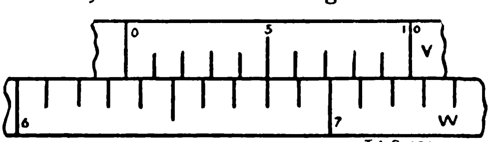


Fig. 3

To find the area of the figure given in Fig. 5, start at point b. From there go to point a by the straight line and then back to b by the curve; from there go to c by the straight line, and then back to b by the curve. The difference between the first and last reading will give the area.

The planimeter should be used on a flat surface covered with drawing paper of a uniform medium smooth surface. The paper should have no wrinkles, as the working of the instrument depends upon the constant friction between the surface and the wheel. The wheel should always remain on the surface of the paper and should never run up on the figure being measured.

The planimeter finds many uses, a few of which are: the measurement of hysteresis curves in electrical engineering; the measuring of the volume of earth works in civil engineering, and the measuring of steam engine indicator diagrams in mechanical engineering.

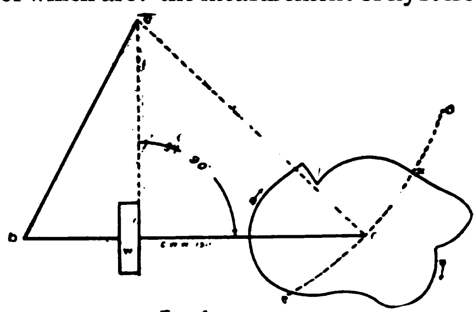


Fig. 4

Hysteresis is the tendency of a magnetic substance to persist in any magnetic state that it may have acquired. When a coil of wire is placed around a magnetic substance and a current is sent through the coil, the substance is magnetized. Some energy has, however, been expended in overcoming this persistence in the substance. This energy appears as heat. If observations are made and plotted, a diagram is obtained, the area of which represents the energy lost in heat. Fig. 7 shows such a hysteresis curve.

The methods of use as applied to civil engineering are too long to be taken up here. The horse-power of an engine can be measured by means of the indicator diagram. A recording mechanism is placed on the cylinder of the engine in such a manner that the steam pressure is recorded for every point of the stroke

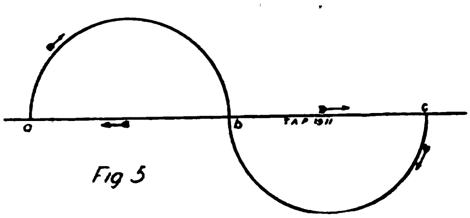


Fig 5

of the piston. This gives a diagram, as shown in Fig. 6. Let AB represent the length of stroke (drawn to some scale; in practice, this length is made about 3 in.), and let distances laid off on AF equal steam pressures. Thus, for a position C of the piston the pressure of steam for the forward stroke is represented by the point E, and the pressure for the return stroke by the point D.

Now, horse-power is given by the formula

$$\text{Horse-power} = \frac{PLAN}{33{,}000}$$

where

P = mean effective pressure
L = length of stroke (this is the actual length and not the length of the diagram)
A = area of the piston
N = number of revolutions per minute.

It is seen by the diagram that the pressure is different for every position of the piston. To get the mean we find the area of the figure by means of the planimeter and divide by the length of the base AB. The result is the average height of the diagram. The diagrams are automatically drawn to scale. One scale used is where 1 in. measured on AF represents 40 lbs. pressure. Thus, multiplying the average height obtained by 40, we have the mean effective pressure. From this we can substitute in the formula and solve for the horse-power.

THEORY

It may be of interest to some readers to know why the planimeter measures an area by tracing its outline, so for the benefit of those, the following graphical proof is given. This proof while not as satisfactory as a purely mathematical one, can be easily understood by the average reader.

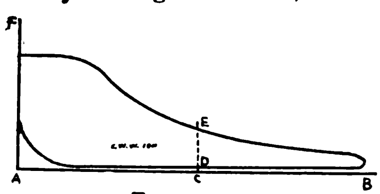


Fig. 6

In Fig. 8, let ab be the length of the tracer arm of a planimeter and let c represent the wheel. It is easily seen that if we move the arm along its own axis to b', the wheel will slip, but will not roll, thus not changing the reading. Now if we let ab be moved parallel to itself to the position $a'b'$, Fig. 9, it will be seen that the wheel will roll, but will not slip. Now, if we know the circumference of the wheel, the distance aa' equals this

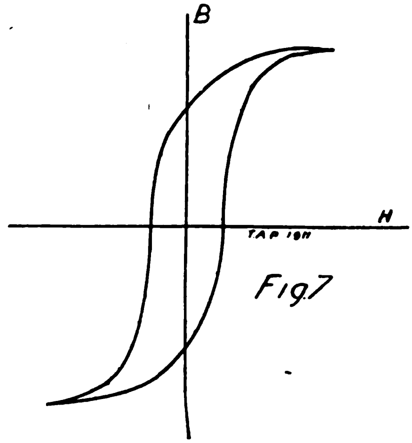


Fig. 7

circumference times the number of revolutions. Then by geometry the area of the figure $abb'a'$ equals ab times the circumference times the number of revolutions; or calling

K = circumference
n = number of revolutions
A = area

we have

$$A = ab \times K \times n$$

Now combining the two diagrams, Fig. 10, we have ab moved to $a'b'$, and then along its axis to $a''b''$. By geometry we know that area $abb''a''$ = area $abb'a'$ = $ab\,Kn$; therefore, area $abb''a'' = ab\,Kn$. If now we go through both motions at the same time, that is, moving directly from ab to $a''b''$ along the lines aa'' and bb'' the effect will be the same as before. Now passing to the next step, Fig. 11, in which aa'' and bb'' are curves, we have

$$A = ab\,Kn.$$

In the above we have considered the

Fig. 8

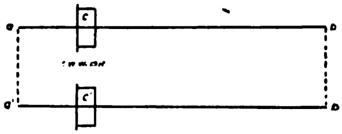


Fig 9.

tracer arm moving parallel to itself, which, of course, it does not do in practice, so let us now consider Fig. 12, in which *oa* is the polar arm and *ab* is the tracer arm. We now can move *ab* parallel to itself along the arc aa', which has its center at *o*; then area $abb'a'=ab\,Kn$. Now let a' be fixed and move b' to b'', causing the wheel to rotate. We will pass by this motion for a moment and come back to it later. Now in the same manner as before, $a'b''$ can be moved parallel to itself to position ab''', the area $a'b''b'''a$ being equal to $ab\,Kn'$: where n' is not equal to *n*.

To complete the movement, b''' is moved to *b*, causing the wheel to rotate in the reverse direction from that in covering the arc $b'b''$. By geometry, since $a'b'$ is equal and parallel to *ab*; and $a'b''$ is equal and parallel to ab'''; then angle 1 = angle 2 and arc $b'b''$ = arc bb'''; Thus the distance the wheel moves when the tracer goes from b' to b'' equals the distance the wheel moves when the tracer goes from b''' to *b*. But the wheel moves in opposite directions, therefore, one motion cancels the effect of the other, and the only motions which have any effect on the final reading of the wheel are those when the arm moves parallel to itself.

As the tracer travels from *b* to b' the wheel records a certain amount; call this *u*. Now if we so choose the circumference of the wheel that when a square

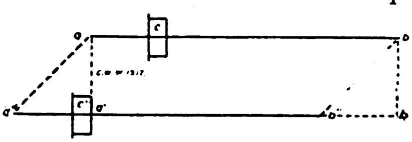


Fig. 10

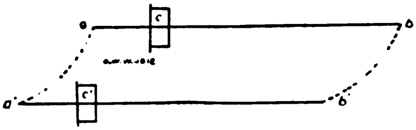


Fig 11.

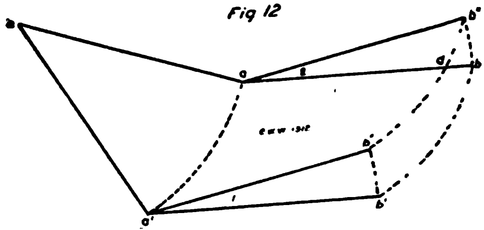
inch has been passed over the reading of the wheel will be 1, it is seen that *u* will be the area passed over. From b' to b'' another amount, call this *v*, will be recorded, but the wheel will now revolve in the opposite direction, so that the reading at *u* will be lessened by the amount *v*. Therefore, the reading at b'' equals $u-v$.

In going from b'' to b''' the wheel revolves in the same direction as from b' to b'', thus reducing *u* still more; call this amount *w*. Then reading at b''' will be $u-v-w$.

In going from b''' to *b* the wheel again changes direction of rotation, thus adding to *u*; call this amount *x*. Then the final reading will be $u-v-w+x$. But we have seen that $v=u$, therefore, the final reading will be $u-x-w+x=u-w$; where *u*, of course, equals $a'b'ba$ and *w* equals area $a'b''b'''a$.

In order to find the difference of these

Fig 12



two areas we proceed as follows: Imagine the area $abb'a'$ cut from cardboard. Cut out area $a'b'b''$ and transfer to position abb'''; this does not change the area of the entire figure, for it has been shown that area $a'b'b''=abb'''$. Thus far we have taken the area *u* subtracted from it the area *v* and added to it the area *x*. Our work thus far can be represented by $u-w+x$.

Now, if we cut away the figure $a'b''b'''a$, we have left the area $b'bb'''b''$, but area $a'b''b'''a=w$, so our work can be represented by $u-v-x+w$, but $v=x$, so the result is $u-v$.

In the movements we have subtracted area *x* from area *u* leaving erea $b'bb'''b''$. Therefore the reading of the wheel equals area $b'bb'''b''$, and we have found its area by tracing the outline with the tracer point.

Now let us carry this still farther and take the irregular area, Fig. 13. Consider it divided into a number of areas similar to area $b'bb'''b''$, Fig. 12. By

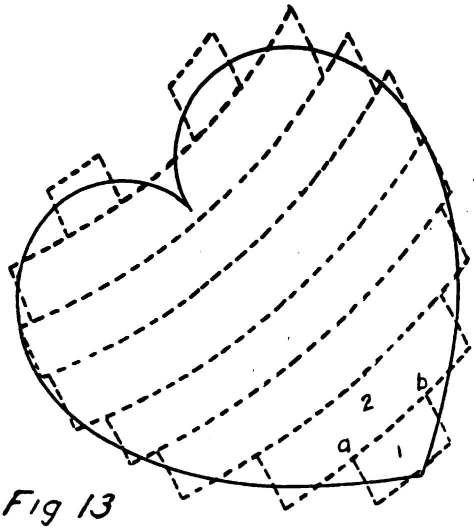


Fig 13

tracing the outline of the several figures we have their areas by the reading of the wheel. By measuring all of the areas and adding them together, it is seen that we have approximately the area of the irregular figure. Again, take the line *ab* common to areas 1 and 2. It is seen that in tracing area 1 the motion will be from *a* to *b*, but in tracing area 2 the motion will be from *b* to *a*, for the motion around a figure must always be in a clockwise direction, as given under "Method of Use" above. The wheel will, therefore, in going from *a* to *b* turn in the opposite direction from that in going from *b* to *a*, and the motions will cancel each other. The same is true for all other lines common to two areas. Therefore, if all common lines cancel each other the final area can be obtained by tracing around the outline of the figure which is made up of the separate areas.

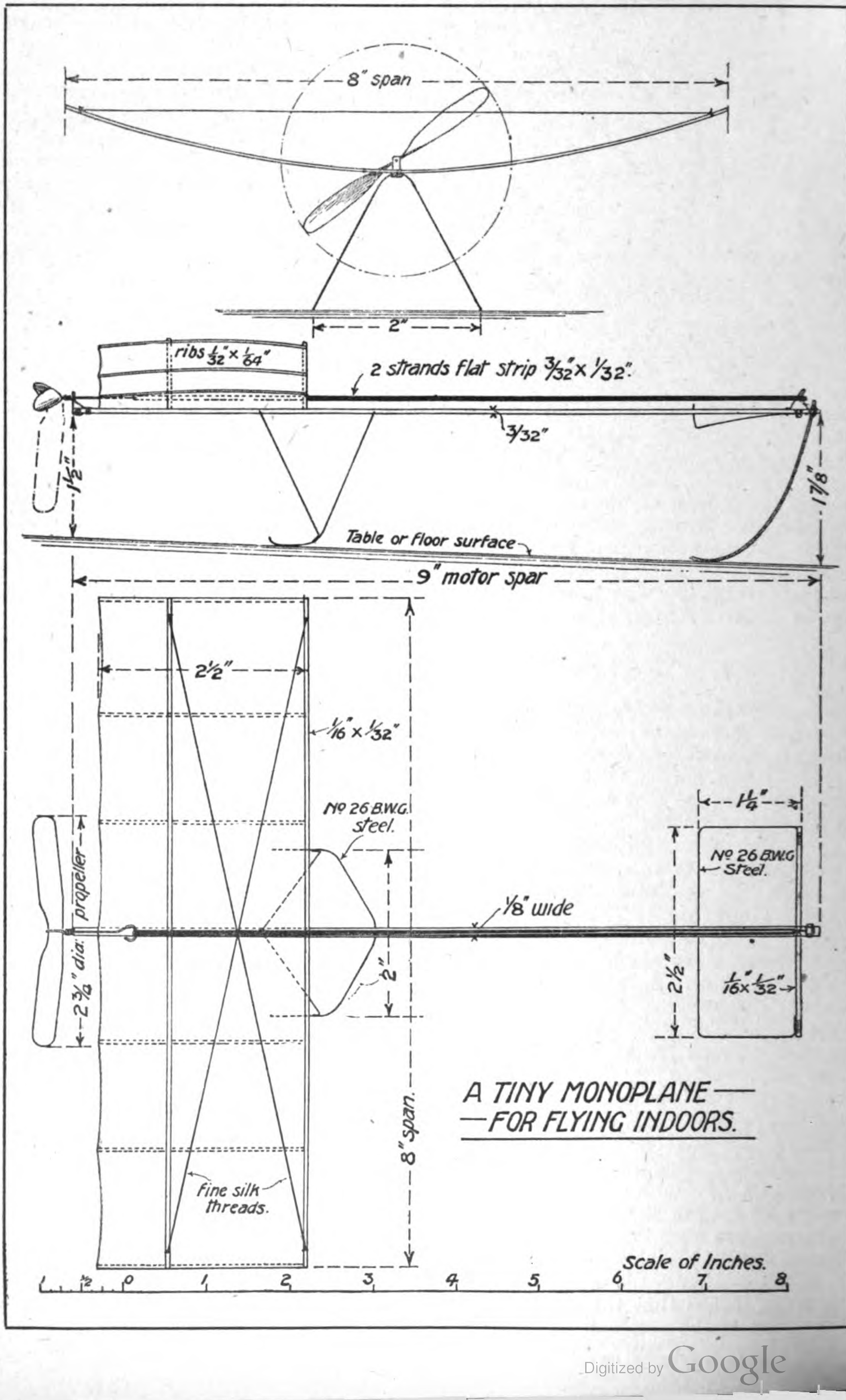
Now, it is seen that if we make these areas narrower, of course increasing their number, their combined area will come nearer to coincidence with the irregular area. Finally if we make them so narrow that they have no width their number will be infinite and their combined area will be the area of the figure. Thus it is seen that to find the area of any irregular figure we trace its outline and read the area from the wheel.

THE ORIGIN OF THE DIAMOND

The fascinating problem of the genesis of diamonds receives further attention, remarks *Knowledge*, from Dr. O. H. Derby (Journ. Geol., Oct.-Nov., 1911), who puts forward a new speculation as to the origin of the gem. As is well known, diamonds occur, at least in South Africa, in pipes of volcanic origin which are filled with a peculiar ultra-basis rock called "kimberlite." This rock is invariably much fragmented and altered, and contains numerous foreign inclusions (xenoliths), both of igneous and other origin. The weight of evidence is in favor of the diamonds being assigned to the eruptive rock proper, and not to the xenoliths included in it. Dr. Derby believes that a positive, and perhaps genetic, relation exists between the diamond and the fragmental condition of its matrix, basing his opinion on the experiments of Gardner Williams, who crushed 20 tons of the eclogite boulders or segregations from the Kimberley Mine without finding a single diamond.

The association of diamond with fragmentation means that the origin of the diamond is to be assigned to reactions between the rock constituents, made possible by the explosive and disintegrating action of the agency that formed the Kimberley pipes. Under this view the extensive hydration and carbonation of the Kimberley rock is due to deep-seated pneumatolytic action rather than to atmospheric weathering. Kimberlite from the deepest part of the De Beers Mine (2,040 ft.) still contains 6.81 per-cent of combined water, and it is improbable that this can be due at that depth to atmospheric weathering.

Dr. Derby presents a new hypothesis of the origin of the diamond on the assumption of the deep-seated origin of the alteration of the diamond matrix. He believes that the Kimberlite pipes were saturated with hot (possibly superheated) gases and liquids, and constituted huge crucibles in which carbon would be present at least in the form of carbon dioxide, and probably in other gaseous forms. Thus the material and some of the physical conditions for unusual carbon segregation would be present, and it is possible that, under these conditions, diamonds would be formed.



A TINY MONOPLANE—
—FOR FLYING INDOORS.

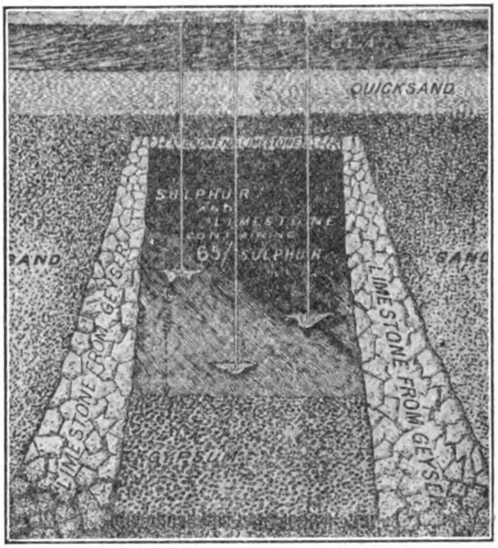
THE SULPHUR INDUSTRY IN THE UNITED STATES

CARLETON HAIGIS

For more than one hundred years prior to 1895 the world's production of sulphur came from Sicily, where it is mined from the craters of extinct volcanoes. It, however, occurs in many other countries in small amounts, either as native sulphur or in compounds such as iron pyrites and other sulphides. These compounds are, however, rarely mined, as a source of sulphur, since sulphur itself is found free in such large amounts that any extraction process would be prohibitive on account of the cost of reduction.

In the United States prior to 1868 the element was not known to exist in the free state, and its discovery happened in a rather peculiar way. It was about the time that the petroleum industry was becoming important; and in several places in Louisiana, a peculiar viscous liquid was noticed oozing from the ground. Wells were bored, but no oil was found; instead, at a depth of 1,000 ft., in nearly every case, sulphur was found. Investigation has proved this deposit to be located in the mouth of an extinct geyser, which became silent far back in the geological ages. In boring, the drill passes through 200 ft. of clay, 200 ft. of quicksand and also through a cone of limestone which proves beyond doubt that this immense geyser was covered by the alluvial deposits at the time of the glacial floods. An approximate section through the deposits is shown in the illustration.

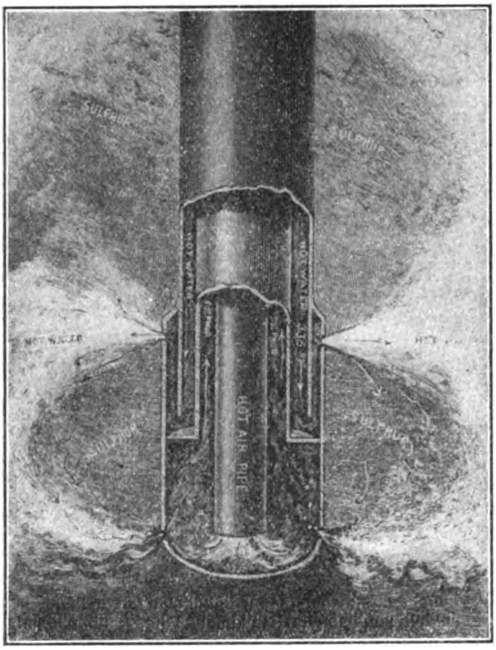
At the time of the discovery many methods were attempted in order to raise the sulphur to the surface, but none were successful. The ordinary method of sinking a shaft was out of the question as the sub-surface water of this region, which is nearly at sea level, could not be controlled. After many fruitless attempts the works were abandoned; and not until 1895, when a novel scheme was invented to bring the sulphur to the surface, were the mines reopened. The inventor proposed to send down a series of concentric pipes, 6, 3 and 1 in. respectively. The largest pipe is enlarged at the lower extremity to a diameter of about 10 in. Superheated water at a temperature of 335 degrees Fahrenheit is forced down in the annular space between the 6 and 3 in. pipes from a battery



An Approximate Section through the Sulphur Deposits

of boilers and allowed to flow through the perforations in the enlarged end. The water, because of its great heat and pressure, forces its way through the cracks and crevices of the sulphur-bearing limestone, causing the sulphur to melt out and drain down to the bottom of the well, where it enters another series of perforations communicating with the annular space between the 3 and 1 in. pipes. Since sulphur is twice as heavy as water, columns of the latter and sulphur will stand in equilibrium, the water column being twice the height of the sulphur. Therefore, when the top of the water column stands at the surface, the sulphur is elevated only one-half that distance. It is, of course, impossible to raise the melted liquid the remaining 500 ft. with pumps. This difficulty was overcome by forcing compressed air down in the 1 in. pipe. The sulphur is thus aerated until its weight becomes less than that of water, and it then rises to the surface through the central pipe kept above its melting point by the superheated water surrounding it. The diagram illustrates clearly the action of the sulphur at the bottom of the tube.

It will be seen that the amount obtained from one well depends on the area which can be melted by the water. This



Section through Bottom of Pipe

is usually not more than 50 or 100 ft. in diameter, and when one well is exhausted another is drilled and the process is again repeated. One well has been known to deliver as much as 400 tons per day, and another has actually given 60,000 tons of pure sulphur.

Such large amounts of pure sulphur have been excavated that the ground in the vicinity has sunk to an average depth of 30 ft., and many thousands of carloads of dirt have been used for refilling.

At the surface the sulphur is conducted into large vats constructed out of rough planking. These vats are about 250 ft. long, 350 ft. wide and 40 ft. high. After it solidifies it is broken up with the pick and shovel and loaded into cars ready for shipment.

Prior to 1907, when the plant first began successful operation, the United States produced less than one percent of her total consumption, which is 200,000 long tons. In 1908 the Louisiana mines produced a sufficient amount for the United States market and exported 27,894 tons, having a value of $561,538. In 1909 37,142 tons were exported having a value of $736,000, and in 1910, 350,000 tons were produced, placing the United States in a position to supply the European market, as well as her own, with a product 99 percent pure against Sicily's inferior article containing only 90 percent.

The "Ten Demandments"

A business concern at Steveston, which is away up in western Canada, has the following worldly wisdom conspicuously posted in its shop. While this may be a bit arrogative, it is nevertheless straight from the shoulder:

First—Don't lie. It wastes my time and yours. I am sure to catch you in the end, and that will be the wrong end.

Second—Watch your work, not the clock. A long day's work makes a long day short, and a short day's work makes my face long.

Third—Give me more than I expect, and I will give you more than you expect. I can afford to increase your pay if you increase my profits.

Fourth—You owe so much to yourself you cannot afford to owe anybody else. Keep out of debt, or keep our of my shops.

Fifth—Dishonesty is never an accident. Good men, like good women, never see temptation when they meet it.

Sixth—Mind your business and in time you'll have a business of your own to mind.

Seventh—Don't do anything here which hurts your self-respect. An employee who is willing to steal for me is willing to steal from me.

Eighth—It is none of my business what you do at night. But if dissipation affects what you do the next day, and you do half as much as I demand, you'll last half as long as you hoped.

Ninth—Don't tell me what I'd like to hear, but what I ought to hear. I don't want a valet for my pride, but one for my purse.

Tenth—Don't kick if I kick. If you're worth while correcting you're worth while keeping. I don't waste time cutting specks out of rotten apples.

Among the curios preserved in the Bank of England is a bank note that passed through the Chicago fire. The paper was consumed but the ash held together, and the printing is quite legible. It is kept carefully under a glass. The bank paid the note.

IMPRISONED IN BOILER WITH FIRE UNDERNEATH

Imprisoned in a big boiler, underneath which a fire was gradually heating the flues to a point which would have meant a horrible death if his escape had been delayed but a few minutes longer, is the experience recently undergone by Arthur McDonal, a young boilermaker of Arkansas. He has just left the hospital, a nervous wreck. His hair, which was coal black, now hangs over his forehead, a soft, glistening white.

The experience occurred at a saw mill at Hope, Ark. A new set of boilers had been put in, and negro firemen were relied upon to attend them. Something went wrong, and McDonal was called upon. After fixing the first boiler, he ordered the firemen to fill it with water and build a fire under it, when they had finished the work they were then doing. McDonal then entered the second boiler, and had been working about an hour, when he noticed his candle growing dim, and started to investigate. He found that the manhole cover had been replaced, and, sick with horror, realized that the negroes had misunderstood his orders and were building a fire underneath him. A moment later he heard the rush of water and frantically called for help and struck his hammer against the sides of the boiler, hoping to attract their attention. Soon the heat began to be felt. He touched a flue and started back with a gasp. It was warm—ever so slightly, but warm, nevertheless.

With hands torn and bleeding, and eyes almost bursting from their sockets, the now thoroughly crazed man crawled back and forth in his prison, panting, praying and moaning. The flues became so hot they burned his feet, and his head swam with the heat.

At last, more dead than alive, he threw himself down on the flues to hasten the end, and then at almost the last moment a way of escape dawned upon him. Grasping his chisel, he placed it against one of the flues under water and dealt it terrific blows, driven by frenzy. The first blow missed, and, striking his little finger, smashed it off. The other blows fell true, and the chisel broke through the flue, letting the water follow. The negroes heard the water when it struck the fire, and, believing that the boiler still leaked, opened the water plug and raked out the fire.

McDonal had a faint recollection of a patch of daylight when the manhole was opened, but knew nothing more for five days.

New Way of Making Cutting Tools

Some remarkable results have recently been obtained by the Bureau of Ordnance of the United States Navy Department with cutting tools produced by a new and interesting process.

Instead of making the tool from high-cost steel tool, containing the carbon and other elements in its entire mass, the new tools are made of soft steel, easily shaped into the proper form, and then treated by the so-called "infusion" process, the carbon and other elements being placed in contact with the metal in the form of a special powder and subjected to a heat treatment which causes the soft steel to become hardened to such a depth as to convert it into cutting material even superior to the far more costly tool steel.

The tests at the Ordnance Bureau showed that milling cutters made by the infusion process cut deeper, faster and further than tools made of the best carbon tool steel, and fully as well as cutters made from modern high-speed tool steel of far higher cost. The chief of the Bureau says that the infusion process "appears superior to any hardening process now in use at the naval gun factory," so that it appears that we are now in possession of a method of making tools of the highest grade for cutting metal out of ordinary soft steel.—*Cassier's Magazine*.

Perverted Proverbs

The engineer is worthy of a higher hire.

A rolling stone gathers no cement.

A touch from a live wire is breakfast for a coroner.

A survey goeth before construction, and a power plant before a fall.

Too much anchor-ice breeds lament.

The flat wheel makes the greatest sound.—*Power and Transmission.*

WIRELESS TELEGRAPHY

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

THE OSCILLATION TRANSFORMER

RICHARD U. CLARK

At the present stage in the development of the art of wireless telegraphy, one naturally expects to find in modern equipment, only instruments of the highest efficiency and most advanced design.

While it is undoubtedly true that in some cases every instrument is of the most efficient and approved type, yet the majority of medium-powered stations generally are lacking in some one point. Nine times out of ten this deficiency is due to the improper handling of the oscillations produced by the sending coil or transformer, which, in turn, is caused by the absence of an oscillation transformer.

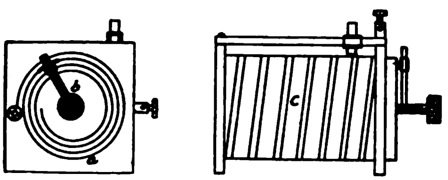


Fig. 1

It seems very strange that while no one would think of being without a receiving transformer, when it comes to the oscillation transformer a few turns of wire are considered a sufficient substitute.

This condition of affairs is undoubtedly due to the fact that this special branch of the art has been greatly slighted as far as comprehensive and practical advice on the subject is concerned. It is, therefore, the purpose of the author to give a short description of the oscillation transformer.

In order to explain clearly the principle involved in its use, it is necessary to

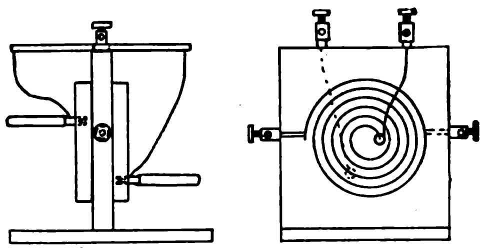


Fig. 2

start with the sending coil or transformer. When an oscillation is produced in the secondary circuit of the coil, it is of a highly dampened nature, that is, it produces a wave which quickly dies out. In order to prevent this dying out of the wave, a condenser is employed, which, in conjunction with the spark gap, gives a wave of greater sustaining power.

Now, when an inductance or a straight sending helix (not a transforming helix) is introduced into the circuit with these instruments, the dampening effect is still further reduced, due to the storing up

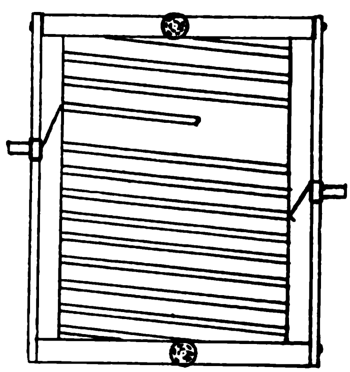


Fig. 3

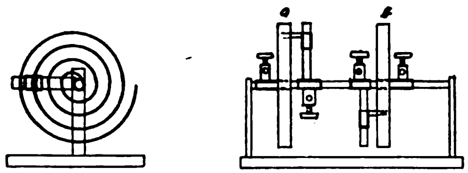


Fig. 4

of energy in the helix itself, and when the proper amount of resistance and self-inductance has been introduced (by varying the amount of wire on the helix) the wave emitted will be properly dampened, and therefore as persistent as possible under the given conditions. However, when a helix of this type is used the full efficiency is not realized, this being due to the following facts.

In order that the energy stored up shall be of the greatest value in producing electro-magnetic waves, it must properly energize the antenna. As an example, consider an aerial capable of using a given amount of energy. Now, any amount in excess of this is wasted in the form of heat. It is therefore necessary that the aerial should be made capable of using all the energy given it, and that it shall be properly handled.

It is not possible to do this with a common helix, which makes a good reservoir of power, but a poor distributer. That is, when employed as a reservoir it can not act as a controller or adapter of energy at the same time. In other words, being directly connected with the antenna, the power stored up is at once dissipated, and in this way the aerial does not receive its energy constantly.

However, upon the addition of a secondary circuit, which can readily be brought into resonance with the circuit already mentioned, the proper results may be obtained. In this case, in the primary circuit (which is really the secondary circuit); or the oscillatory circuit, the energy is stored up by the primary of the oscillation transformer, while it can readily be consumed by the aerial

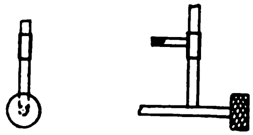


Fig. 5

by bringing the aerial circuit into resonance with the closed circuit (constituting the spark gap, condenser, etc.). This is accomplished by varying the resistance and inductance.

In the design of such an instrument as an oscillation transformer, great care must be exercised in order that short-circuiting may not occur between the consecutive turns of conducting material, as the difference in potential, even in a few turns, is very great, sometimes amounting to several thousand volts. However, if of the proper design and construction no trouble will be experienced in this line.

Among the many prominent and efficient types of oscillation transformers placed on the market today, Fig. 1 illustrates perhaps the most common. It is composed of a primary of copper ribbon, which is about 1 in. wide and is wound as shown in the drawing at *a*, the convolutions being separated by corrugated

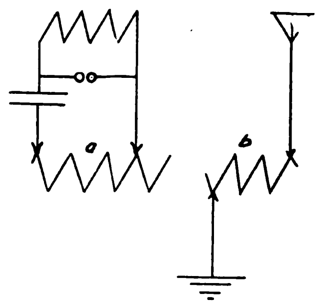


Fig. 6

cardboard strips about ½ in. wide. The variable contact is made by the rotary slider *b*, in Fig. 1.

The secondary *c* is composed of copper stripping ½ in. wide and No. 28 gauge. One end is connected to a binding-post as in usual practice, while contact is made by a slider similar to that of a tuning coil, only a little more massive in construction.

In Fig. 2 is seen a much simpler type, which, however, is not quite so efficient, as it cannot be adjusted as simply as the type shown in Fig. 1. This can be wound with wire or ribbon, the latter, when procurable, is always preferable, as it offers more surface for the oscillations to travel upon.

A very simple type is shown in Fig. 3,

being wound on cardboard tubing of a large diameter, say about 1 ft., in the same way as the secondary of the transformer shown in Fig. 1. Connections may be made in most any manner.

Fig. 4 displays another type in which the primary and secondary *a* and *b* are similar in form, both being like the primary of the transformer shown in Fig. 1. In this case the primary and secondary are both movable and are very well insulated; however, the conducting material must be at least 5/16 in. thick in order that it may keep its place unaided. The slider used for this transformer is similar to the one in Fig. 1, *a*, and is shown in detail in Fig. 5.

If one has a good straight helix which cannot well be converted to one of these forms, the right effect can be produced by placing another helix parallel to it.

In Fig. 6 is shown the circuit used in conjunction with a loose-coupled sending helix. In this illustration *a* is the primary and *b* the secondary of the oscillation transformer.

When this instrument is used a hot wire ammeter should be included in the aerial circuit in order that the maximum efficiency may be obtained.

VARIABLE CONDENSER

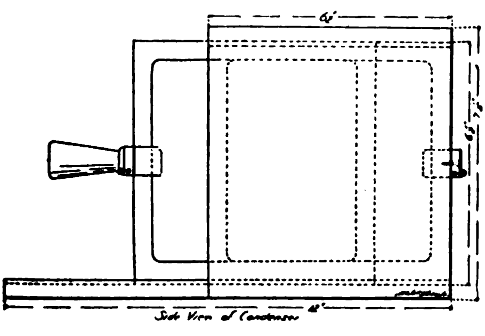
H. D. KEMP

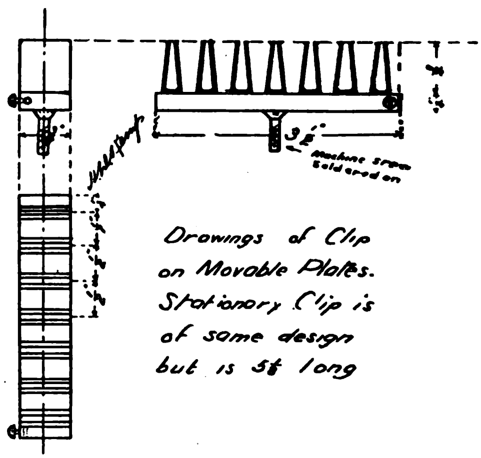
Many owners of wireless stations would like very much to add to it a variable condenser, but are unable to make a rotary one on account of the machine work entailed. The condenser described in this article, if well made, will work as well both electrically and mechanically as any rotary one.

The first thing to make is the grooved board which is used to separate the plates. If a circular saw is available, this work should be done on it, if possible, as it is so much more accurately and easily done. If one is not available, the grooves may be carved out with a narrow chisel, or cut with an ordinary saw. There should be two pieces made: one 12 in. long, and the other 6½ in. long. They both have the same cross-section, as is shown in the drawings. They are 4⅛ in. wide, ½ in. thick, and have 15 grooves ⅛ in. wide, ⅛ in. deep and ⅛ in. apart.

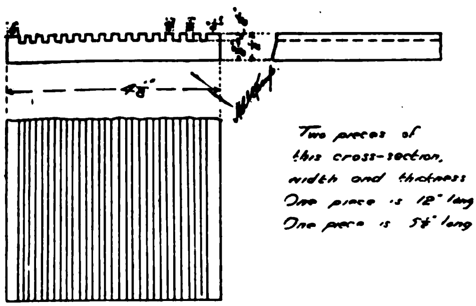
The two side pieces may now be made. They are 6½ in. long, 7¼ in. wide and ½ in. thick.

The frame may now be put together and nicely sand-papered and given some kind of a finish.





We now come to the plates. There are 15, of which 8 are movable and 7 are stationary. These plates are made of glass and are coated with tin-foil. This method of construction is used, because if metal plates were used the dust settling between them would form a high resistance conductor, which would affect the system badly. Glass plates of this size are also very easy to obtain, are easy to work, and are much less expensive than brass or aluminum ones of the same size. The maker should go to a photographer and obtain about a dozen and a half old, used 6½ x 8½ photographic plates. This allows two plates for breakage when they are cut. Before cutting they should be cleaned of the gelatine on them. If three or four tablespoonfuls of common



washing lye are put in a basin of hot water and the plates allowed to remain in it a few minutes, the film will either be dissolved or removed from the plate. Great care should be taken not to get any of this solution on the hands, as it is rather painful. After the plates are dry, they should be cut off so that they are a little less than 6½ in. long. This is so that they will slide easily.

After the plates are cut to size, they should be covered on each side with tin-foil. A piece of tin-foil 5½ in. square is stuck to the center of each side of each of the movable plates, and to both sides of all the stationary plates, except the two outside ones which are covered on only one side. White shellac is a very good thing to use to cement the tin-foil on with. They should be carefully smoothed out before being cemented on, and should be put on rather carefully.

After the case and plates are finished, the clips to hold the plates and connect the tin-foil sheets should be made. This will probably be one of the hardest things to do. Some rather heavy strip brass ¾ in. wide is cut up in 1¾ in. lengths and is bent into the shape shown in the drawings. After 15 of these clips are made they should be soldered to two pieces of heavier brass. The heavier pieces are 3½ in. and 5⅛ in. long, and ¾ in. wide and ¼ in. thick. It will be seen that the clips are spaced ½ in. apart, and there are 7 of them on the movable plate and 8 on the stationary one. A flat head machine screw should be soldered to the movable clip to screw the rubber handle to. The stationary clip should have two holes bored through it, ¼ in. from the ends, so that a small wood screw may be used to fasten the clip and plates to the frame.

When assembling, it should be seen that each side of each clip is touching a sheet of tin-foil, or a sheet is wasted for each non-contact.

This condenser, if carefully made, will prove of great help in tuning, and will work as well as most professionally made ones.

THE NATURE AND PRODUCTION OF HERTZIAN WAVES

ERNEST C. CROCKER

Hertzian waves are the messengers which carry our wireless messages, just as are light waves the messengers which carry heliograph or bonfire-signalling messages. The relation of Hertzian waves to light waves is closer than even the comparison would indicate, for they are really one and the same thing. Both are vibrations of the ether; in the one case very rapid (light), and in the other case relatively slow. Light and Hertzian waves, being ether waves, are rather intangible, but they bear a very close resemblance to sound waves in the air, with which we are more familiar.

Whenever we have any body vibrating, and the rate of vibration is between the limits of 16 and 10,000 vibrations per second, there is produced in the air a vibration which effects our ears, and which we call sound. Although the air is set vibrating by even slower or faster vibrations than those of the nine octaves of audible sound, our ears are incapable of responding. Even in the range of nine octaves (doublings of the rate of vibration) there is a marked difference in the behavior of the sound waves; for instance, sounds of the highest octave which is audible cannot go around corners to any great extent, while low-pitch sounds penetrate and permeate almost everything. It is with surprise that one first notices that even a small obstacle, such as one's hand, interposed between an extremely high-pitched whistle and one's ear, will entirely shut out the sound, so prominent is the shadow effect.

In the case of light and Hertzian waves, we have a special atmosphere, the ether; but in this case we do not have vibrations of solid bodies, but vibrations of electricity, which acts in this case like a special kind of solid body and the only kind which can set the ether into vibration. In this case, as in the case of sound, the vibrations may have almost any frequency, but only certain frequencies are recognizable. If the vibrations are between the limits of 400 trillion and 750 trillion per second, there is produced "light," a vibration of such rapidity as to effect our eyes. If a little slower than that indicated, we can still detect the vibrations by the sense of touch and not with our eyes, but this time as heat. If instead of trillions, we have a frequency of a few hundred thousand or a few million vibrations per second, we have Hertzian waves. If the rate of vibration is slightly higher than that indicated for light, we have "ultra-violet," but if a little slower, "infra-red light." The "heat" waves commence where light waves leave off, and extend well down the scale towards Hertzian waves, but there is still a small gap which has yet to be bridged in order to have a steady progression of frequencies from those of Hertzian waves, through heat and light to ultra-violet light, as we have in sound between the lowest and the highest frequencies.

As with high-pitched sounds, high-frequency ether vibrations travel only in practically straight lines, producing the well-known light-shadow effect; but also, as with low-pitched sounds, the relatively low-frequency Hertzian waves are not so limited as to travel only in straight lines, but can bend around, and so have great penetrative power. It is this flexibility which makes it possible to use Hertzian waves for purposes of wireless telegraphy, for straight-line transmission of messages could never carry even 100 miles. Hertzian waves can bend around any large body and on this account alone is trans-oceanic or circum-terrestrial telegraphy possible.

According to the statements of physicists, light is produced by the vibration of electrons (little pieces of negative electricity) within a molecule (small particle of matter). The space through which they vibrate (less than one millionth of an inch) is so small and the particles themselves so small, that it need not surprise us that they vibrate at the rate of 500 trillion vibrations per second, a quantity which is here expressed in figures to give an idea of its immensity; 500,000,000,000,000 (or 5×10^{14}).

Since light is caused by the vibration of small particles of electricity in a very limited space, it follows that if we are to produce the similar, but slower-vibrating Hertzian waves, we must cause the movement of a large body of electricity in a relatively large space. A vibration of a large mass of electricity to and fro is an alternating electric current, a thing with which we are already familiar.

Since Hertzian waves are always produced whenever we have an electric current alternating at the right frequency, we can now best study the production of Hertzian waves by studying the production of their parent, the alternating current. For wireless telegraphy we need Hertzian waves vibrating at the rate of from 70,000 to 1,200,000 times per second, hence we must use a current vibrating at these high frequencies.

Dynamos can be and have been constructed which give considerable outputs of electrical energy at the proper frequency, but as a general producer of alternating currents for Hertzian waves, the dynamo is practically out of the field. since it is so expensive and troublesome and since we have better methods of producing alternating currents of the required high frequencies.

It was found many years ago that if a Leyden jar was charged to a high potential and then suddenly discharged, that the discharge was alternating, and afterwards, it was found that the frequency of the alternations could be controlled and that the current itself could be used. A great many systems have been produced which utilize condenser discharges for the production of rapidly alternating currents for wireless telegraphy, but they all reduced to two types: the simple antenna circuit (no tuning apparatus) and the various methods of inductive coupling of condenser circuit to the antenna circuit. In both of these types we have sub-divisions as to whether the "spark gap" is long or short or is an arc, and also sub-division as to how the condenser is charged. Although in some cases the difference between two systems may appear to be slight, there may be a very fundamental difference in the character of the Hertzian waves produced.

To understand why a condenser discharge is alternating, we must bear in mind that electricity has a property analogous to "inertia" in matter, and that once electricity is set in motion it must continue in motion until the energy which was imparted to it in setting it in motion is all absorbed. When we lift a billiard ball to a considerable height we store up a considerable amount of energy in the ball. When now we release the ball and allow it to fall, it tries to give back the energy which we put into it by heating the air through which it falls, and in producing heat by impact when it hits anything. If we allow it to fall on a hard surface, but not from a height great enough to cause it to break, there will be very little energy used up in the air, and on account of the almost perfect elasticity of ivory very little energy will be used up by the impact, and the ball will bounce up again to a height nearly as great as that from which it fell, and this bouncing will continue for some time, until the energy of the ball is all used up. Similarly, when we charge the two plates of a condenser to a considerable potential and then allow the whole charge to fall from the plate of high potential to that of low potential. There will be a bouncing back and forth for some time, just as with the billiard ball, for a considerable amount of electrical energy is to be absorbed, and on account of the small absorption of energy by the condenser (due to the imperfect dielectric, the resistance of the metal plates and spark-gap, and to whatever current is radiated, leaks away, or is led off and used) the energy is usually not used up until after many swings. If we could have a perfect condenser and had a discharge circuit of no resistance or radiation, the oscillating or alternating discharge of a condenser when once started would keep up forever.

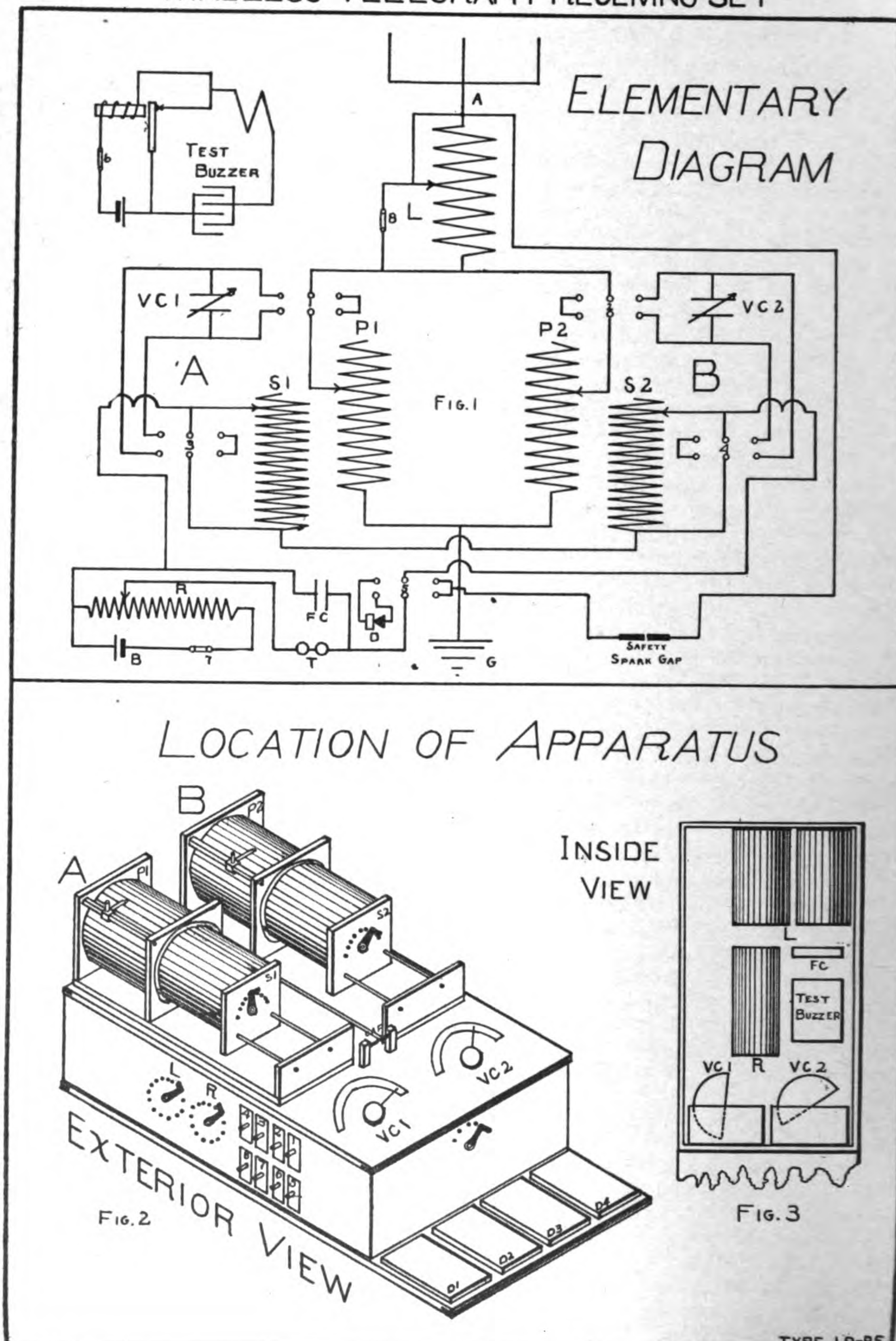
In what has gone before, we have considered the relation of Hertzian waves to things like light and sound with which we are already familiar. The waves themselves are disturbances in the ether as are light waves, and radiate in all directions as do both light and sound waves, but beside these properties, they possess the additional property, shared only by low-pitched sound waves, of being able, to a considerable degree, to deviate from the straight line in order to penetrate into an undisturbed or "shaded" region. It was shown that Hertzian waves are identical, in the essence, with light and heat waves and it may be further stated that if, instead of the customary few hundred thousand alternations per second employed in a wireless antenna we had 500 trillion, we would have emitted instead of Hertzian waves a stream of pure light waves, free from other kinds of radiations.

We considered how Hertzian waves were produced whenever we had rapidly alternating currents. In this case, of course, the electricity must vibrate in a wire, but such is not the case with light or heat waves which may be radiated by either an electrical insulator or conductor, for the electrons producing the disturbance or vibration which we call light can always move within the molecule itself. We also considered how it was possible to produce rapidly alternating currents by condenser discharges, and at another time we shall take up the subject of the different methods of utilizing the alternating currents which the condenser discharge produces.

GUIDED RADIO-TELEGRAPHY

Experiments with Major Squier's system of employing telephone and telegraph wires to guide Hertzian waves were recently made between the Bureau of Standards, in Washington, and the New York office of the Postal Telegraph Cable Company. The object of these experiments was to determine the best frequencies for long distances. It was found that frequencies of from 10,000 to 25,000 cycles per second would serve best for long distance transmission, while frequencies ranging from 25,000 to 100,000 cycles would be used on shorter circuits. Various methods of connecting the transmitters and receivers to the line were tested. Inductive coupling was found to give the best results, and was more flexible, for it permitted the operation of a number of lines from a single generator. It was shown conclusively that guided radio-telegraphy was far more economical in the consumption of power than free radio-telegraphy.

WIRELESS TELEGRAPH RECEIVING SET



1911 PLATE I H.B.RICHMOND

A WIRELESS TELEGRAPH RECEIVING SET

H. B. RICHMOND

In the designing of a wireless telegraph receiving set the experimenter occupies a rather peculiar position. On one hand he is beset with the necessity of having his set compact and as serviceable as possible, while on the other hand it must be of such a nature as to permit of considerable experimenting. It must be selective, yet it must not be complicated. To meet these difficulties the following set was designed. The actual dimensions have, for the most part, been omitted, because the experimenter usually desires to try for himself, and to make the set suit his own needs.

The theorist demands a wide range of variable inductances and capacities, while the practical operator turns from such a set to one containing a single tuner and condenser. In the following diagram both demands have been conceded to. Fig. 1 shows the electrical connections. The set consists of two receiving transformers, two variable condensers, four D.P., D.T. telephone key-switches, and the usual apparatus for the detector circuit. By means of switches 1, 2, 3 and 4, it will at once be seen that the circuit may be varied from one containing but a single loose coupler and no variable condensers to the more complicated Fessenden Interference Preventer. A few illustrative examples will best show the merits of this set. For the above-mentioned switches the "down" position has been chosen for the one in which a variable condenser is introduced into the circuit, while the "up" position simply places a loop across the circuit. To obtain the Fessenden Interference Preventer it is necessary to have two loose couplers with their primaries in parallel and their secondaries in series; in addition to this, two variable condensers must also be placed in the primary circuit. A glance at the diagram will show that in order to accomplish this result switches 1 and 2 should be "down," while 3 and 4 remain "neutral."

Perhaps the most commonly used interference preventer is the IP–76 set, used extensively in the U.S. Navy. Here the oscillation circuit contains no other apparatus than the primary of a loose coupler, while in the secondary circuit the secondary winding is bridged by a variable condenser. In this set we have two chances to accomplish the results of the IP–76 system. Referring again to Fig. 1 it will be seen that in order to use the *A* set, switch 1 must be "up," while in order to cut out *P*2 of the *B* coil, switch 2 must be left at neutral. Since across *SI*, *VCI* is needed, switch 3 must be "down," and in order to cut out *S*2, switch 4 must be "up." Using the *B* set the reverse is true. The advantage of this combination set is that when listening-in the less selective systems may be used, while when working with stations with which much business is done the more selective systems may be used; the actual changing from one to the other taking on an average three seconds, once the operator is familiar with the set. For convenience a short table, such as has been started below, may be made which will greatly help the operator in using the switches, although once familiar with the set it has been found that the switches can be shifted in less time than it would take to find the positions from the table. Such a table, however, will be of great help to the operator who is using the set for the first time. The following shows a convenient method of arranging the table; the names used for the systems being those by which they are most commonly known.

The various pieces of apparatus are so well known that they do not need any detailed description. It is well to re-

TABLE

System	Switch 1	Switch 2	Switch 3	Switch 4
Fessenden I.P.	Down	Down	Neutral	Neutral
Pickard "A"	Up	Neutral	Down	Up
Pickard "B"	Neutral	Up	Up	Down
Etc.	Etc.	Etc.	Etc.	Etc.

member, however, that with a loose coupler the distance between the windings is an important factor. Since there are two loose couplers in this set it is well to make one with the least possible distance between the windings and the other with ¼ to ⅜ in. clearance. The former will be the more efficient, but less selective than the latter. Their primaries should contain about 900 microhenrys of inductance, while their secondaries should contain from 3 to 5 millihenrys, depending on the wave length desired to be obtained. The variable loading coil *L* should contain about 3,000 microhenrys of inductance. Although it is possible to get along with ones of smaller capacity, it is best to have the variable condensers of a maximum capacity of .003 microfarads. The remaining apparatus is all of the standard type, so no mention of it need be made.

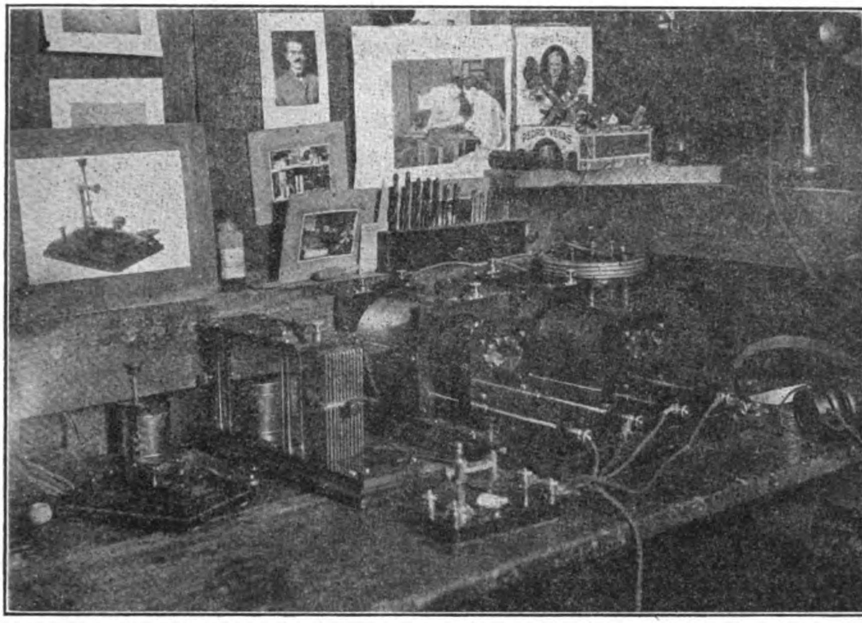
Fig. 2 shows the exterior view of the set when completed. This arrangement need not be followed, but it is a very convenient one. The switch numbers are the same as were used in Fig. 1; 1, 2, 3 and 4 being for the control of the various systems, while 5, 6, 7 and 8 are the usual ones connected with any set. No form of detector has been suggested because every operator has his own preference. The detectors are switched in by means of the switch located directly above them. Fig. 3 shows a very convenient inside arrangement, leaving plenty of room for the connections from the potentiometer *R* and the loading coil *L* to their respective switches.

A few over-all dimensions may be of some assistance to the designer of a similar set, so it may be mentioned that a cabinet with a base 27½ in. x 14 in. forms a very suitable case. An inside depth of 5½ in. is allowed, while a space of 6¼ in., extending across the front is reserved for the detectors. With a little thought on the part of the operator as to the purpose of the different pieces of apparatus, the actual operation of the set will be found to be much simpler than it first appears.

Mr. B. ANDERSON'S WIRELESS STATION

Mr. B. Anderson of Kansas City, Kan., has recently sent us some interesting photos of his wireless station and his description of the station is as follows: Transmitting Apparatus:—½ k.w. transformer with controlling re-actance coils; helix for tuning oscillatory circuit with aerial circuit; zinc spark gap; special

Transmitting Apparatus



Receiving Apparatus

type key of my own design and other accessories, such as antenna switch, switchboard for power circuits, etc. Receiving Apparatus.—Two loose-coupled tuners, silicon detector, two different types of variable condensers, and 2,000 ohm telephones. The antenna, at time photograph was taken, consisted of wires arranged for directive radiation. This has later been changed to a "lateral inverted V type," also arranged for a directive effect. Height of mast 75 ft., built of 4 x 4 in. yellow pine. This mast was put up in a most economical way and no engineering laws were put in practice in the erection of same. In fact an interested spectator may feel justified in making remarks to the effect that it would not endure a "mild wind-storm," such as are prevalent in this part of the country, but it has already breasted several "miniature" tornadoes with wind velocities of 80 miles an hour. Before I close the description, I may mention the fact that the mast is guyed by No. 12 B.&S. gauge galvanized iron wire, 3 sets of 4 wires each. This mast has been in service about four years; and I am now beginning to get worried as to how to take it down, owing to the fact that the neighborhood has increased its population considerably since the mast was erected. Have had some remarkable results with this equipment, which is nearly all home-made, and Colon, Panama, New Orleans, Chicago, Milwaukee and Leedington are only a few of the long distance stations heard. My transmitting distance with the aerial and transformer as described has been over 75 miles, while at one time a transmitting distance of 160 miles was covered in day-time with a more efficient aerial and mast made by my co-worker, Mr. Arthur G. Kepkinger, to whom I am indebted largely for the success attained.

A NEW USE FOR WIRELESS

The idea of using a wireless telegraph station for the purpose of aging cognac or clarifying champagne is, at first thought, fantastic, but it is being tried with success. Many years ago chemists conceived the idea of utilizing the action of electric currents of high frequency in the perfumery industry, producing a kind of electrolysis, which, in a way as yet unexplained, unites and compounds the diverse essences that enter into the composition of a scent. This phenomenon inspired some experiments undertaken in France.—Youngstown, O., *Telegram*.

ANOTHER GALENA DETECTOR

H. L. THOMAS

The detector of the "up-to-date" wireless experimenter is galena.

There are several forms of this detector, such as the copper point, and in combination with zincite. There is, however, a better form than either of these. This is the form using a tungsten wire for the contact point. A piece of this wire (of the size used in 25 watt lamps) must be obtained. It cannot be taken from an old lamp, however, as the wire is brittle after it has been heated. The wire should be curled so as to form an open spiral spring, the end being bent perpendicular to the mineral. It may be soldered to the adjusting apparatus, but an easier way is to drill a small hole and fasten it with the alloy given at the end of this article.

The contact must be very light. This is very easy to obtain with this extremely fine wire.

As a general rule, the detectors using a light contact are easily "knocked out" of adjustment, but the author has seen the following test applied:

A detector of this type was securely fastened to the operating table without felt or springs. A station was tuned in, and an assistant pounded the table with his fist, but produced no effect on the detector.

Very few of the crystals are sensitive. The best way is to obtain several ounces of the material, break it into suitable sizes (no smaller than ¼ x ¼ in.) and test each piece. When a good crystal is obtained, this detector will be found considerably more sensitive than any other form known at present.

The following alloy will melt at 176 degrees Fahrenheit, or 36 degrees below the boiling point of water. It may be used to fasten the galena into a brass cup:

Bismuth.................8 parts
Lead.....................5 parts
Tin.......................3 parts

All parts by weight.

STANDARD THREADS

W. W. BRIDGE

While reading articles showing how to build machines, electrical appliances, etc., one will become confused as to what sizes to use, and what thread for a given wire. I take the liberty of stating the standards which have been adopted by the American Screw Co., one of the largest makers of machine screws, and one of the leading makers of cap screws and set screws; also the makers of taps and dies.

MACHINE SCREW SIZES

Wire Threads: 2 x 56; 4 x 36; 6 x 32; 8 x 32; 10 x 24; 12 x 24; 14 x 20; 16 x18; 18 x 16; 20 x 16.

Avoid the use of other threads as much as possible; also the use of sizes such as ¼ x 20 and ½ x 13, which are cap and set screw sizes. These sizes are made in machine screws, but one will find that they are very hard to obtain in any hardware stock. The use of fine threads cannot be avoided as adjusting screws where very close results are required, but in other places it would be better to use only standard sizes.

CAP AND SET SCREW SIZES

Wire Threads: ¼ x 20; 5/16 x 18; ⅜ x 16; 7/16 x 14; ½ x 13; 9/16 x 12; ⅝ x 11; ¾ x 10; ⅞ x 9; 1 x 8.

The use of 3/16 x 24 should be avoided, as this size is not carried at all hardware stores. At one time ½ x 12 was standard but this has been changed to ½ x 13.

The size drills to be used in connection with taps can be found in most any catalog of drills or taps and dies. When drilling in steel for a tap to follow, use a drill from one to five thousandths larger than given in lists. This will save a great many broken taps.

Correction

On page 262 of our April issue we published an article entitled "A Square Cut Chair." We regret to state that inadvertently the credit for this article was given to "Hobbies" when it should have been given to our esteemed contemporary "Popular Mechanics."

WIRELESS NEWS

The Alexander Bill

March 30, 1912.

To the Honorable House Committee on Merchant Marine and Fisheries:

Washington, D.C.

Gentlemen:—I beg to protest against the adoption of the Alexander Bill for the regulation of wireless telegraphy. I am hardly a schoolboy amateur, for I began telegraphing as a business in 1894, in railroad work, and, though not now so employed, I have not lost interest in the art: I find wireless an entertaining and instructive pastime, and I know this bill in its present form will be a serious detriment to wireless development. There is much to be learned yet before the science is perfected, and improvements in the past have generally come, not from paid or professional operators, but from experimenting amateurs. This bill gives power to suppress every such station to a government department which is confessedly antagonistic, and is a much more drastic measure than is necessary for the conduct of wireless business. That some government regulation might be beneficial I admit; but a general law that would make wilful interference with an operator, or the refusal to keep apparatus quiet for a reasonable time, when requested by any operator actually engaged in working with a distant station an offense punishable as are other misdemeanors (something like the laws relating to the interference with other government employees, such as revenue officers, mail carriers, etc.), is all that is necessary; no restrictions are necessary regarding a station for receiving only, for such a station can in no way whatever interfere with any other. If the divulgence of private messages should prove an annoyance, a clause could be included making the offender liable to the injured party, or subject to imprisonment if civil action would not hold.

No one could or would object to absolute government control of all wireless apparatus in war time or other emergency; but the possibilities and convenience of wireless communication are too great to be hampered or throttled almost at the beginning by unnecessary seizure and absolute control by the government. A law covering the matter of wilful interference with business, applicable to all operators alike, with a clause protecting private messages, would do more to expedite the handling of wireless business of all classes than any regulations regarding wave-lengths or specified hours for each class of business could do, and it would do it without depriving some eighty thousand of our citizens and embryo citizens of a most fascinating and educational recreation, to say nothing of the value of private installations for communication in a business way.

The eighty thousand amateur and experimental stations now in operation in this country represent an investment in the line of over a million dollars.

I notice in the newspapers and the electrical magazines, that in support of this bill the Navy Department lays particular stress on alleged interference with messages of distress from the torpedo boat *Terry*, when it was disabled off the coast of Virginia on January 7th last; my station is but two or three miles distant from New York City Hall, in a district that is probably as busy, wirelessly, as any in the country: in justice to the amateurs of this vicinity, and in reply to whatever statement on that incident may have been submitted to you regarding the matter, I respectfully submit a copy of my record of the occurrence; I keep a careful daily record of what I hear in the time other work allows me to give to wireless, and I would ask that you compare these notes, and in particular the *time* given for each remark, with any that have been submitted to you. When I copied this out of the air, I had no expectation that it might be used in this way, consequently there is no "padding" in the matter at any place, and I am entirely willing to submit it in the form of an affidavit as a "true and correct copy of what passed between the various wireless stations around New York, on the date and at the times mentioned," if you would prefer it that way. I have approximately 300 pages of this kind of matter, taken in the past two and one-half years, and in many places it shows that some of the worst of the interference trouble came from some of those now most in favor of passing this bill.

Please note on the attached, that the first notification of the trouble of the *Terry* was given at 6.23 p.m., January 7th, *by an amateur station in Bayonne, N.J., to a New York commercial office*, who repeated it to the Brooklyn Navy Yard.

Thanking you for your attention, and awaiting your further wishes, if I can be of any assistance to you,

Very truly yours,
CHAS. E. PEARCE,
748 Albert St., Steinway, N.Y.

Copy of Daily Record of Wireless Messages Received at Steinway, Long Island, by Chas. E. Pearce.

(In this copy, conversation is here written out fully, instead of the telegraphic abbreviations used by operators).

January 7th 1912.

"Sat in" (began listening) at 6.15 p.m.

6.20 p.m.—JD (steamship *Northland*, Maine S.S. Co.) calling NY. (NY is the New York office of the United Wireless Co.)

6.22 p.m.—NY answers, and JD reports passing Hell Gate at 6.15 p.m.

6.23 p.m.—WD (an amateur station in Bayonne, N.J.) calling NY; NY answers, and WD says:

"Say, did you get that SOS from RNS? —WD." (SOS is the call for help signal, and RNS is the steamship *Tagus*, Royal Mail Steam Packet line).

NY says: "Yes—can you get the rest of it?—NY."

"Am trying to.—WD" says WD.

6.26 p.m.—NY to QY (QY a New York amateur): "Keep out—there's a boat in trouble and I can't hear a thing through that clatter of yours.—NY."

QY immediately *stopped working*, and I did not hear him again during the evening.

NY calling RNS, and I heard him answer, though my outfit is too small to get what he said, but NY asked:

6.32 p.m.—"RNS: What's your trouble?—NY."

I could hear RNS working, but too faint to read.

6.36 p.m.—NY calls NAH (NAH is the Brooklyn Navy Yard.)

NAH answers at 6.40 p.m., and NY says:

6.40 p.m.—"Say, the RNS reports NUI in trouble about 500 miles east of the Virginia capes. Says the Revenue Cutter *Onondaga* has word. Latitude 38.21 north; longitude 67 west.—NY."

NAH to NY—"O.K. Thanks.—NAH."

NY to NAH: "Say, who is the NUI?—NY."

Ans.—"The torpedo boat destroyer *Terry*. —NAH."

Nothing more was said of the matter, except NY handled a few commercial messages, working with the *Tagus*, and other ships for some time. NAH called the *Tagus* and *Norfolk* a few times, but evidently was unable to hear them if they replied. Was working with the *Tagus* to the extent of telling him he was too far away, he couldn't get his signals.

7.10 p.m.—RCM (Revenue Cutter *Mohawk*) called NY, and gave this message when NY answered him:

RCM to NY: "Noon. NUI lat. 38.21 north, long. 67 west. Turbines, engines and pumps out of commission. All stores ruined and wireless not working.—RCM."

Now, if the wireless on NUI was not working at noon (as reported by the RCM), how could the Brooklyn Navy Yard expect to work with the disabled vessel in the evening?

7.12 p.m.—JD calling WN (Wilson's Point, Conn.), and sends a message.

All big stations silent until 8.10 p.m. when WD calls NY, and gives the following ship position reports:

8.10 p.m.—WD to NY:

"8.00 p.m.—FH *Savannah* 324 miles south Sandy Hook."

"8.00 p.m.—YM *Yucatan* 806 miles south Sandy Hook."

"8.00 p.m.—CB *Carolina* 340 miles south Sandy Hook."

Nothing more was said about the disabled boat during the evening, as long as I was listening, probably about 10.30.

January 8th.

6.20 p.m.—DR (a large New York amateur station) calls NAH, and says he just heard the following message:

6.20 p.m.—DR to NAH: "from Norfolk Naval Station to NRZ."—"(NRZ is the U.S.S. *Salem*): *Terry* expected to reach Hampton Roads tonight. Continue search for others. Missing destroyers Department ignorant of whereabouts Drayton, McCall, Mayrant, Patterson, and Burroughs."

Winthrop,
Acting.

CANADIAN CENTRAL WIRELESS CLUB

Winnipeg, Manitoba, Canada

This Club has a number of men of all ages, from the boy in his teens to the middle-aged business man. Meets every two weeks at the home of a member. Most of the members have their own instruments, some of which have been bought, and others made by themselves, but all persons interested in wireless telegraphy or telephony receive a cordial welcome to the meetings, whether they have instruments or not. The president of the Club, Alex. Polson, 94 Cathedral Ave., has an aerial outfit. So also has A. St. Louis, 819 McMilan Ave.; S. Scorer, B. Lazarus (secretary), E. Duma, A. Scott, Reginald Davis, Fred Golmer and Bertram Hill, others have their indoor receiving and sending outfits.

OREGON STATE WIRELESS ASSOCIATION

6th and Taylor Sts., Portland, Ore.

The officers are Chas. L. Austin, president; J. R. Kelley, secretary; Ed. Murray, sergeant-at-arms; C. L. Bischoff, treasurer and corresponding secretary, Box No. 73, Lents, Ore.

The corresponding secretary's call letter is MV, 1 k.w., rotary gap, 200 miles radius. Murdock loose coupler, single slide tuner as loading coil; also have double slide tuner on different circuit. Either straight or loop-aerial as desired. Sixty feet high at one end, 45 at the other, 350 ft. long. Get pretty near everything on the Pacific Coast from Sitka, Alaska to San Francisco, also ships at sea.

Mr. Joyce Kelley and Mr. Charles Austin's call letters are RPC and C2 respectively. These two stations were among the first installed; they are the highest, each having two poles, 150 ft. to 125 ft. in height. The two owners are first-class operators, both having worked on ships, and understand the art perhaps better than any amateur in the United States and better than over half of the licensed operators. Mr. George Swartz also has a high-class station, call letter GE. Each of the above own over a 2 k.w. transformer. Mr. Kelley has a small set which he uses around town and very seldom uses his large set except when handling business or sending a considerable distance. The two first-mentioned stations are better than a good many commercial stations that I have seen.

Yours truly,
CLARENCE BISCHOFF,
Corresponding Secretary.

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.

1757. **Electroplating. Spark Coil.** O. M. P., Yoakum, Tex., asks: (1) for solution for electroplating with (*a*) copper, (*b*) nickel. (2) Will the use of iron in the construction of a detector affect its sensitiveness or interfere with its action in any manner? (3) I am building a spark coil for a 2 in. spark with the dimensions given in June, 1910, issue of *Popular Electricity*: Core ⅝ x 7 in.; primary 184 turns No. 16 d.c.c. wire; secondary, eight sections, using 1 lb. No. 36 enameled wire; condenser 1,400 sq. in. tin-foil; and I want to know if I can fix it so that I can use one-half the secondary, one-half the primary and part of the condenser for a 1 in. spark or both parts at once for two 1 in. sparks, and if so, how to connect it. Ans.—(1)(*a*) For the preliminary bath use a double cyanide of potassium and copper solution, the method of making this solution being given in answer to question 1745 published in the April issue of this magazine. For the body of the deposit use as an electrolyte a solution of cupric sulphate in very dilute sulphuric acid. (*b*) A good solution for nickel-plating is as follows: nickel and ammonium sulphate, 10 parts; boracic acid, 4 parts; distilled water, 175 parts. Use a sheet of nickel for your anode. Be very sure that the surface which is to be coated is absolutely clean as even finger marks will render the deposit liable to peel off. If the metal which is to be plated is iron, nickel or zinc, it is difficult to make metallic deposits upon them adhere. To overcome this difficulty, first give them a coating of copper in a solution made as follows: potassium cyanide, 2 parts; copper acetate in crystals, 2 parts; sodium carbonate in crystals, 2 parts; sodium bisulphite, 2 parts; water, 100 parts; moisten the copper acetate with a small quantity of water and add the sodium carbonate dissolved in 20 parts of water. When reaction is complete add sodium bisulphite dissolved in 20 parts of water. Lastly add potassium cyanide dissolved in remainder of water. (2) This cannot be answered by a simple statement. Iron is essential in magnetic detectors, and sometimes useful or necessary in coherers and "carbon-steel" detectors. In the perikon detector, there is iron in the zincite and in the chalcopyrite. In the silicon detector, iron may be used, instead of brass, for the contact point. In an electrolytic detector, iron is as a rule harmful, as the platinum is more readily ruined when iron is present. As a rule it cannot be said that the presence of iron has anything to do with the sensitiveness of a detector, for the currents flowing in a detector are too small to produce perceptible magnetic effects. (3) It is not desirable to make primary or condenser any smaller. Simply use less secondary. Less than one-half the amount will give one-half the spark.

1758. **Wireless without an Aerial.** W. R., New York, asks: If there is any wireless system which can successfully transmit and receive messages without using an aerial wire. A system which only uses the ground connection for sending and receiving. Ans.—There are several experimenters in Germany who are now working out a practical wireless system which does not make use of the ordinary antenna, either for sending or receiving. It is claimed that the "ground circuit" method (using Hertzian waves) is very successful, although, strange as it may seem, there is considerable trouble from "atmospheric" electricity, especially when very long waves are used. Mr. Marconi is also interested in carrying out experiments on the Sahara Desert in Africa, where the soil is sufficiently insulating so that the two horizontal wires may be laid directly on the ground. It seems probable that in a few years some of the earth current methods will be put into actual use.

1759. **Wireless Aerials.** J. C. W., Topeka, Kan., asks: (1) Will the aerial shown in diagram give good results with connections shown? (2) Is the insulation of the aerial shown in diagram sufficient for a ¼ k.w. transformer? (3) If a loop aerial is used with the set described in the August number of *Electrician and Mechanic*, may the other aerial wire be run through a single slide tuner to the ground? Ans.—(1) No, it is not effectively connected. It would be much better to connect the lead-in wires at the place where the sloping part joins the horizontal part. The horizontal part, in the place you now have it, adds very little to what the sloping part alone will do. (2) Yes. (3) Yes. There is only a doubtful advantage in using a loop aerial, however.

1760. **Teleautograph.** H. M. A., Cambridge, Mass., asks: (1) about the teleautograph mentioned in the February number, on page 136, under the heading of "New Wireless Apparatus." (2) The formula for finding wave length for wireless. Ans.—(1) The full details of this teleautograph are not yet available. It may be months before the information is given to the public. (2) The wave-length of a wireless circuit depends upon two quantities: the inductance and the capacity of the circuit. When the capacity C is expressed in microfarads (the customary unit) and the inductance L is expressed (in the C.G.S. units) in "centimeters," wave-length (in meters) $= 60 \sqrt{CL}$. If the capacity is in microfarads, and the inductance in milhenrys, wave-length (in meters) $= 60{,}000 \sqrt{CL}$.

1761. **Detector Minerals.** R. D. M., New Orleans, asks: (1) The address of the firm that sells the best silicon for long distance work. (2) The address of the firm that makes and sells the best minerals for a perikon detector for long distance work. (3) What is the best material for the point to rest on the silicon, in a silicon detector for long-distance and local work? Ans.—(1) It is difficult to state what concerns sell the best silicon for wireless work. The Wireless Specialty Company, which controls the detector patents, presumably has the best silicon obtainable. (2) Wireless Specialty Company, 81 New St., New York, N.Y. (3) Brass or phosphor-bronze is the standard material.

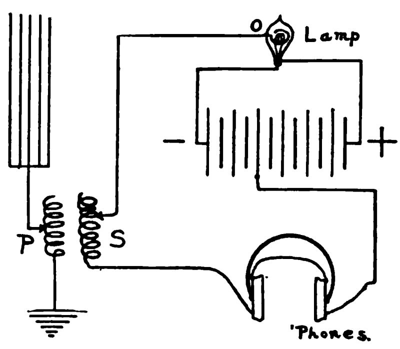
1762. **Condenser.** T. S. V., Los Angeles, Cal., asks: (1) What will be the necessary capacity of a condenser to be used on an induction coil of this size: core 9½ x 1 in., two layers No. 16 d.c.c. wire and 4½ lbs. of No. 34 enameled wire wound in eleven sections? (2) Is there any difference in thickness of tin-foil used in this condenser? (3) What would be the voltage for the above coil in volts and amperes when using the coil with a Machenzie-Davidson type interrupter described in your April, 1911, magazine? (4) If I use 110 volts A.C. to 110 volts D.C., can I get the necessary amount of electricity for the above coil? Ans.—(1) From 1 to 1½ mf. capacity. The exact amount is not of particular importance. (2) The thickness of the tin-foil used in condensers is of no importance so long as it is great enough to allow a good connection to be made to the plates. (3) The above coil should work at its best on from 8–12 volts, taking, perhaps 3 to 5 amperes. (4) Such a coil is not suitable for use on 110 volt circuits, either A.C. or D.C.

1763. **Tesla Transformer.** L. R. C., Beverly, Mass., asks: (1) For data on oil-insulated Tesla transformer to give 12 in. sparks or better, when used in connection with a ¼ k.w. transformer. (If copies of the *Electrician and Mechanic* are referred to, please state whether obtainable or not). (2) If glass is a satisfactory insulator between the primary and secondary of a spark coil giving a very heavy spark, and if lead glass is less efficient than regular flint or crown glass. (3) Whether or not a thoroughly efficient station should have sharp points, or corners on the sending end. I refer to such things as a spark gap with a screw adjustment, sharp-edged binding posts, etc. Ans.—(1) We believe that the *Scientific American Supplement* contained in a recent number, if we recall correctly, was published some time in January or February, gives the information you desire. (2) Yes. It is more usual, however, to use ebonite, paraffined paper or "empire cloth." Lead glass contains lead salts which are insulating and which do not prevent good insulation. The only glass to be used with caution is manganese glass—this usually has a pink or violet color. All bluish, greenish or crystal-white glass is usually safe. Very often, flint glass contains lead. (3) Sharp points and edges are only harmful where there is a very high electrical potential. As a rule, there will be no perceptible loss from points except near the top of the antenna. At the spark-gaps, etc., the loss is entirely negligible.

1764. **Wireless.** N. A., Kenton, Ohio, says: (1) When constructing an aerial 100 ft. long, 4 aluminum wires, how should the lead in wire be connected to the aerial and at what place should it be located on the aerial? What size of wire is best, and should it be bare or insulated? (2) With the following instruments, 1,000 ohm receiver, Wm. Murdock $3.00 variable condenser, fixed condenser, silicon detector (ferron type), Dawson & Winger double-slide tuner, and aerial 100 ft. long, four aluminum wires, mast 84 ft. high, how far had I ought to receive? (3) How far had I ought to send with ¼ k.w. transformer helix, zinc spark gap, four 2 quart Leyden jars and same aerial? Ans.—(1) As a rule, the station is located at the bottom of the aerial "grid" of wires and connection is made at this point. Use good rubber-crossed wire No. 14 or No. 16 B.&S. gauge, and where the joint is made with the aluminum part, be careful to solder well with "aluminum solder" (obtainable in most auto supply stores) and wrap well with rubber tape to keep moisture away from the joint. (2) It is very difficult to state your receiving distance, so much depends upon the strength of the sending stations. You should be able at night to hear a 2 k.w. station 100 miles away. (3) Probably 25 miles.

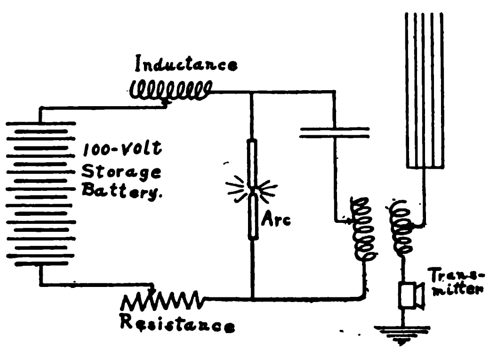
1765. **Coupling.** J. A. L., Maynard, N.D., asks: (1) Is the demand very great for automobile chauffeurs and repairmen? Is a competent one (one who is a graduate of a good auto school) sure of steady employment? (2) Is the demand very great for wireless operators? (3) What is the meaning of "coupling" as used in wireless? Ans.—(1) There is always a good demand for thoroughly-trained chauffeurs. The supply seems to be equal to the demand. (2) Not at present. (3) By "coupling" in wireless, we mean the "closeness" of connection between two circuits, the facility with which one circuit can unload its electrical energy into another circuit.

1766. **Fleming Oscillation Valve Detector.** X. D., Baltimore, Md., says: (1) I have a Fleming oscillation valve detector and the following directions to use same: (*a*) Connect 4 to 6 dry cells in series to the lamp filament; (*b*) Connect one side of a pair of 2,000 or 3,000 ohm phones to the second negative from the negative end of the battery of dry cells; (*c*) Connect the other side of the phones to one terminal of the secondary of the inductive tuning coil; (*d*) Connect the other terminal of the secondary of the



inductive tuner to the cold plate of the valve through the coiled wire on the lamp. I do not grasp the meaning of this, will you explain more fully the operation of this detector? (2) I enclose a hook-up of my receiving set, which is self-explanatory; can you tell me if I can use the valve detector in this circuit, and how, with the best results? (3) Can you tell me of any other circuit in which I can use this detector, using double-slide tuner of 6,000 meters, 2,000 ohm phones, fixed condenser and aerial of about 800 meters and necessary switches, etc.? Ans.—(1) The circuit which is meant by the description is here given; it will be seen that one side of the phones is connected to the "second negative from the negative end of the battery of dry cells," and that the other side of the phones is connected to "one terminal of the secondary of the inductive tuning coil *S*." The other terminal is connected to the cold plate of the valve through the coiled wire *O* on the lamp. (2) The most effective way of using the oscillation valve is that shown in the diagram with the addition of a variable condenser across *S*. It is a very good scheme to connect a potentiometer, of about 1,000 ohms resistance, across the battery and connect the wire from the phones to the sliding contact of the potentiometer. (3) The valve, in series with the battery and phones, may be used with any tuning circuit in the position which is usually occupied by the detector in series with its fixed condenser.

1767. **Wireless Telephone.** R. H., Springvale, Me., asks: (1) If the accompanying circuit is practical for a wireless telephone transmitting outfit. (2) If not, please give diagram which should be used with same instruments. (3) Should the sound of the arc be heard as far as the sound of the voice and how far should sound of voice be heard with said instruments? Ans.—(1) No. The arc for wireless telephony must be supplied with a perfectly steady direct current and not with a rectified alternating current. The telephone transmitter is placed in the aerial circuit and not in series with the arc. Furthermore, the arc cannot deliver energy to the antenna in an efficient manner unless one uses an oscillation transformer and tunes the circuit carefully. (2) Much difficulty will be experienced by a beginner in wireless telephony. The adjustment of inductances, resistances and capacities (condensers) is very trying. (3) No; the arc itself makes no sound in a well-regulated circuit. The greatest commercial distance covered by the arc method is about 20 miles.



1768. **Coil-making.** W. A. T., Memphis, Tenn., has about 5 lbs. of No. 26 copper wire, and wishes to utilize it in making a transformer for wireless telegraph purposes. He asks for directions. Ans.—This size of wire is quite useless for the purpose. You need considerable coarser for a proper primary, and very much finer for a secondary. Do not go to considerable expense just to use the wire. Unless you really have some motive worth while, do not embark on a course of experimenting that will cost $50.00 just to get rid of $2.00 worth of wire. If the lot is old, the chances are that the insulation is poor and unreliable. If you really wish to make a wireless coil, we could refer you to several good articles already published.

1769. **Induction Coil.** L. W., St. Louis, Mo., proposes to make an induction coil of the following dimensions: core of Norway iron wires, bundle 12 in. long, 1¼ in. diameter; varnished muslin and fiber tube to cover or contain these wires, and then wound with two layers of No. 14 copper wire; double insulation of this sort between primary and secondary, latter consisting of 5 lbs. of No. 34 wire wound in the manner described by Stanleigh in the March, 1911, issue. Condenser of 160 sheets of tin-foil, 6½ x 9 in., separated by paraffined blotting-paper. He asks what voltage the coil should give, and what strength of battery is necessary. Ans.—Your proportions and dimensions appear good. Do not fear that you have provided too much insulation between primary and secondary. A glass tube ⅜ in. thick, or its equivalent, is none too much. Blotting-paper for insulation of condenser will be altogether too thick. The effectiveness of a condenser is proportional to the thinness of the dielectric. Double thicknesses of bond or rice paper, paraffined of course, will be much better. We do not know what voltage the secondary will generate, but sparks about 4 in. in length should be obtained. Use six storage cells on the primary.

1770. **Phase.** W. G. C., Fall River, Mass., asks: (1) What is meant by the "phases" of a generator? (2) Is malleable iron good for making the field magnet of a small motor? (3) Are twist drills for wood the same as those for iron? Ans.—(1) The number of groups of windings that are acted upon by any pair of poles represent the number of successive waves or phases associated with the currents. There are usually as many terminal wires leading from the armature of an alternating current generator as there are phases. The idea is somewhat like a consideration of the number of cranks a steam engine may have. (2) Yes, but annealed cast iron will do just as well and be cheaper. (3) Tools for working in wood are usually left sufficiently soft to be readily sharpened with a file. Metal cutting tools must, of course, be left just as hard as possible without danger of cracking. Drills for wood should be ground at a much sharper angle than those for iron.

1771. **Coil Operation.** H. W. S., Spokane, Wash., has a large induction coil that readily gives 5 in. sparks when energized by direct current through the medium of an electrolytic interrupter. When connected to the 60-cycle alternating circuit, though no resistance is interposed, the coil gives no spark whatever. What is the reason? Ans.—Any "interrupter," and especially one of the electrolytic sort, gives an exceedingly sudden break to the primary current. An alternating current is supposed to follow a sine curve for its wave form. Now this purposely gives a gradual and not a sudden change in strength, and the secondary generates only a comparatively feeble electromotive force. The proper and necessary condition for the induction coil to have is that while the primary current is established only after a considerable struggle against the counter electromotive force of self-induction, the break is almost instantaneous. The case is something like getting a heavy fly-wheel started; after some expenditure of effort extended over an appreciable length of time the desired speed may be attained. The motion may be annihilated, however, in an instant, by poking a stick of cord wood in between the spokes. A resounding crack will result, and something is likely to be broken. So when the lines of force are suddenly wiped out, the resulting induction in the fine wire may be enormous, and perhaps the insulation may break down. The steadily rising and falling alternating current would resemble the wheel stopped by the same stages as used at the start.

1772. **Induction Coil.** R. B. P., Cooperstown, Ill., is proposing to make a coil of the following dimensions: core, 1 in. diameter, 9 in. long; winding space 7½ in. long, 4½ in. in diameter. Primary, 2 layers of No. 12; secondary, 5 lbs. of No. 32, emanel insulated. He asks: (1) Is enamel better than s.c.c. paraffined? (2) After secondary has been run through melted paraffin, is it well to boil the whole assembled secondary in paraffin? (3) What length of spark should be secured? Ans.—(1) Yes, in that you can get more turns in a given space. Still you should put paraffined paper between the layers, insulating the end sections much more heavily than those in center, as was described in the March, 1911, magazine. (2) No. (3) Your winding is rather out of proportion, if length of spark is what you wish. For wireless use, the size of secondary is right, but we think 3 lbs. should suffice. About 1 in. sparks will be obtained.

1773. **Dynamo Design.** J. A. E., writes a kindly worded letter calling attention to the wide variations in proportions of wire for apparently the same size of machine as described by different writers. He asks if some of the extreme cases have been tried out in practice by the actual building? Ans.—The designing of a dynamo is not altogether unlike that of an architect's problem in designing a house. One person may devise a much more elegant and economical arrangement than another. Part of the discrepancies to which you refer may be traced to quite extensive differences in specifications. One machine may be made with a cast iron field magnet and a smooth core armature, while another for the same speed and horse-power may be of wrought iron with a toothed armature. Such considerations will greatly affect the quantity of wire. You will find the book on "Electric Motors," by Hobart, instructive for commerical motors of recent design; one on "Dynamo Electric Machines," by Wiener, for earlier types; and one on "How to Build Dynamo Electric Machines," by Trevert and Watson, for explicit directions covering cases of machines actually built and used for a great variety of purposes.

1774. **Induction Motor.** A. S., Fergus Falls, Minn., is proposing to make a motor resembling that given in connection with the vacuum cleaner outfit described in the September, 1911, magazine, only ¼ h.p., however, being desired. He asks for dimensions and for rather clearer instructions for connecting the coils than were given in that article. Ans.—It will be rather inexpedient to make the diameter of the parts less than those mentioned in the article referred to, but the stack of sheet iron can be 2 in. or 2⅛ in. in thickness rather than the 3 in. specified. Also, in order to assist the motor to start instead of permitting rotor and stator teeth to "lock," it will be better to have an odd number of rotor holes and rods, say 29, rather than the 36 specified. It may be of assistance to you to adopt the "concentric" form of coils, winding them in place instead of trying to put on the "formed" coils described in the text. Also you will find it easy to wind starting coils after the "Heyland" plan. You should make a diagram first, and making it yourself will fix the scheme in your mind. Draw a stator sheet full size and number the slots from 1 to 24 inclusive. Represent a coil that can completely fill slots 1 and 6, folded back onto the surface of the sheet so as not to pass in front of slots 2, 3, 4 and 5. (In actual winding, a wooden form ½ in. or more thick should be fastened over these slots at each end, over the back edge of which the wire can be passed as successive turns are put on. After the coil is wound the blocks can be removed and the coil bent away from the iron sufficiently to allow taping the turns compactly together, and then again pressed back into place.) Represent similar coils extending between slots 7 and 12, 13 and 18, and finally, 19 and 24. (Coils should be wound in exactly similar manner, with start in relatively same position, and when connecting, join the inside ends of two adjacent coils, then the outside ends of one of these coils and the next, then the inside end of this third coil with the inside of fourth, and finally there will be two outside ends to lead to the connection board.) Now represent a coil filling slots 5 and 8, and spreading also into slots 4 and 9; inside end will be at slot 5, outside end at slot 9. Similarly a coil occupying slots 11 and 14, and then filling 10 and 15; 17 and 20, along with 16 and 21; finally, 22 and 2, along with 21 and 3. As before, couple first two ends inside, whereby one pair of these coils will be joined in series with the adjoining pair, then two outside ends, then two inside ends, leaving two outside ends for the leads to connection board. For 110 volts we should advise nothing finer than No. 18 wire, using this size for both windings, getting in all the turns you can. We shall be glad to learn of your success.

1775. **A.C. Generator.** L. O., Minneapolis, Minn., is proposing to make a model of a slow speed multipolar machine, with revolving armature, and asks for some general directions. His sketch shows a design with 16 radial poles, a piece of thick 7 in. steam pipe forming the outside frame and magnet-yoke. Armature is 4 in. in diameter, but axial length is not specified. A speed of 260 revolutions per minute is preferred, and while the winding should consist of the diamond shape of formed coils, no particular voltage or number of phases are important.

Ans.—We would suggest that you have the stack of sheet iron about 1¼ in. thick, and cut with 48 slots, making them as large as possible, yet not requiring the teeth to be less than 1/16 in. thick at bottom. This number will permit a 3-phase winding to be used, and be much more valuable for experimental purposes than the plain single phase sort, yet permitting single phase currents quite as well as one limited to that kind only. When you have progressed far enough to know the dimensions of field cores, space for their winding, length of air gap, and size of armature slots, we can advise you as to the requisite number of turns to produce any desired voltage. We should advise you, however, not to try anything above 50 or 110 volts, and if you needed higher, obtain it through the use of transformers. If you can get three different colors of insulation on wire, or when winding the coils, can mark their ends in some distinctive manner, you will run less risk of error in connecting them, and we could the easier give the requisite directions. For instance 16 of the 48 coils could have their outside ends dipped in orange shellac, another 16 in black, the rest in white. The distinction between inside and outside ends you can hardly confuse. Whereas all 48 coils would need to be put on together, as if you were winding an ordinary direct current drum armature, you would confine the first run of connections to every third coil. Join two inside ends, then two outside ends, then two inside ends, and so on, having finally two outside ends. Then take coil No. 2 and No. 5; join their inside ends, then advance to two outside ends, and so on, resulting in two more final ends. Then with coils 3 and 6 proceed in similar manner, getting six outside ends to the final grouping. If you wish a Y connection, join the ends of coils 1, 2 and 3; ends of 16, 32 and 48 will lead to collector rings. If you wish Delta connection, join 1 with 48, and lead that to one ring: join 16 with 17, and lead that point to another ring; finally, 32 with 33 for the last ring. The cycles resulting from the number of poles and speed you propose, 35 per second, are rather out of the common standards, 25 being largely used for power transmissions, 60 for general purposes. However, there are installations operating at 40 cycles in the central part of the State of New York, and in some Southern States. Fifty cycles is the standard European frequency.

1776. **Ignition.** S. V. K., Cooleyville, Mass., asks: (1) Can direct current at 110 volts be used for operating the "make and break" (flash) ignition coil? (2) What other metals than platinum are suitable for the contacts? (3) What quantity of No. 24 iron wire should be used in constructing the heating coils for an incubator? Ans.—(1) Not directly, for the flash would be too severe for the life of the contacts. A highly satisfactory makeshift is to open the cord circuit of some incandescent lamp that may be convenient, and insert three cells of some simple storage battery. Let the coil connect to these cells. Let the lamp run most of the time, and the cells will always be fully charged. (2) There is practically no substitute for platinum. (3) We do not know what size of incubator you desire to heat, but instead of making a special resistance coil, why do you not use incandescent lamps? They form the cheapest and most convenient form of resistance, and of course for a given number of watts liberate the same amount of heat as from any other sort of circuit. One or more lamps may be used, and of different sizes, so you can get as wide a range of heating capacity as desired. By letting the lamps be mostly immersed in a dish of water there will be great regularity in the temperature.

1777. **Electromagnet.** L. J. A., Jacksonville, Ill., is proposing to make an electromagnet 2 in. in diameter and 3 in. long. He asks what should the winding be to produce the greatest lifting power when connected to a 110 volt circuit, and how many pounds will that be? Ans.—We are not sure whether you mean that the iron is 2 in. in diameter or that this is the size of the spool. Neither do you explicitly state that the shape is the familiar U. Is the magnet required to lift a weight some distance, or are you interested merely in the weight that can be sustained? You should make a sketch of just what you have in mind and then we can advise you quite definitely.

1778. **Hardwood Floor.** H. S. M., Syracuse, N.Y., asks: How should a hardwood (maple) kitchen floor be oiled, so the floor will retain its light color and not be darkened as so many oiled floors appear to be? Kindly give constituents of the dressing, quantity required for given surface, manner of application and frequency of application. Ans.—The floor should be scraped and cleaned until all roughness and dirt has disappeared. First, the cracks should be filled. A very good filler is made in the following manner: to one part of white lead in oil, add two or three parts of bolted whiting, and enough coach varnish to form a stiff paste. This should be applied with a putty knife. It will resist moisture, and when dry may be sand-papered and rubbed. Next, give the floor two coats of white shellac, allowing ample time for each to dry; and finally apply a very thin coat of paraffin oil with a brush or a rag, and thoroughly wipe off any surplus remaining on the surface. This oiling should be repeated every week, or whenever the owner thinks the floor needs it. This method of floor treatment has a number of advantages over the wax or varnish finishes. It is ready for use as soon as applied, withstands the hardest wear, is easily put on, and it costs but little after the floor is once put into condition to receive it.

1779. **Telephone Receiver. Dry Battery.** E. C. K., Lawrenceburg, Ind., asks: (1) How to construct a simple telephone receiver. (2) Can a dry battery be restored and how? Ans.—(1) In the June issue of the *Electrician and Mechanic* there will be an article describing the method of constructing a simple telephone receiver and transmitter which will probably meet all of your needs. (2) A dry battery can be restored, but it is seldom a satisfactory operation. For a temporary restoration of the batteries, you might try the following method. Punch nail holes in the zinc containing vessel and stand the battery in a jar (such as a fruit jar); now fill the fruit jar with a sal-ammoniac solution to within 2 in. of the top of the battery. This method is said to work successfully.

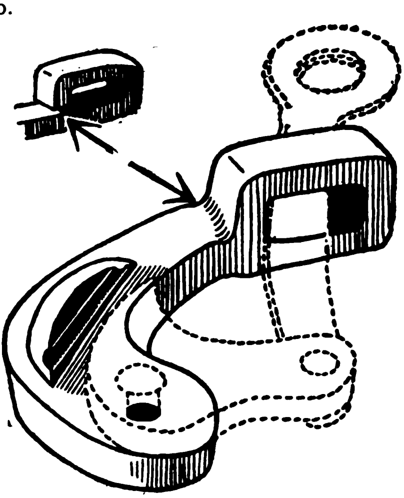
TRADE NOTES

The Wm. J. Murdock Co., of Chelsea, Mass., have made several changes in some of their instruments, and have added a new receiving transformer which they believe should prove popular among wireless experimenters. Among the changes are the improvement of their small spark gap which has been a favorite in the past, together with the designing and construction of a new small helix which ought to be of great interest to those using the smaller powers for transmitting. The new loose coupler will be put out at a very low price, in fact at the lowest price that any reliable instrument has ever been put on the market for before. In addition to these instruments, the Murdock Company is now making in their own factory, and of their own material, three sizes of antenna insulators which they think should appeal to the amateur trade. These instruments and the insulators are shown in the latest bulletin of the Murdock Company, which is being distributed this month.

An Improved "Red Devil" Haven's Clamp

Following the policy laid down some months ago by the Smith & Hemenway Co., No. 150–152 Chambers St., New York, N.Y., to make the year 1912 memorable for the productions of entirely new or improved tools, they are now putting on the market an improved Haven's 'Red Devil" Clamp, as shown herewith.

This Red Devil Clamp, the makers say, is the only drop-forged steel clamp of its kind on the market for stretching telephone, telegraph and farmers' wires. Heretofore, these clamps were made with a bent-over loop, but the Red Devil Haven's Clamp is now made of drop-forged steel, doing away entirely with the bent loop.



In the illustration the dotted lines show the solid steel forgings, and the makers broach a hole and pass the slip-neck through the forging, thereby making it practically an impossibility to break it. During the life of the patent on the old-style tool, it was never made in this way, and the Smith & Hemenway Co. announce that they have met with wonderful success with this new Red Devil Clamp, having had it adopted by all the leading telephone and telegraph companies.

The clamps are made of a high-grade drop-forged steel, are gun-metal finished, and are packed one-half dozen in a box. They are all branded with the Red Devil trade-mark which carries with it the Smith & Hemenway Co.'s usual guarantee as to high quality.

The Blaw Steel Centering Co., Westinghouse Building, Pittsburg, Pa., are offering six prizes for the best plans and specifications for small concrete residences. The designs must be submitted by May 15, 1912, and the company will then select the ten which in their opinion possess the greatest merit. The ten designs selected will be submitted to Professor A. D. F. Hamlin of Columbia University, who will make the final selection. The prizes offered are as follows:

$100.00 for the best set of plans.
$75.00 for the next best set of plans.
$50.00 for the next best set of plans.
$25.00 each, for the three next best sets of plans.

The competition will be conducted under the rule of the American Institute of Architects and is open to all. It is the desire of the Company to receive suggestive designs that will give the greatest value for the expenditure, and also new ideas that will tend to stimulate the construction of poured concrete houses. It is immaterial in this contest whether the value is secured by utility, beauty, novelty, fireproof qualities, or by combinations of these.

Following the award of the prizes, the plans of the successful contestants, with names and addresses of the designers, will be published in a booklet, which will be given wide circulation among prospective builders to encourage the construction of concrete houses.

The conditions governing the competition may be obtained by writing the company at their Pittsburg, Pa., address.

We are in receipt of an interesting catalog from the South Bend Machine Tool Co., of South Bend, Indiana. In the catalog are described and illustrated their line of screw-cutting engine lathes. These lathes may be driven by foot-power, engine-power or by an electric motor. All parts of the South Bend lathes are interchangeable and each machine when finished is put under belt, operated and tested.

The General Electric Company is just issuing its 1912 catalog of electric fans. The publication is an attractive one, printed in colors, and contains descriptions and illustrations of the fans manufactured by that Company for use in the home, office and public places. The line of fans comprises those suitable for use on desk or table, and which are manufactured with fan diameters of 8, 12 and 16 in. All of these fans are convertible without the use of tools or additional parts, so that any one may be used on a horizontal surface or attached to a wall. They are made in two styles: fixed and oscillating. The publication contains also illustrations and descriptions of the ceiling and column fans manufactured by the Company, and a line of supply parts for these.

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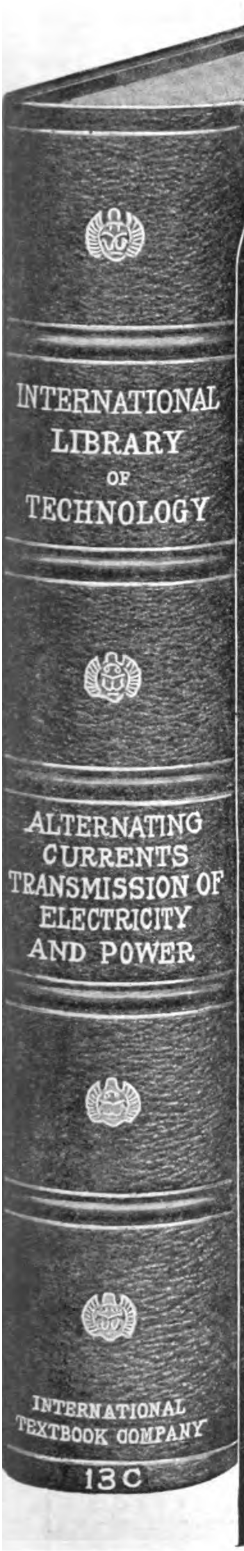
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HAVE you read "How to Succeed"? It is the greatest satire ever written on the get-rich-quick mania; 15 cents postpaid. A. RUHNAU, Dept. 80, 280 Columbus Ave., New York.

FOR SALE—Roll top desk, 4 ft. 6 in. long, almost new. Will sell for half its value. H. SLOCUM, 145 Powers St., Brooklyn, N.Y.

FOR SALE—Marine gasoline engine, heavy duty, 6 h.p., 4 cycle reversing propeller complete, in perfect condition. H. S. HUSBAND, 13 Priestly St., Wilkesbarre, Pa. (s)

FOR SALE—Hammond typewriter, price $10.00; cost $75.00. R. C. NEWMAN, 2,424 Orchard St., Chicago, Ill. (s)

FOR SALE—Plating Dynamo, 6 volt, 100 amperes, with nickel and silver outfits. Dynamo will work 500 gallons, solution. $35. HARRY STRANG, West Unity, Ohio.

LEARN to make hatpins and brooches of rosebuds and butterflies. Pleasant, profitable employment. Beautiful sample and booklet, 12 cents. A. E. BENSON, Stewartville, Minn.

NO MORE fussy polarity indicators. Send dime for enough "Pol-Test" paper for 30 to 90 cheap, simple, certain tests. Mail order department, 390 N. Euclid Ave., St. Louis, Mo.

EXCHANGE combination billiard and pool table, good condition, size 3 x 6 for induction motor to party living near Seattle. W. M. HINELINE, 512 Maple Leaf Place, Seattle, Wash.

HOW TO RENEW OLD DRY BATTERIES at a cost of 1 cent each. Send 15 cents coin to R. T. KALB, 2631 Sutton Ave., Maplewood, Mo. (5)

AMATEURS LET ME QUOTE YOU on parts. Anything you may be making. Lathework a specialty. C. M. CURTIS, 15 N. 6th St., Fulton, N.Y. (5)

FIFTY VIEWS OF ROCKY MTS. or State Capitols, all different, in colors, glazed finish, prepaid for 25 cents in stamps. Address F. R. BLAIR, post card jobber, Harrickville, Pa. (5)

PATENTS

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C. L. PARKER, Patent Attorney, ex-examiner, U.S. patent office, 952 G St., Washington, D.C. Inventor's handbook "Protecting, Exploiting and Selling Inventions," sent free upon request. (4)

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