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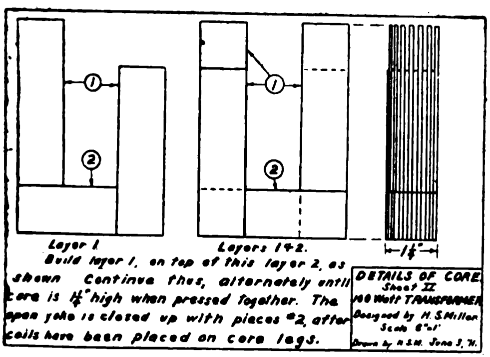
A 100-WATT STEPDOWN TRANSFORMER

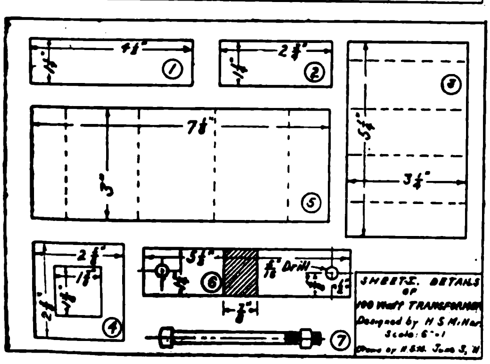
HOWARD S. MILLER

The accompanying drawings give all the data necessary for the construction of this transformer, but the following notes may prove useful to the novice.

To make the spools on which the coils are wound, cut out two pieces No. 3 from 1/16 in. fiber, soak them in hot water, and bend into square tubes over a piece of hard wood 1¼ in. square. Make the joints in the tubes come on the middle of a side, and not on an edge. Cut out the spool ends, No. 4, and place one on each end of the square tubes.

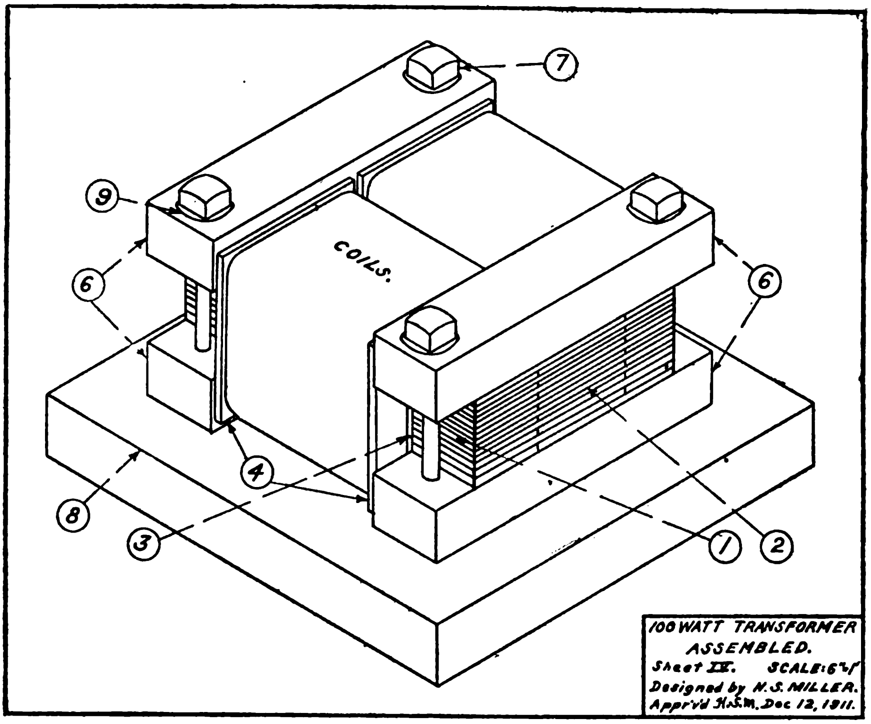
Put the fiber tube on a 1¼ in. square wooden arbor, place it between the lathe centers, and wind on 7 layers, 70 turns per layer, of No. 20 B. & S. d.c.c. copper wire. Over this place the fiber tube No. 5, holding it in place with a few turns of string until the secondary winding is started.





On top of this insulating tube wind the secondary, putting on 2 layers, 25 turns per layer of No. 10 B. & S. d.c.c. wire. Bring the ends of these windings through holes drilled in the heads of the spools. These holes should all be on the side of the spool which is to be *outside* when the spools are in position on the core legs, to avoid interference with the clamping bars and the core. The two spools are both exactly alike, and when assembled, the primary coils, and the secondary coils on each are connected in series, so that the current flows in opposite directions on the two legs.

If various voltages are desired from the transformer, taps may be brought out from the secondary winding at the proper points. Every ten turns on the secondary give an e.m.f. of about 1 volt. An arrangement of taps which gives 20 different voltages from ½ to 10 in steps of ½ volt is: taps on the following turns—20, 40, 60, 80, 85, 90, 95. These taps may be brought to a row of binding posts, or the beginning of the secondary and the first four of the taps may be connected, in order, to the contacts of a five-point switch, and the last three taps and the end of the secondary connected, in order, to the contacts of a four-point switch. A wire is then connected to each switch arm, and these form the low tension terminals. Number the contacts of the five-point switch, 0, 2, 4, 6 and 8; and those of the four point, 8½, 9, 9½ and 10. Then, to obtain any given voltage, set the switch levers so that the number of the contact



used on the four-point switch minus the number of the one on the five-point switch equals the desired voltage. Fig. 5 shows this connection of the secondary taps.

The secondary winding is most conveniently tapped at the required points by means of strips of No. 24 B. & S. gauge copper ⅜ in. wide, and of any desired length. A hook bent on one end of this strip, as shown in Fig. 6, allows the tap to fit the wire closely. Thus when the open end of the hook is bridged over by soldering, an efficient joint results, which when filed up and taped with thin silk, increases the diameter of the wire only slightly, thus preserving the uniformity of the winding. In placing the taps, wind up to the required point, mark the location of the tap on the wire, and then unwind a few turns. This makes it easy to remove the insulation at the marked point, and solder the tap in place, with the assurance that it will come in exactly the right place when the wire is rewound.

If a constant secondary voltage other than 10 is desired, wind the primary as above; but for the secondary use a new size of wire found as follows: divide 100,000 by the desired voltage. The quotient is the size in circular mils of the wire which will safely carry 100 watts at the desired voltage, and the corresponding gauge number can be found from any wire table. Put on ten times as many turns of this wire as you wish volts, winding half the turns on each spool.

The core is built up as shown in sheet II, using two No. 1, and one No. 2 pieces in each layer. If desired, instead of using the three pieces for each layer, a piece might be cut which would have the shape of the three assembled as shown. A piece of such shape would be more difficult to cut from the sheet iron, but would have the advantage of being easier to assemble, and of allowing less magnetic leakage. If regular transformer iron is not available, these pieces may be cut from tin cans, for it has been found by experiment that the iron in cans, being fairly soft and only about .0125 in. thick, generally gives better results than the grade of sheet iron commonly obtainable. Before assembling, all these iron pieces should be given a coating of thin shellac varnish, and allowed to dry.

The core is most easily built up by

building around nails driven in a board, allowing the open yoke to project about 2 in. over one edge of the board. When the core is of the required height, another board is placed on top of the core, and the whole pressed together in a vice. The spools which have been wound may then be pushed on the projecting core legs as far as possible, and the vise released slightly to allow a little more of the board to be pulled out. The vise is then tightened and a piece of the board split off with a chisel, allowing the spool to be pushed further on the leg, and continuing thus until both spools touch the closed yoke. Then the open yoke is closed up with pieces No. 2.

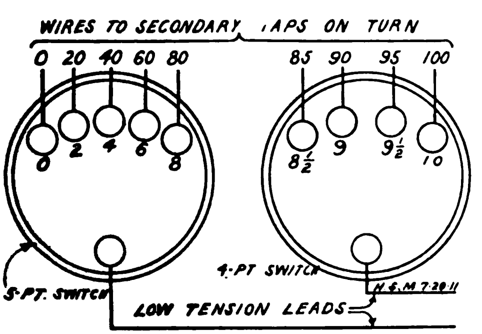
The clamping bars may then be placed on the yokes, and the core drawn together with the bolts, which also pass through, and secure the whole to the base.

The primary and secondary terminals, and taps, if any are used, may be brought to binding posts, terminal blocks, switches, etc., and proper fuses inserted in primary and secondary circuits, according to the individual needs or desires of the builder.

If desired, the whole transformer may be immersed in transformer oil contained in a sheet iron box. Such a construction would allow a more ready dissipation of heat if transformer were to be used constantly, and would preserve the windings.

The following are the directions and drawings for the construction of a compact and durable relay, combining all the features of a commercial instrument:

The core is made of a piece of well-annealed Norway iron, 2 7/8 x 3/8 in. At one end a No. 19 hole is drilled 1/2 in.



CONNECTION OF SECONDARY TAPS.

Fig. 5

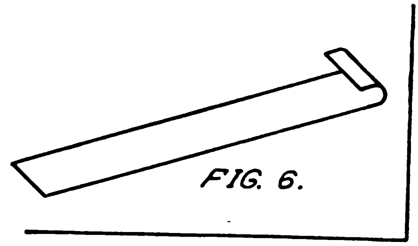


FIG. 6.

deep and tapped for a 10-32 thread. Over the core is forced two fiber "heads," 1 in. in diameter by 1/8 in. thick, placed 5/32 in. from the ends. The entire space is then wound with No. 36 s.s.c. copper wire, so that the wound bobbin will have a resistance of about 500 ohms. The coil ends are then soldered to the leading out terminals at one of the "heads," as seen in the drawing. The yoke is made in an L-shape, of soft iron. The one end is drilled 1/4 in. deep and tapped for a 4-36 threaded brass rod, the thread of which is 3/4 in. long, for the check nuts, in order to regulate the movement of the armature. This latter piece is also made in an L-shape. The upper part has a hard rubber stud projecting 1/16 in. above the surface so as to insulate the armature, etc. The springs are made of brass or bronze, insulating each other by fiber washers and held fast to the yoke by two fillister screws. The contacts may be made of either platinum or German silver, though the former is superior. A piece of rod 1 11/16 in. in diameter is threaded 5/16 in. long with a standard 1 5/8 in. pipe die for the instrument cover, which is made of brass tubing 3 3/4 in. long, one end having a disc of the same diameter soldered tight and the other tapped 1/4 in. deep with a 1 5/8 in. thread. These two parts may be made at any plumbing shop at a small cost. The attachment piece is last constructed, being made of soft iron in an L form, the upper part having three countersunk holes in order to fasten instrument where it is most suitable. The coil, yoke, etc., are held in place by a 10-32 threaded brass rod and nut to the attachment piece, but insulated by fiber washers, as seen in the drawing.

By following these directions closely the builder will have a strong and reliable instrument which may be placed on either base, behind switchboard or wherever space is available, as there are no parts to get out of order and is absolutely dust-proof.

MUTILATORS OF TELEGRAPHY AND TELEPHONY

FRANK M. EWING

There is nothing in this world more exasperating or nerve-racking than for a train dispatcher or an operator to struggle along, quite frequently under great difficulties, trying to receive from a mutilator of the Morse telegraph code or converse with a person with indistinct articulate speech over a telephone circuit. When the quality of Morse is good it is a great pleasure to work, and an experienced operator can answer questions or carry on a conversation while receiving without any discomfort. If the sending is mutilated then the mechanism of the ear thus combines the functions of both separator and transformer, while almost every nerve is strained in order to properly translate the mutilations.

There is really no excuse for operators remaining in ignorance of their defects, provided they are open to conviction. The bad senders endeavor to back up their claim of good Morse by mentioning one or two operators "who receive from them all day without breaking," not taking into consideration the fact that those patient and good-natured victims have evidently familiarized themselves with their combinations and put down what they mean instead of what they send. The various characteristics of bad sending noticed are as numerous as those existing between the different styles of chirography or conversation of different people. The peculiarity of their sending lies in the lengthening of the first or last dot of a letter, running the spaced dot letters together, dropping dots off some of the letters, running some letters of words together and spacing the others, making different combinations out of them and not allowing the proper interval of time for the letter and the spaces. Thus R sounds like "Ti," C like "It," figure 3 like "v," the word coat like "Is at," them like "Thw," Emporium like "Wposium," Harrisburg like "Hasspburg," President "P R & I don't." etc., and almost every word transmitted must be figured out by the receiving operator by making due allowance for the mutilation.

Accurate sending is more desirable than high speed. It is well to remember that operators are no judge of their own Morse, and therefore should not try to see how fast they can send until they have had considerable experience. Who has ever heard a mutilator admit that his sending was poor? Now and then one may concede that his speed is below par, but as to the quality of his Morse, there can be no question, the fault is always with the receiver.

Some entertain the erroneous idea that firm transmission of the alphabet depends largely upon the pressure brought to bear on the key, and by pursuing that course do not allow the muscles of the fingers to fully relax between the formation of one dash or dot and another. The result is that a dot is lengthened into a short dash. The custom of timing for ascertaining the speed of sending should be very sparingly indulged in, for it is likely to produce careless habits.

The speed of sending should be graduated to suit the capacity of the receiver; the latter should never be crowded. Fast sending is seldom indulged in by strictly first-class operators, but fast time is made by them on account of their firm, steady, even gait.

Accept the average receiver's opinion regarding your sending before you decide for yourself that your sending is all right, for the poorest operators often think their sending is good. If the receiver tells you that you do not space properly, or calls your attention to some particular fault, do not get angry, but take the hint, and try to remedy your weak points. There should be no difficulty in correcting one's faults, as a mutilated Morse character can be detected instantly by anyone who will listen carefully to his own sending.

It was thought that the introduction of automatic transmitting machines would put a ban on the bad sender, hence his future toleration depended upon reform or a machine. Experience has shown it simply divides mutilators into two distinct classes, those using the Morse key and those using transmitting machines. Statistics show if a person is poor at handling one instrument, he rarely becomes an artist in handling another. Of machine sending there is this to say: Those employing an ordinary typewriter keyboard like the Yetman transmitter, will transmit perfectly-formed Morse characters provided the discs are clean and the electric contact is good; and the machines enable some senders who have lost their grip to do good work. All that is required is to simply touch the characters and the machine transmits them over the wire; but if the discs are allowed to accumulate dust, or become rough, the signals will be light owing to high resistance, or drop out altogether. The machines, operated by a side motion, of the Mecograph or Vibroplex type (with the exception of dot letters) require as many movements of the hand as the Morse key.

Sending machines are so trying to receivers and so unsafe when not properly adjusted that the advisability of prohibiting their use is being seriously considered. Automatic sending devices are very often so adjusted that dots are made at the rate of 80 or 100 words a minute, while the actual speed made by the operator is only 30 or 40 words a minute. Everyone, especially at repeating stations, notices that the signals from sending machines are thin and drop out when not properly adjusted and manipulated. Sending operators always know when the dots are needlessly fast and they can add to the comfort of the receivers and help to make good signals by giving careful attention to the adjustment of their machines.

Better results might be obtained from sending machines if the tinkering process were not applied to them. No machine on earth will hold up or withstand the onslaughts of a professional tinker who imagines he is thoroughly familiar with the mechanism of all kinds of machines. A great many machines of various types have been literally ruined in a short time in the hands of these artists. If a machine is properly adjusted and simply let alone it will last indefinitely, doing good work if proper care and judgment is exercised in handling it.

It is amusing to hear operators with one or two years' experience, comparatively young men or women in the point of years of service, with practically no sending worth speaking of during their assigned hours, say their arm is playing out and they must get a sending machine in order to save their arm from playing out entirely. The reason they want a sending machine is because it is something new, they want to try it out and experiment with it, much to the discomfort and dissatisfaction of the receiving operator. Their sending resembles coal rattling down through a chute and the same with a poor sender on the Morse key. There are great many operators in the telegraph field who are troubled with a tired feeling, and they will surround themselves with all kinds of utensils and devices in order to see how near they can get to something to do their work without them making any effort to do it themselves. On the other hand we have men and women in the field who have done the heaviest kind of telegraphing for a period of 30 or 40 years, transmitting the prettiest Morse you would wish to listen to with the ordinary Morse key; never complaining about their arm giving out nor expressing any desire to try an automatic sending machine.

The "go as you please" sender, for whom no apology can be made, is the product of pure carelessness or indifference. Quite frequently we see him in a telegraph office in a lounging attitude with his feet elevated on the table higher than his head while sending, simply tapping the key and making no effort to send perfectly-formed Morse characters. When he is through sending he will sit upon the table with his feet upon his chair in order to accumulate as much dirt upon the chair as possible before using it to receive. It corresponds with his sending. When he is called to receive he will sit down upon the dirty chair, wrapping his legs around the top of his typewriter, which he imagines is a very graceful and easy position to receive in.

The "go as you please" sender is an operator who never sends two consecutive words or sentences at the same rate of speed or in the same style, and is never sure of a word until he hears the last letter completed and is then so surprised at his execution that he usually stumbles all over the word that follows.

The proper position for holding the key and the one adopted by the majority of the most speedy and perfect operators, is to rest the first and second fingers on the top and near the edge of the key button, with the thumb against the edge of the key button. Curve the first and the second fingers so as to form the quarter section of a circle. Avoid straightness or rigidity of these fingers and the thumb. Partly close the third and fourth fingers. Rest the elbow easily upon the table, allowing the wrist to be perfectly limber. When the proper "swing" is acquired, the forearm moves freely in conjunction with the wrist and fingers. The fingers and thumb should act as the end of a lever, the wrist and forearm doing the work. Let the grasp on the key be moderately firm, but not rigid. Grasping the button tightly will quickly tire the hand and destroy control of the key, causing what is termed telegraphers' cramp. Avoid too much force or too light a touch, and strive for a medium firm closing of the key in order to obtain uniform duration of the period of electric contact. It is not the heavy pressure of the key but the evenness of the stroke that constitutes good sending.

Telegraph repeaters can be adjusted for both light and heavy senders, but not for an uneven sender. A telegraph repeater adjusted for either a light or a heavy sender might be out of adjustment for a perfect sender. The motion should be directly up and down, avoiding all side pressure. Never, of course, allow the fingers or thumb to leave the key; that is, do not tap, pound, or strike the key with the fingers, or allow the elbow to leave the table. I have seen operators who were careless smash the key shut and knock the circuit breaker knob across the room. It is well to remember there are others working in the office, quite often at the same table, and they don't want to be disturbed with your efforts to demolish the key. The correct method of sending is an easy one, and when it is properly done, an operator should be able to send for twelve hours continuously without tiring.

Since the typewriter has come into general use for writing down the telegraph messages as the operator receives them from the sounder, making the receivers' work much easier, there is no danger of worrying an experienced operator by sending too fast. A good typewriter operator can write from 60 to 70 words a minute and more, but an expert telegraph operator cannot send steadily over 45 or 50 words a minute; consequently a receiver has plenty of time, in addition to writing the message, to insert the "time received," the operators personal sign, etc., even when receiving at the fast rate mentioned. Every young operator should learn to operate the typewriter rapidly and accurately. It is generally conceded by expert operators that a double bank typewriter is best adapted for telegraph work on account of its simplicity and the ease by which the operator can manipulate the machine, no shifting for capital letters and other characters being necessary.

Mutilations and misunderstandings occur in telephony as well as telegraphy. Acoustics is that branch of physics which treats of the phenomena and laws of sound and sound waves. There are two distinct definitions of sound: First, sound is the sensation that is perceived when the nerves of hearing are properly excited; and, second, sound is a physical disturbance capable of producing on the auditory nerves the sensation of hearing. According to the first definition, therefore, sound is the sensation itself, while according to the second, it is the stimulus or cause of the sensation.

The physical disturbance capable of exciting the auditory nerves is a wave motion passing from some vibrating body through some material medium, which is usually air, though it may be any gas, solid or liquid. It is well established that all action between points or bodies separated by space is due to vibrations of the medium filling this space, no matter what that medium may be. In the phenomena of light, heat, or electricity, the medium is the ether; while in the case of sound, some more tangible medium such as a gas, liquid, or solid, is needed.

If these waves originate in or are communicated to the medium in which the ear is situated, then at each recurring condensation the elastic membrane, called the *tympanum*, or drum of the ear will be pressed inwards, and at each recurring rarefaction will be drawn outwards. These vibrations will be transmitted by means of a chain of bones, termed the *hammer*, *anvil* and *stirrup*, to the membranous wall that closes an internal cavity, called the *vestibule*, through it and some canal-like passages filled with a liquid and containing ramification of the auricular nerve, which the vibrations finally reach and excite. This nerve ends in minute rods or fibers, each of which seems to vibrate at a definite frequency, and each one is excited only by a wave having the same period of vibration.

The greater the degree of condensation and rarefaction of the medium in a given time, the greater will be the motion of the drum of the ear that acts on the nerves. Hence, it follows that the function of the human ear is the mechanical transmission to the auricular nerve of each expansion and contraction that occurs in the surrounding medium, while the function of the nerve is to convey to the brain the sensations thus produced. From the above, one can understand why it is possible to make some persons who are deaf on account of an unnatural condition of some part of the ear mechanism hear by the use of apparatus that collects and transmits sound vibrations through the teeth and bones in the head to the auricular nerve. The nerve itself must, of course, in order to accomplish this, be in a natural state, free from disease.

All vibrations that set up waves in the manner already mentioned are not capable of producing the sensation of sound.

A uniform series of vibrations, a definite number of which are produced in a given time, and which are within limits capable of exciting the auricular nerves, is called a tone. Thus a simple musical tone results from a continuous, rapid, and uniformly recurring series of vibrations, provided that the number of complete vibrations per second falls within certain limits.

If, for example, the vibrations number less than 32 per second, a series of successive noises are heard, while, if their number is greater than 40,000 per second, the ear is not capable of appreciating the sound. Of course, different people have very different powers of hearing and different articulate speech. The number of vibrations of a musical tone is somewhere between 35,000 and 32 per second, and the number of vibrations produced by the human voice when talking is between 61 and 1,035 per second. In ordinary conversation, the average frequency is about 300 per second.

All sounds have three characteristics, variations in which enable us to distinguish between the different sounds we hear. They are termed loudness, pitch and timbre.

Loudness is that characteristic of sound which depends on the amplitude of the sound wave. It depends on the amount of energy in the vibrations producing the sound.

Pitch depends entirely on the number of vibrations per second, that is, on the frequency. A low rate of vibration produces what is called a low tone and a high rate a high or shrill tone.

Timbre is the quality of sound, and depends only on the form of the sound wave. A pure tone is one produced by a simple vibration. The quality of a tone may therefore be said to depend on the form of the resultant wave.

The successive vibrations set up by the vocal organs, forming distinguishable and intelligible sounds, are called articulate speech. These vibrations, which are the most complex in the whole realm of sound—so complex, in fact, as to defy mathematical analysis; but it is certain that their variations in loudness, pitch and timbre depend on the facts already outlined. By means of these variations, we are not only enabled to understand the words spoken by others, with all their various shades of intonation and corresponding shades of meaning, but we are able to distinguish between the voices of the many people with whom we are acquainted.

The letters T, V, B, P, and the words "weaver," "stever," "lever," are difficult to distinguish over a telephone on account of the similarity in the pronunciation. On some circuits they number each letter of the alphabet and give the number of the letter in order to insure accurate transmission. Quite frequently a doctor is called by telephone to see a patient and calls at the wrong house, going many blocks out of his way on account of indistinct articulate speech or similarity of the pronunciation of names. Persons with an impediment in their speech who are not a success in speaking over a telephone circuit, make good telegraph operators transmitting good Morse. When the 'phone receivers are off the hook any noise in the vicinity of the telephone passes through the telephone making it difficult to receive conversation. When telegraph keys are open no noise passes out over the circuit.

ENGINEERING LABORATORY PRACTICE—Part III

The Ericsson Hot-Air Engine

P. LE ROY FLANSBURG

In one respect at least all heat engines are similar, namely that they all receive heat from some source, transform a certain portion of this heat into work and then reject the remainder of the heat. Since we know that the efficiency of a heat engine is equal to heat transformed into work divided by the entire amount of heat supplied, it is at once apparent that maximum efficiency will be obtained when all of the heat is added at the highest practical temperature and the heat rejected is rejected at the lowest possible temperature.

$$e = \frac{Q - Q_1}{Q}$$

Where e equals efficiency.
Q equals heat applied (B.t.u.)
Q_1 equals heat rejected (B.t.u.)

The ideal type of cycle for carrying on such a heat change is known as the Carnot cycle, and if this cycle could be exactly obtained we would get maximum efficiency from the engine. However, it is not possible to exactly follow this cycle, and it therefore serves merely as an ideal type which is approached as nearly as practical conditions will allow. In obtaining the Carnot cycle, heat is supplied to and withdrawn from a constant mass of working substance, and the hot-air engine is the only engine which attempts to follow this example of the Carnot engine.

There are various makes of hot-air engines, such as the Stirling, the Ericsson and the Ryder Compression hot-air engine, but in this article I shall confine my discussion to but one type, the Ericsson. The attempts to develop hot-air engines on a large scale have been practically abandoned, but they are still used for small domestic pumping stations since they are free from danger and require but little attention. The chief difficulty with any hot-air engine is to transmit the heat to and from the working substance.

In the Ericsson hot-air engine but a single cylinder is used, and in this cylinder are two pistons, each connected to the fly-wheel by a linkage system. The duty of the lower piston (or transfer piston as it is called) being to transfer the air contained in the cylinder, alternately from one end of the cylinder to the other, and it is important that the air should be transferred at exactly the proper time. The upper piston is known as the main or air piston.

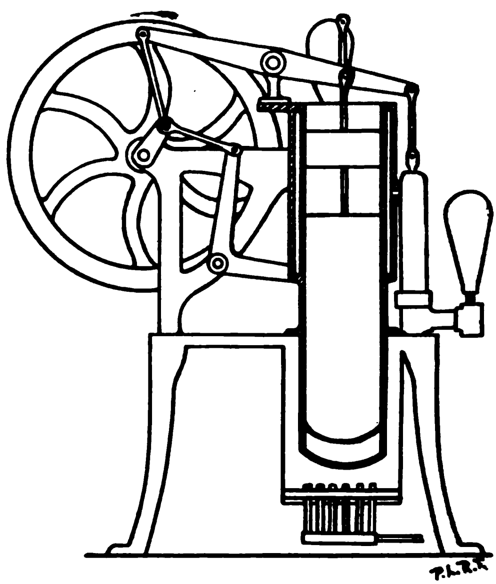


Fig. 1.

Heat is applied at the bottom of the cylinder, and the bottom of the cylinder is allowed to become as hot as is practical. The upper end of the cylinder is kept cool by means of a water jacket, and all of the water pumped is passed through this jacket.

The operation of the engine is as follows: The air is first compressed in the upper part of the cylinder, it is then transferred to the lower part of the cylinder, where it becomes heated and expands. As it expands it furnishes the power.

Fig. 1 shows a diagrammatic view of the engine.

The cycle upon which this engine works is called the Stirling cycle, and is represented in Fig. 2. The air is heated at constant volume, expands at constant temperature, is cooled at constant volume

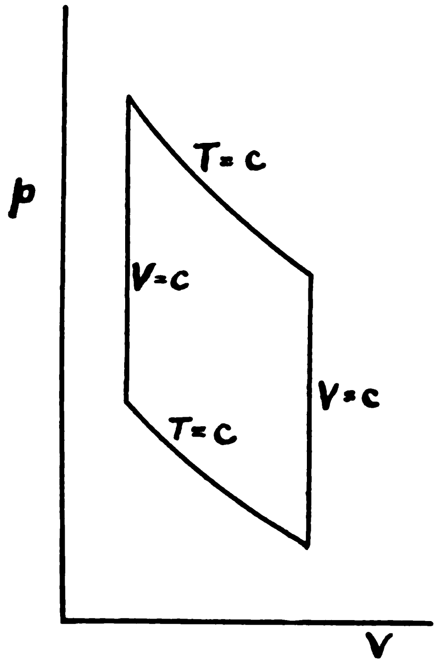


Fig. 2.

and is compressed at constant temperature.

The pump which the engine operates is direct connected by a lever arm. As the engine (like all hot-air engines) is but single acting, a large fly-wheel is used and the momentum of the fly-wheel continues the revolution until it is given an additional impulse by the engine. The engine makes but little noise and the same air is used over and over again.

The following results were obtained as a result of tests carried on by the author.

DESCRIPTION OF TEST

Three ten-minute tests were run on the Ericsson hot-air engine, to determine the horse-power developed, the cost per horse-power hour, and the thermal and mechanical efficiencies of the engine. The discharge pressures were varied from 3 to 13 lbs., and readings were taken every two minutes of the discharge pressure, the revolutions per minute, indicator and the gas-meter dials. Indicator cards were taken every four minutes during each run, and the total amount of water used per run was measured.

The horse-power developed was calculated by means of the M.E.P., as given by the indicator cards, the dimensions of the engine and the speed. The cost per horse-power hour was found from the horse-power developed, the cubic feet of gas burned per minute and the cost of the gas per 1,000 cubic feet. The thermal efficiency is merely the ratio of the output in indicated work to the input which is due to the heating value of the gas. The mechanical efficiency is the ratio of the output in water work done to the indicated work done. (The water work done being equal to the product of the pounds of water pumped per minute times the total head acting on the water.)

DATA

Diameter of piston	8 in.
Length of stroke	$3\frac{7}{8}$ in.
Height of center of gauge above water level in tank	48 in.
Cost of gas (per 1,000 cu. ft.)	\$0.80
Heat of combustion of gas (per cu. ft.)	600 B.t.u.

OBSERVATIONS

	Test No. I	II	III
Rev. per min.	68	76	79
Dis. pres. (lb.)	3.3	8.2	12.2
M.E.P. (lb.)	2.69	2.97	3.71
Cu. ft. gas (per min.)	.45	.45	.45
Lb. of water (per min.)	41.6	40.5	39.8

COMPUTATIONS

$$\text{Indic. H.P.} = \frac{PLAN}{33{,}000}$$

Test No. 1.

$$\text{Indic. H.P.} = \frac{2.69 \times 3.88 \times 50.3 \times 68}{33{,}000 \times 12} = 0.09$$

Test No. 2. (similarly)

Indic. H.P. = 0.11

Test No. 3. (similarly)

Indic. H.P. = 0.15

$$\text{Thermal Eff.} = \frac{\text{Indic. Work}}{\text{Heating value of gas}} \times \frac{1}{778}$$

Test No. 1.

$$\text{Thermal Eff.} = \frac{0.09 \times 33{,}000 \times 100}{600 \times .45 \times 778} = 1.42\%$$

Test No. 2. (similarly)

Thermal Eff. = 1.73%

Test No. 3. (similarly)
Thermal Eff.=2.35%

$$\text{Mech. Eff.} = \frac{\text{Water H.P. output}}{\text{Indicated H.P.}}$$

Test No. 1.

$$\text{Mech. Eff.} = \frac{41.6 \times 11.6 \times 100}{33{,}000 \times 0.09} = 16.3\%$$

Since total head (3.3 x 2.3)+4=11.6 ft.

Test No. 2. (similarly)
Mech. Eff.=25.6%

Test No. 3. (similarly)
Mech. Eff.=25.8%

Cost per H.P. hour.

Test No. 1.

$$\frac{.45 \times 80 \times 60}{0.09 \times 100{,}000} = \$0.24$$

Test No. 2. (similarly)
Cost=$0.20

Test No. 3. (similarly)
Cost=$0.14

RESULTS

	Test No. I	II	III
Indic. H.P.....	0.09	0.11	0.15
Thermal Eff.....	1.42%	1.73%	2.35%
Mech. Eff........	16.3%	25.6%	25.8%
Cost per H.P. hour	$0.24	$0.20	$0.14

IGNITION AND IGNITION METHODS

ROGER B. WHITMAN

(Of the Bosch Magneto Company)

The state of perfection of the present-day internal combustion engine has not been reached without deep study and investigation, in the course of which it has been realized that ignition has vastly more to do with efficiency than was at first believed.

The early conception of ignition was the production of a spark some time toward the end of the compression stroke, and if this spark was successful in igniting the mixture, that was all that was desired. The character of the spark, the accuracy of its production, or the exactness of its timing were points that were disregarded by the designer, because he did not understand that these had any bearing on the power output or on the fuel consumption of the engine.

The modern designer takes an entirely different view of the subject, however, and it may be of interest to outline the problem as it is now understood.

To appreciate the fine points of this problem, the engine must be considered in its true light as a heat engine pure and simple.

The mixture that is drawn into the cylinder during the inlet stroke represents a certain heat value, and the efficiency of the engine depends upon the manner in which this heat is applied to the expansion of the gases. Any condition by which some of this heat is lost, or by which it is not applied directly to the forcing of the piston outward on the power stroke, will reduce the engine efficiency.

The first step in the securing of efficiency will be to study the points at which losses of heat may occur, and to adopt means by which these losses may be prevented.

The charge of mixture represents a certain heat value and has a certain maximum pressure. To exert the greatest possible proportion of this pressure against the piston, each particle of mixture should be made to give up its heat at the instant when the piston is at the end of the compression stroke and is ready to move outward on the power stroke.

To gain this result, it would be necessary to ignite each particle of the mixture at the same instant, and thus to have ignition and combustion occur at top dead center. The mixture would thus be compressed into a minimum space before ignition and the rise in pressure due to combustion would then be most abrupt, the piston being driven outward with maximum force.

No existing ignition system will permit the ignition of all of the particles of mixture at the same instant. The system in use, therefore, permits ignition of the mixture at one or two points from which the flame is expected to communicate itself to the remaining mixture particles.

In a perfect mixture, each particle of gasoline vapor will be surrounded by the particles of air necessary for combustion, and to ignite the mixture it will be necessary to raise the temperature of these particles to the point at which the chemical change known as combustion will occur.

Under usual motor conditions, the heat developed by the electric spark is depended upon to raise the temperature of certain of these particles to the point at which they will ignite, and the flame thus started is communicated to the particles of the mixture immediately surrounding it, thus being propagated throughout the entire charge.

To our senses, the spread of the flame from the point of ignition is instantaneous, but in comparison with the speed at which a gasoline engine operates, the time required is very considerable, and must be taken into consideration. Thus there enters into our calculations the period of time that must elapse between the instant at which ignition occurs and the instant at which the entire charge will be inflamed.

It is desired to apply to the piston the greatest pressure possible, and, obviously, the greatest possible pressure will be produced at the instant when combustion is complete. At this instant, therefore, the piston should be at the top of its stroke. We must not overlook the fact, however, that some pressure is produced at the instant when ignition occurs, and that this pressure will be constantly increasing as combustion spreads. If combustion is to be complete when the piston is at its top point, it is clear that ignition must occur while the piston is still moving upward on the compression stroke. For the last portion of its stroke the piston will therefore be subjected to this pressure, which is rising to maximum, and by which the piston will tend to be driven backwards; at the same time the momentum of the fly-wheel is urging the piston upward. Some of the power of the engine will thus be required to force the piston upward, and in this is found one of the most serious of the losses in engine efficiency. If the engine is going at sufficient speed, the momentum of the fly-wheel will force the piston against the pressure in the combustion space to top center, but the result of the conflicting pressures will be shown in abnormal wear of the wrist pin, crank pin and main bearings.

All motorists have had experience with a back-fire when cranking an engine, and known that it is the production of maximum pressure in the combustion space before the piston reaches the top of its stroke, the result being that the engine starts to run backward. This same condition in a lesser degree exists in a running engine under the normal condition of ignition occurring before top center.

The charge of mixture represents a certain heat value, and can be made to exert a certain definite pressure upon the piston. To get the best possible results, all of this pressure should be exerted against the piston when the latter is at the top of its stroke. If some of the pressure is exerted before the top center is reached, less pressure will remain to act on the piston during the power stroke. This entails a double loss, for not only is the rotation of the crank-shaft somewhat retarded, but the maximum pressure developed at top center is reduced. The effect is shown in an increase in the consumption of fuel and in a reduction of the power output.

Another loss that results from ignition earlier in the stroke is due to the absorption of heat by the cylinder walls; these surfaces being of metal are natural conductors of heat, and, of course, the longer the period during which the flame is in contact with these surfaces, the greater will be the heat absorbed and wasted in this manner.

The obvious way to reduce loss of power from these causes is to produce ignition as late in the stroke as possible, but this is limited by the necessity for having combustion complete at top center.

The remedy will therefore be to hasten ignition as much as possible, or, in other words, to reduce the time necessary for the propagation of the flame throughout the mixture.

One of the most important factors in this is the location of the spark plug, which should be so placed that the distances through which the flame must be spread are as short as possible. If, for instance, the plug is located in a valve pocket on one side of the cylinder, the distance through which the flame must spread will be practically maximum, and the operation will require more time than would be necessary if the spark plug were located in the cylinder head. Furthermore, the plug should be so located that its points are actually plunged in the mixture, and not set in a cavity or pocket. Engines are occasionally seen with valve caps that are solid and possibly an inch thick. If a standard plug is screwed into such a cap, the spark points will be found to set some distance up from the internal face of the cap; the spark will ignite the mixture which is in the hole or pocket, and some little time will be required for the flame to spread down through the hole and to be communicated to the mixture.

Such a construction will require considerably more advance of the spark than would be necessary if the spark points were in direct contact with the charge.

The size of the ignition is also a factor that determines the time required for combustion. The ideal ignition spark should be a mass of flame with as large a surface as possible, for this will result in the ignition of a large number of mixture particles. It should be understood that the spark must come into actual contact with the mixture particles in order to ignite them, and if the spark is thin, it will be quite possible for it to pass through a throttled mixture without actually coming into contact with any of the particles. With a spark that is in the nature of a flame this cannot take place. A large spark not only insures ignition, but makes combustion more rapid, for combustion will certainly be more rapid if, for instance, 100 mixture particles are ignited by the spark instead of but one.

Following along this line brings us to the proposition that it might be better to ignite the mixture at two widely separated points instead of but one, on the theory that this will reduce the time necessary for the propagation of the flame.

If, in a T-head cylinder where the valves are arranged opposite to each other, a spark plug is placed in the inlet valve cap and a second one in the exhaust valve cap and sparks are caused to occur at these plugs at the same instant, the time required for the spread of the flame throughout the whole charge will be much less than would be necessary were the flame to originate at one side and be required to spread across the entire width of the combustion space.

This has been theoretically admitted for a long time, but the difficulty in its practical application lay in the securing of apparatus that would permit the production of two sparks at absolutely the same instant.

Ignition apparatus of this character has now been perfected, however, with results that are satisfactory from every point of view. It may be said at the beginning that it is essential to locate the spark plugs properly. If the two are set side by side in the inlet valve cap, for instance, there will be no gain through the use of two-spark ignition over one-spark. To secure proper results from this system, it is necessary to separate the plugs and to locate them so that the flame will have an approximately equal distance to spread in all directions from each.

A series of comparative tests was recently made at the Automobile Club of America before the Society of Automobile Engineers on an engine arranged for operation either with one-spark or with two. These tests showed that the maximum power output possible with single spark ignition was equaled by two-spark ignition at considerably less than one-half the advance, while with two-spark ignition it was possible to increase the maximum power output by 16 percent.

At first sight it seems somewhat extraordinary to claim that the power output of an engine will be increased 16 or more percent by producing ignition at two points in the cylinder instead of at but one, but the line of reasoning that we have followed makes it clear that the gain is due to the preventing of losses that follow early ignition.

The two-spark ignition system has been used on racing cars for over a year, and every car entered in the recent Gold Cup and Vanderbilt Cup Races was so equipped. By actual tests these cars have shown increases of speed of up to six miles per hour more than was possible for them to obtain with single-spark ignition.

The tests at the Automobile Club above referred to showed that the maximum output of 24 h.p. obtainable with single-spark ignition was reached at a speed of 1,750 revolutions per minute, while with two-spark ignition 24 h.p. was produced at a trifle less than 1,500 revolutions per minute. In other words, two-spark ignition delivered equal power at 250 less revolutions per minute; or six gallons of gasoline and two-spark ignition will do as much as seven gallons of gasoline and single-spark ignition.

It was further shown that 1,750 revolutions per minute was the maximum speed possible to obtain with single-spark ignition, while with two-spark, the maximum speed was nearly 2,000 revolutions per minute. Two-spark ignition is thus seen to give greater economy in consumption and greater flexibility than is possible with single-spark ignition, however favorably the single-spark plug may be placed.

Not the least advantage of this system is its great reliability, for one plug may become fouled without interfering in the slightest with the operation of the other. It has further been many times demonstrated that oil has far less effect on this system than it has on a single-plug system, and that over-oiling that would put a single-spark magneto completely out of business will not interfere in the slightest with the perfection of the operation of two-spark ignition.

Realizing the necessity for causing ignition to occur as late as possible in the stroke, it follows that the ignition apparatus should produce the spark at exactly this point and at no other.

If the apparatus selected does not produce this result, and if it permits the spark to occur a little earlier on one stroke and a little later on another, the result will be an unsteadiness in the operation of the engine, a reduction in power output, and an increase in gasoline consumption.

Anyone who has had experience with an automobile knows that the engine will run more steadily and more powerfully on a high-tension magneto than it will on a battery-and-coil system, but the reason for this is not always understood. It lies largely in the fact that the magneto produces a spark absolutely accurately and without variation, while with the coil-and-battery system the point at which the spark will occur will vary considerably.

The battery timer may make contact at the proper instant, but this does not mean that the spark is produced accordingly.

Upon the closing of the battery circuit by the tmier, the battery current is permitted to flow through the primary winding of the coil, with the result that the core becomes magnetized. The effect of this is to draw the vibrator blade away from its contact, and thus to break the battery circuit, the consequent collapse of the magnetic field causing the induction of a high-tension current in the secondary winding. It is this current that furnishes the spark.

It is seen that the electric current is required to do certain work between the closing of the circuit by the timer and the production of the spark at the plug, and the lack of accuracy in the system lies in the fact that the current does not always consume the same time in performing these functions. This can be demonstrated on the apparatus that consists of a shaft that may be driven at variable speed by an electric motor. This shaft carries a pointer that travels around the inner side of a graduated ring. One end of the shaft carries a battery timer, while the other end drives a high-tension magneto, the magneto armature and the timer revolving at the same speed.

The circuit is so arranged that the spark produced by the magneto or by the coil may be caused to pass between the moving pointer and the graduated ring.

Turning the apparatus slowly by hand with the magneto thrown into the circuit will show that the spark is produced at the zero point of the graduation. By throwing in the electric motor, the speed may be increased to anything up to about 1,500 revolutions per minute, and it will be seen that the magneto spark invariably occurs at the same point.

In other words, the point in the rotation of the shaft at which the magneto spark occurs is not affected by the speed.

As the speed increases the igniting ability of the spark evidently increases, for its size can be seen to increase until at 1,500 revolutions per minute it endures for about 30 degrees of rotation.

Throwing the magneto out of circuit and cutting in the battery, the apparatus may again be turned slowly by hand. The first battery spark will be seen to appear at the zero point, and at low speed there is an apparent sheet of flame for the entire 40 degrees during which the timer is making contact.

Running the speed up slightly it will be seen that this sheet of flame is broken up into a series of single sparks which occur very close together. Throwing in the electric motor, it will be seen that at 500 revolutions per minute the distance between the successive sparks is increased very considerably.

Each of these sparks corresponds to a single movement of the vibrator, during which the battery circuit through the primary winding of the coil is broken.

Another interesting thing is that the first spark no longer occurs at the zero point, but some 20 or 25 degrees afterwards, and this lag will immediately be recognized as representing the time required for the electric current to perform its various functions between the instant when the timer closes the circuit and the instant when the spark appears.

The delay in the production of the spark may be corrected by moving the timer so that contact is made some little time before the spark is actually required. The lag due to the work that the electric current must perfom is thus overcome mechanically by moving the timer.

If the spark is observed, it will be seen that it does not always occur at the same point, but varies considerably, the total variation being 8 or 10 degrees.

At the instant when the timer closes the circuit the vibrator contact may also be closed, but, on the other hand, the vibrator contact may be open, the blade not having come to rest from the movement caused by the previous closing of the circuit. A slight variation in the voltage of the battery will also cause a difference, for the lower the voltage the less able will the primary current be to force itself through the winding of the coil.

The coil offers resistance, of course, and it takes certain electrical pressure to overcome it. To overcome it more rapidly, the pressure must be increased, or, in other words, the voltage in the battery must be raised.

If the voltage of the battery could be changed to correspond with every change in the speed of the engine, better results might be obtained, but a vibrator blade would still be needed that would be in actual and good contact every time that the timer closes the circuit. Furthermore, it would be necessary to insure the actual closing of the circuit at the timer, for when the timer contacts are covered with grease or dirt, the circuit may not be actually closed until the moving part of the timer is half-way across the timer contacts.

The timer that was used with the testing apparatus was operating under perfect conditions and the contacts were clean and uncorroded. This is not often the case with the timers that are used on automobiles, and consequently the results of the use of such apparatus on an automobile are far worse than is here indicated.

The device of doubling a wire on itself before winding it into a resistance coil reduces the inductance of the coil to a very small quantity, but unfortunately introduces a considerable capacity which is equally undesirable if the coil is to be used in alternating-current measurements. Chaperon's method of winding the coil in sections, in each of which successive layers are wound in opposite directions and the magnetic area of each layer made the same, reduces the capacity considerably, but the more recent suggestion to balance residual inductance and capacity has been taken up by Dr. E. Orlich, of the Reichsanstalt, with marked success. He winds one layer of wire on a slate slab five by twelve centimeters and three or four millimeters thick with rounded edges, then places bridges over the edges and winds the second layer over the bridges. The distance between the two layers of wire is calculated so as to make the capacity and inductance equal for frequencies not very high. The results of the calculations are tabulated for resistance coils exceeding 3,000 ohms, below which the method is not applicable.

Positive purpose holds fortune captive; fortune can be coerced but not coddled.

HOW TO MAKE A HORIZONTAL SUN-DIAL

CHAS. HEATH

As a model engineer for some years, it struck me that the application of such small abilities as I had might be directed into some original channel, and that some articles might be constructed which afterwards would be more interesting to others than the class of work I had hitherto done. The most simple which crossed my mind was a sun-dial, which, even if inaccurate, always gives a quaint appearance to a garden; and, on the other hand, if constructed properly and with due regard to the equation of time caused by the variation in the sun's velocity, it can be made a really useful article.

This old relic of an age when clocks were scarce is by no means difficult to construct, and can be made on a painted wood base to represent stone, or on a square stone, slate, or marble, all of which can be scratched sufficiently deep to make a permanent readable dial. Brass, of course, screwed on a wood base, and the lines filled up with black wax, afterwards ground off level, is equally suitable, and will probably be chosen by workers accustomed to the use of this material.

The style, or gnomon, will be of brass, and can be cast from a pattern, or built up of ½ in. square rod. The shadow of either edge of the top surface of the gnomon is cast by the sun on either side of the dial—the left side for the morning hours and the right side for the evening ones.

The angle from the horizontal of the gnomon should always be that of the latitude of the place—in London 51⅓ degrees; but the dial will be all right if the angle is cut equal to the latitude, wherever it is.

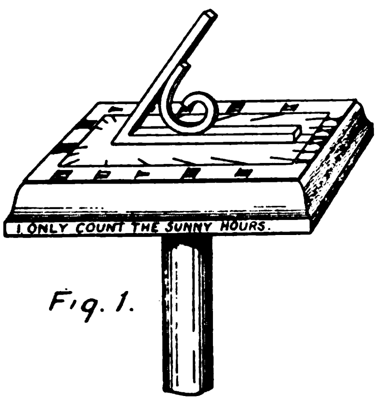


Fig. 1.

The usual difficulty is in marking, as, owing to the dial which receives the shadows being oblique to the plane in which the sun is supposed to move, equal angles of the sun's apparent motion become unequal upon the dial. A mathematical man can calculate these easily enough; but as all modelmakers are not mathematicians, I propose to show a method by which a dial can be scaled without any calculation whatever and quite mechanically, which is perfectly correct, and with slight adjustment can be used to indicate the divisions on a dial of any inclination or obliquity.

It is necessary first to make the gnomon (Fig. 2). This can be cast to any design or ornament which the art or plagiarism of the maker can suggest, providing the top face is straight, the bottom face is straight, and that the angle formed where their planes meet is that of the latitude. We will suppose we are in London, and it will be 51⅓ degrees. This can be got out by a protractor, or

(*Continued on page* 88)

An iceberg detector is the invention of Professor Barnes, and it takes the form of a particularly delicate electric thermometer, which records changes in temperature up to so minute a point as one-thousandth of a degree. This instrument can be carried attached to a ship's hull, but under water, and would record the temperature of the water on a dial, which may be placed in any convenient spot in the ship—the bridge, the chart-room or the captain's cabin. By watching the temperature of the water, as recorded on this dial, the ship's navigators would be able to tell when an iceberg is being approached, and also to compute with considerable accuracy its distance from the ship. So gigantic is an iceberg that it will cool the water around it for a distance of several miles, and the iceberg detector, in favorable circumstances, will begin to give its warning at a distance of ten miles.

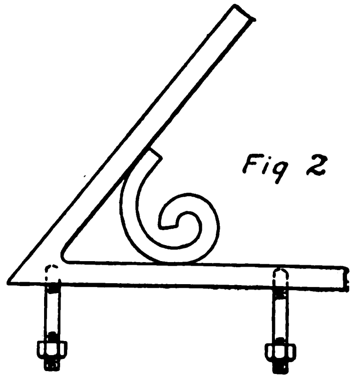


Fig 2

formed by making a triangle, whose sides are 12, 9½, and .7½, respectively. This is very near the correct tangent of 51⅛ degrees, being 1.2571. For a 12 in. dial a top edge of 7½ in. will be enough, as the point will be fixed back from the edge, in order to allow room for the shadows of morning and evening hours, before and after six o'clock. If built up from ½ in. square brass, it can be halved by filing, riveted, and soldered together (Fig. 3), making sure that the angle formed is 51⅓ degrees. Drill the bottom for two or three ¼ in. studs, long

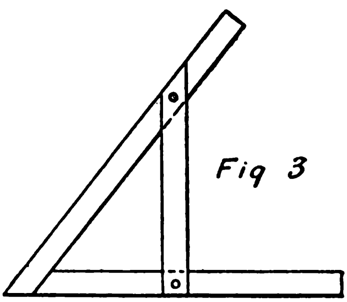


Fig 3

enough to go through the base and bolt up dead square, missing the center, which will be required to carry a socket capable of being revolved to adjust to the correct orientation last. If a casting, when filed up true and square to the angle, the same drilling, tapping and studding, will be required.

For the base, we will suppose wood, which must be either framed up 12 in. square, and a piece of good clean stuff screwed on all round, or a stout piece, 1¼, 12 in. square can be procured, and be protected from warping by fillets screwed up under it, crossway of the grain. Any edge can be worked on it, or left dead square. It must be centered on the underside, and a ½ in. back plate to take ½ in. gas barrel screwed on. When in place, the barrel being centered in plaster or cement in any pedestal, will enable the socket to be screwed up with sufficient stiffness to remain, yet allow of slight adjustment, which need only once be made.

A square of brass ⅛ sheet to fit the base must now be procured, flattened, but not yet polished, and fastened to the

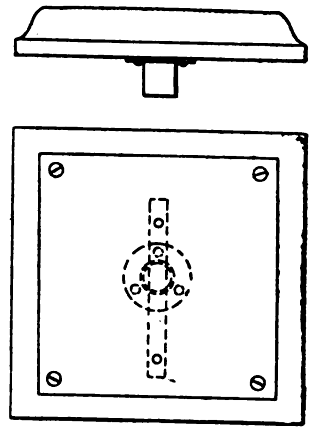
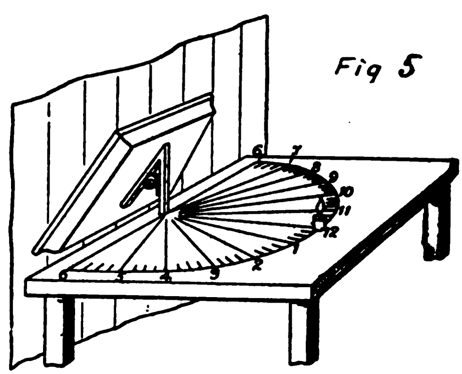


Fig 4

wood by flush countersunk screws of brass, and the holes drilled on a center line to take the studs right through the wood (Fig. 4). The gnomon being temporarily bolted in place, and its base filed till it stands square on each side, the whole affair must be leaned against a well, with the point of the gnomon resting on the table in such manner that the top face of gnomon, tried with a square, is perfectly vertical to the face of the table (Fig. 5).

Have ready a half circle of stout brown paper (as large as the table will carry) which has been divided with chalk lines into twelve equal divisions, and these

Fig 5



into quarters (Fig. 5). Adjust this on the table in a shady time of day or place, putting a piece of candle, lit, on the center line of the paper at its curved edge, shifting the paper round till the shadow of top part of gnomon falls exactly centrally on the dial. This is the 12 o'clock line, and will be ½ in. wide, and a slight scratch with a needle on each side of the shadow will mark it. Then fix the paper by drawing pins, and shifting round the candle to the end of next radial line, again scratch the place of shadow without moving the dial, repeating this operation for each of the radial lines. When all are marked, you will have the dial as Fig. 6.

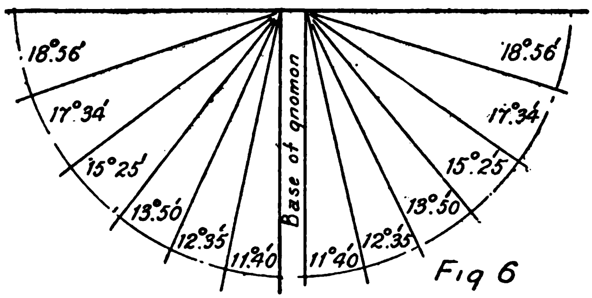


Fig 6

Unscrew the gnomon, and with a ruler as guide and the point where the gnomon meets 12 o'clock line scribe the lines shown in Fig. 7. Roman figures are best for a job of this kind, as they can be cut in with a diamond-shaped tool held against a steel rule. For the earlier and later hours continue 5 night for 5 morning, 4 night for 4 morning, and the opposite side for 7 and 8 in the evening, which, in an open situation, will be visible in the neighborhood of longest day. When all is cut as shown, and the intermediate lines cut, if required, by the same method, lines can be well filled with hot wax, the brass plate screwed onto its foundation, and the whole ground off flat and polished. The gnomon can be attached and the dial screwed onto a vertical ½ in. threaded gas barrel and adjusted to show 12 o'clock on either April 15th, June 14th, August 31st, December 25th, in any year, and with plus or minus the equation of time as shown in any almanac for any day in the year the correct time can be got as well as a shadow can be read.

If it be decided to make of framed wood, the lines can be marked in pencil and ruled with black paint on the white painted ground, such an inscription on the edge written, as, "Time flies," "I only count the sunny hours," or "Tempus fugit," complete.

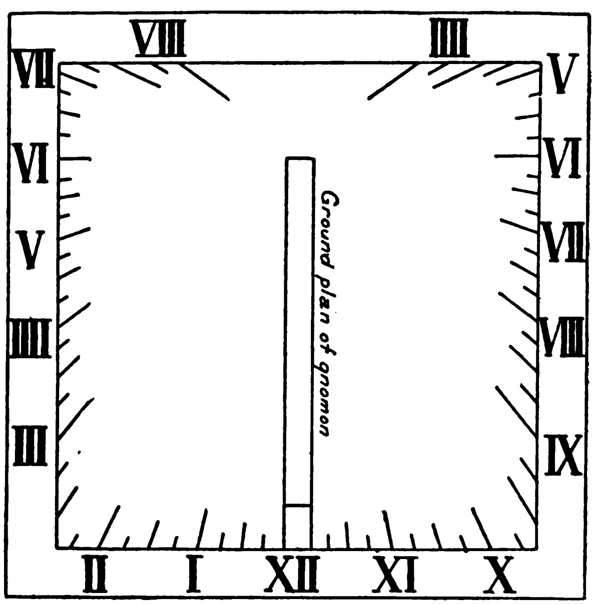


Fig 7

GARAGE OF THE EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON

The Edison Company having entered upon an educational campaign for the purpose of stimulating the sale and use of electric vehicles in its territory, realized the advantages to be obtained by the existence of an up-to-date, thoroughly equipped and skilfully managed strictly electric garage in the heart of the business section of Boston.

The necessity of such a station was more forcibly brought to the company's attention by the complaint of certain electric vehicle owners that their trucks were not giving the high grade of service experienced in other cities. They readily argued that with proper care and scientific charging the results obtained would be far more gratifying, and the claim was made that during the early stages, at least, of electric vehicle operation this could be brought about only by the establishment of a garage under the auspices of interests willing to sacrifice present gain to the ultimate success of the larger proposition.

After various conferences and discussions the Edison Company decided to provide and operate such a garage under the auspices of the Electric Vehicle Association of America, and a committee was appointed to formulate and carry out such a project.

A one-story concrete building, owned by the Edison Company and formerly used as a garage for both electric and gasoline vehicles, was procured, and a fund was appropriated for its complete equipment. In fitting up the building no attempt was made toward artistic effect, but every effort was exerted to provide means for the best of service in the simplest manner possible, one desire being to prove to prospective garage owners the inexpensive manner in which a model garage can be provided without sacrificing quality of service or the convenience of the public.

The portion of the building fitted for this purpose covers an area approximately 100 x 50 ft., with a roof clearance averaging about 30 ft., and it is figured that this space will accommodate between 20 and 30 vehicles.

The current for charging is obtained from the Edison Company's direct current 3-wire mains, and is conducted to two General Vehicle charging panels located in the operatnig room of the northeast corner of the building. Each panel has mounted upon it six charging switches, instruments and General Electric charging rheostats from which the current is carried to Anderson charging receptacles conveniently located about the charging area.

Sufficient space has been reserved for additional equipment when required.

Charging plugs with sufficient lengths of cable are provided to accommodate vehicles in any part of the building.

The floor consists of a smooth concrete surface, and the entrance is of sufficient size to admit the largest truck when fully loaded.

The washstand, repair shop and battery space are located at one end of the building, while at the other are facilities for charging sparking batteries, also the work bench, with a full equipment of modern hand tools for light repair work.

The office, located in one corner of the room, is comfortably fitted for the convenience of operators, and provision is made for the keeping of operating and maintenance data in detail, so that exact costs of all descriptions can be figured out for the customer's information, or for commercial comparisons.

A gallery at the farther end of the room contains the stock room where supplies and spare parts are stored, also the drivers quarters provided with lockers, table and chairs for their convenience.

The entire room will be lighted with Mazda lamps equipped with Holophane reflectors, so spaced as to give adequate illumination at a minimum expense.

It is the plan of the Company to offer its garage services at a flat rate per vehicle per month, this service to include electric charging, irrespective of mileage, washing, flushing, battery testing, inspections, polishing, expert advice, adjustments and minor repairs, and will be ready at all times to undertake overhauling battery, washing, lead burning, renewal of electrolyte, extraordinary repairs, replacement of worn parts or broken parts and provide and put on tires at the regular commercial rates.

Spare vehicles will be available at the garage for towing home in case of accident or failure of power, at reasonable rates and for rental when machines are laid up for painting or repairs.

In placing this garage at the service of the public it is not the intention of the Company to entice vehicles away from other garages where they are receiving satisfactory service, but to provide a home for commercial electrics in its immediate vicinity, and to offer the best of service to those who cannot procure it elsewhere; and the Company confidently expects, in view of the increasing interest already being shown in electric vehicles, that not only will its own garage soon be taxed to its utmost capacity, but the excellent garages now existing in other parts of the city will also be filled to overflowing.

As has been stated before, the garage is to be conducted under the auspices of the Electric Vehicle Association of America, and any just criticisms or suggestions of patrons will be gladly received in the effort to prove that the electric vehicle is a power and necessity in modern transportation.

A NEW FIRE-ALARM SYSTEM

The recent test of the newly installed air-alarm fire protection equipment at Governor's Island in New York harbor, headquarters Department of the East, United States Army, furnished striking proof of the need of replacing archaic fire protection methods with the creations of modern genius.

The recently completed installation of the system at the Quartermaster's warehouse and dock gave a basis of action, and it was arranged that when the final test on the dock was made the garrison fire alarm should sound. The test was given in the presence of General Grant and staff and other army officers of note.

In just forty-two seconds from the time the test fire was started on the open dock, the alarm rang in. The garrison alarm was sounded according to the system long in vogue at the Island, the location being announced through the telephone to company headquarters.

There was a misunderstanding of the message, the run was made to the wrong place and it was full fifteen minutes from the time the alarm was sent out before the soldiers reached the dock.

The contrast between the almost instantaneous work of the air-alarm and the errors and delay following from the operations of a system that involved human agency in transmitting the fire location to company headquarters, was so marked that it is believed the old system will now be done away with at the post and modern methods substituted.

The Governor's Island test is preliminary to similar tests in many other structures at United States Navy Yards and Army Posts in various sections of the country. General Frederick D. Grant, commanding the Department of the East, before whom the test was made, believes the air-alarm solves the fire prevention as well as fire protection problem, as does Brigadier-general Torney, head of the Medical Corps, U.S.A., who has caused its installation in the Medical Supply Depot at Washington.

It is distinguished from others by the employment of an entirely new principle in automatic fire alarms. A small continuous alloy tube (1/8 in. in diameter) is distributed over the ceilings of the buildings to be protected. The ends of this tubing, on each floor, terminate in a case containing two diaphragms. Electric wires running from these cases control gongs on all the floors and an annunciator, placed at the entrance or other prominent part of the building.

In the event of a fire in any section of a building, the rapid rise of heat on the ceiling, which is the result of the exposure of even a small quantity of flame, causes a corresponding expansion of the air in the tubing. This expanded air is carried through the tubing to the diaphragms at each of its ends, and causing them to expand, closes the electric circuit, which in turn operates the gongs and indicates on the annunciator the exact location of the fire.

If the elevator to success is stopped—try the stairs.

TESTS OF DIRECT CURRENT MOTORS AND GENERATORS

Description of the Factory Tests to which Direct Current Motors and Generators are Subjected

HOWARD M. NICHOLS

Commercial motor testing practice differs, to a considerable degree, from the theoretical tests described in testing manuals. The most noticeable difference is the greater attention paid to purely mechanical features, by the testing department of a manufacturing concern.

The following remarks on direct current motor and generator testing covers the practice of one of the largest electrical manufacturing concerns in their small motor testing department, where motors and generators from ¼ to 25 h.p. are tested. Only the tests that are given to standard machines are described, as the methods of making the special tests, such as field saturation, etc., that are required to develop a new line of machines, follow closely the instructions given in testing manuals covering the testing of direct current machinery.

Usually two machines of the same horsepower rating are set up on a testing base, and the test is conducted simultaneously on both machines. Readings running light are taken on each machine. They are then belted together, one machine being run as a motor and the other as a generator; and the load being taken up by water rheostats. If the machines are rated as motors, power readings are taken on the machine running as a motor, the connections are then reversed and readings are taken on the other machine running as a motor. If the machines are rated as generators, readings are taken on each machine operating as a generator. During the heat run the connections are reversed at each reading so as to get power readings on each machine operating under rated conditions, *i.e.*, as motor or generator, as the case may be.

GENERAL TEST

Before starting the tests on a machine it should be carefully inspected and the following points noted:

See that nameplate is properly stamped and agrees with the test card.

Check connections and see that all are tight and free from paint.

See that commutator has no high bars, is free from paint, splashes of solder, cuts, etc.

If brushes are not properly fitted, fit them with sandpaper.

See that brush holder and field wires do not strike armature, and that brush holder turns freely with setscrew loose.

See that all bolts and nuts are tight and that the pulley fits properly. Under no circumstance use a pulley that is too large.

After oil is placed in the boxes examine for leaks due to blow holes in the castings.

After connecting the machine in circuit and starting up, note the following points:

Try commutator for smoothness. This can be determined by holding the sharpened end of a lead pencil on the revolving commutator. Any rough spots or high bars will cause the pencil to vibrate. If the commutator is slightly uneven it can be smoothed up with coarse sandpaper, but if there are high bars the armature should be placed in a lathe and the commutator turned true, using a fine diamond point tool.

Check the armature for being magnetically central. Unless sure that the machine sets level on the base, remove the pulley and check for being level by placing a spirit level on the shaft. If the machine is found to be level start the motor running and with a piece of board press on first one and then the other edge of the rim of the pulley; if the armature is central, when the board is removed it will oscillate back and forth. If an armature hugs either end it will cause the bearing to get hot. In making this test on a generator run the machine as a motor.

Inspect oil rings and see that they turn and carry oil in the proper manner. If this precaution is neglected a hot-box is likely to result.

Check for balance by running light as a motor and placing the hand on the frame and feet of the machine. If it is out of balance there will be excessive vibration. A sprung shaft will cause this trouble; also armature not being properly balanced after winding.

Check the direction of rotation, facing the commutator end of the machine. If the machine rotates in the wrong direction it is due to a wrong bringing out of the terminals.

SHUNT MOTOR TESTS

Resistance.—If the mechanical inspection and direction of rotation are correct the motor is ready to be started on a heat run. Measure the resistance of the field with a Wheatstone bridge, taking several readings with different ratios in the bridge arms. Measure the resistance of the armature by the drop of potential method. Remove the carbon brushes and substitute for them copper brushes whose ends are chamfered so that they only cover a single segment. Use only one set of copper brushes regardless of the number of poles. The copper brushes are made from solid bar copper and are used only for taking resistance. Count the number of commutator segments between brushes, so as to make sure that the brush holder is adjusted to bring the brushes with the right number of segments apart. See that the copper brushes fit properly, otherwise they will arc and burn the commutator. With the brushes properly in place make a small prick punch mark in the outer end of the segments on which each copper brush rests. Do not strike too hard a blow, or a low commutator bar will be the result. These marks are used for definitely placing the sharp-pointed prick points that are attached to the voltmeter leads. They also serve to make it possible to take hot resistance of exactly the same set of coils, and thus eliminate any errors due to variations in resistance of the cross connections, etc.

Before applying current to the armature, place a wedge in the air gap between the pole piece and the armature, to prevent the armature from turning. If this precaution is not taken the armature is likely to start to turn, due to the current in the armature, inducing sufficient field in the poles of the motor to cause rotation, and the arcing at the copper brushes will burn the commutator badly. After wedging the armature connect it in series with a water rheostat, for regulation, and a circuit having a potential around 50 to 100 volts. Use an ammeter capable of reading the full load current of the machine and a low reading voltmeter. Protect the ammeter with a short-circuiting switch, which should be kept closed, except when taking readings. Remove voltmeter from circuit before opening same. Take about five readings of volts and amperes, starting in with full load amperes and reducing the current at each reading. Take the temperature of the air, armature, and field coils.

Readings Running Light.—Set the brushes at the neutral point running light. To determine this point run the motor at rated voltage, both clockwise and counter clockwise. The neutral position is that position in which the motor runs with the same speed in both directions. To cause the motor to run faster in a given direction turn the brushes in the direction in which the armature is rotating. After having set the brushes on neutral, hold the armature volts at rated value and take armature amperes, field amperes and speed.

Heat Run.—If possible secure a duplicate of the motor for load, if not, get a machine with the same horse-power rating and use pulleys that will give the proper speed on both when they are belted together. Make sure that machines are properly lined up. Check the neutral point under full load. Load the generator on water rheostats; fine adjustments of load can be obtained by putting a rheostat in the generator field. Only a small amount of resistance should be cut into the generator field, however; not enough to change the field current an appreciable amount from the field current obtained under normal operating conditions, otherwise the proper temperatures will not be obtained in the machine run as a generator. Start the machines free and throw on the load when they have come up to speed, being sure that all ammeters are short-circuited. Take readings of line volts and amperes, field amperes, speed and temperature of field coil and frame every half hour. On special machines run until temperatures are constant. Standard machines will be given a definite length of run, depending on the type and rating. Hold the load constant throughout the run. The heat run on most machines is taken at rated full load, but commutation should be observed at 50 percent over load. Never run a test with resistance in the field of the motor, unless the motor is designed to operate with resistance in the field. Short-circuit ammeter after each reading and disconnect voltmeter. Take particular note of the commutation and watch bearings for heating. At the end of the test check the neutral point under full load and mark the yoke and bearing with white paint, locating the neutral position. While the machine is still hot take readings running light as previously described. Take resistance of field and armature, and temperatures of armature, field and commutator. Record the condition of commutation throughout the run. Also test the machine for vibration, during the run, by placing the hand on various parts of the frame.

Insulation Test.—Insulation test with high potential should be made while the machine is hot. Connect all the terminals together and test between them and the frame. Test 110 and 220 volt machines at 1,000 volts a.c. for one minute, and 500 volt machines at 1,500 volts a.c. for one minute. If a ground develops test out the armature, field and brush holder separately. If the ground is in the field locate the defective coil by successive tests of each coil.

Take insulation resistance at 500 volts d.c. All machines must show at least one meg-ohm resistance. To make this test connect one side of a 500 volt d.c. generator to a 500 voltmeter, connect the voltmeter to the windings of the machine under test and connect the other side of the testing generator to the ground. Care should be exercised to use a testing generator that is free from grounds, as otherwise a short circuit is likely to result when one of the lines from the generator is grounded.

Let V represent the voltage of the testing generator, v the deflection obtained with voltmeter in series with the line and testing voltage applied to the machine, r the resistance of the voltmeter, and R the insulation resistance of the machine under test. Then

$$R=\left(\frac{V-v}{v}\right)r$$

The "pumping back" method of making heat runs is sometimes used on large machines to save power. This requires that the machines be of the same horse-power and voltage. Differences in speed can be corrected by using pulleys of different diameters. Connect both machines up to run as motors and belt them together. With the switches all open in one machine, bring the other up to rated speed. Close the field switch of the second machine, and check voltage generated, being sure that the direction of flow is the same as on the line, as otherwise a bad short circuit will result when it is attempted to throw the machine in on the line. Insert a field rheostat in the field of the driving motor, and bring the speed up slightly so as to ge full line voltage on the second machine. Now throw machine number two in on the line, and bring the speed up on number one until full load current flows. Check the load frequently throughout the run, and take readings as in the standard heat run.

SERIES MOTOR TEST

Do not attempt to take free readings on a series motor. Take cold and hot neutral points under full load. When taking speed care should be taken to hold the load constant, as the speed varies with the load. The "pumping back" method should not be used for heat runs and great care should be taken during all tests to see that the load does not fail, since if it should the motor would run away and smash things up generally. Take all other tests as described for shunt motors.

COMPOUND WOUND MOTORS

Take the same tests as for shunt motors. When getting neutral, reverse armature connections instead of field, to reverse direction of rotation. It should be noted that the speed varies with the load.

TEST OF GENERATORS

Run the generator as a motor, at rated voltage and speed, and set the brush holder on the neutral point. Take resistance of field and armature. Then belt to a motor of the proper speed and horse-power. Connect a field rheostat in the field of the motor for the purpose of varying the speed. Also connect a rheostat in the generator field. Bring the generator up to rated speed and adjust the field rheostat to give rated no load voltage. Then take no load readings of field volts and amperes and armature volts.

If the generator fails to pick-up, make sure that it is running in the right direction and that there is no break in the shunt field circuit. Also note that brushes bear properly on the commutator and that the springs are snapped down. If after noting all of these points the trouble is not located, open the shunt field circuit and put a voltmeter across the armature and note the deflection due to residual magnetism. Then close the shunt field circuit. If the deflection decreases it shows that the armature voltage is opposing that due to residual magnetism. The remedy is to reverse either the field or the armature connections. Sometimes excessive vibration will prevent a machine from picking up. This can be overcome by increasing the tension on the brushes.

The same general instructions for heat runs on motors applies to generators. In compound generators place a temporary shunt across the series field so as to get rated full load voltage at full load current. The final adjustment of this shunt should be made at the end of the heat run while the series windings are still hot.

LOCATION OF TROUBLE IN TESTING MOTORS AND GENERATORS

Motor will not start.—May be due to open circuit wiring leading to the motor or in the motor itself. If this is the trouble starting rheostat will show no flash as the handle is allowed to fly back from the first notch. Go over the connections to the motor and inspect starting rheostat for open circuit. See that springs bear properly on the brushes and that the leads are properly connected. The brush yoke may be improperly set. Try shifting the brushes. One or more field spools may be reversed. Check polarity with a pocket compass. First excite field to its normal value, and then open the circuit and check the polarity of the poles. If the field coils are properly connected the poles will alternate north and south. Do not attempt to check polarity with the field excited, as the compass needle is likely to become reversed.

Excessive Field Current.—Often due to short-circuited field spool. Can be detected by taking the voltage drop across each individual spool. May be due to improper field coils. If this is the trouble the total field resistance will be too small.

Sparking at the Commutator.—May be due to wrong lead of brushes, bad fit of brushes, high bar, or rough commutator. An open-circuited coil in the armature will cause a very viscous bright spark at the brushes, and the commutator segments to which the coil is connected will be blackened.

Flashing Over.—May be due to too weak a field, wrong lead of brushes, heavy overload, short-circuited armature, or any other trouble that causes excessive sparking.

GENERAL INSTRUCTIONS

When starting a machine for the first time make sure that the oil wells are properly filled and that the oil rings turn properly at about one-half the speed of the shaft. If the box on the pulley end starts to get warm, loosen the belt if it will still carry full load. Sometimes sand in the casting will fill the oil well with grit and cause the box to run hot. Never let a box get hot enough to smoke.

Never attempt to remove a belt from a machine with the power on. Throw off the power and wait until the machine is nearly still before attempting to throw off the belt.

Use instruments of the proper capacity to give readings within the range of their calibrations. Never leave an ammeter continuously in the circuit during a run, but short circuit it except when taking readings, as otherwise it may be injured by an excessive current due to a short circuit.

The engineering department of the University of Michigan last season graduated its second woman student, Miss Lillian Pearl McOmber. She is the first graduate from that department to take a degree of Bachelor of Science in architectural engineering. This sounds in no way compatible with "a matchless complexion and great violet eyes," and yet these are the descriptive terms of a reporter's admiring pen. Miss McOmber will specialize in steel structural work when she enters a city office.

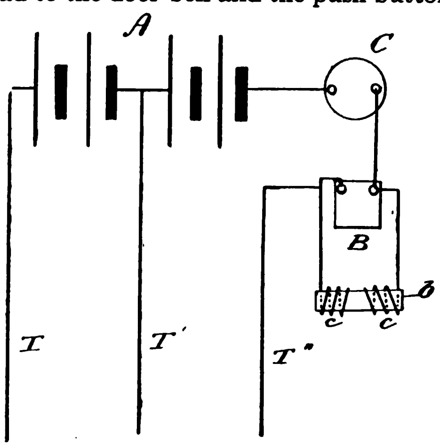
DEVICE FOR MAKING KNOWN A SHORT CIRCUIT IN A GAS-LIGHTING SYSTEM

FRED H. HAYN, M.E.

The sketch shows a simple way in which a short circuit on a house gas-lighting system may be made known.

It often happens that the springs on the gas jet get weak, and, in extinguishing the light, the wiper is left in contact with the projecting platinum tip. This fact is not made known until the next morning when the postman tries to ring the front door-bell. It is well known that it will take several days for the battery to recover, if at all.

In the sketch, *A* is a set of cells, and *C* the ordinary coil for producing the spark at the gas jets. The wires *T*, *T'* lead to the door-bell and the push button.



The wires *TT"* lead to the gas jet. A buzzer *B* is placed in series with the coil as indicated., This buzzer alone, however, is not sufficient to produce the result desired, for it will be found that on attempting to light the gas, that the buzzer only will ring and the spark for lighting will be at the buzzer rather than at the jet.

If, however, two naked coils of wire be wound about a piece of carbon *b*, and the connections to these coils be shunted around the buzzer and adjusted toward and away from each other until the correct position is ascertained, it will be found that the spark will be at the jet and the buzzer will sound as desired.

If the lever or chain, as the case may be, be pulled down quickly, the buzzer will not sound. If, however, the wiper sticks on the platinum tip, the buzzer will be heard groaning throughout the house.

This is an exceedingly simple, easily constructed and efficient device for protecting the batteries of a house gas-lighting system.

How Moving Pictures Originated

Perhaps it is safe to say that the large majority of the discoveries and inventions which have benefited and blessed as well as instructed and amused the world were the outcome of experiments conducted for altogether different results. What we know as moving pictures originated, according to the *Chicago Tribune*, in a question asked by Sir John Herschel of his friend Charles Babbage. This was in 1826, and the question asked was how both sides of a shilling could be seen at once.

Babbage replied by taking a shilling from his pocket and holding it before a mirror.

This did not satisfy Sir John, who set the shilling spinning on a large table, at the same time pointing out that if the eye is placed on a level with a rotating coin, both sides can be seen at once.

Babbage was so struck by the experiment that the next day he described it to a friend, Dr. Fitton, who immediately made a working model.

On one side of a disc was drawn a bird, on the other side an empty bird-cage. When the card was revolved on a silk thread, the bird appeared to be in the cage. This model showed the persistence of vision upon which all moving pictures depend for their effect.

The eye retains the image of the object seen for a fraction of a second after the object has been removed.

This model was called the thaumatrope.

Next came the zoetrope, or "wheel of life." A cylinder was perforated with a series of slots, and within the cylinder was placed a band of drawings of dancing men. On the apparatus being slowly rotated, the figures seen through the slotes appeared to be in motion.

The first systematic photographs of men and animals taken at regular intervals were made by Edward Maybridge in 1877.

CUTTING A SKEW GEAR FOR 2 H.P. GAS ENGINE

F. C. LEES

A few years ago I became possessed of a gas engine of about 2 b.h.p.; I got it second-hand, or possibly third or fourth-hand, for all I know! It had a number of good points, but was, even when I first had it, considerably worn. It was a "nameless" engine, and not standardized in construction, so it was not possible to obtain renewals, except as altogether special jobs. I carefully went over the brasses, and did a lot of tuning up; but there was one part which was badly worn, and obviously would require renewal before long—the screw-wheel on the crankshaft, which worked the "two-to-one" camshaft for the valves.

However, it ran for a couple of years, but at the end of that time one of the teeth was quite worn away in one spot, and it was evident that the wheel was done. I once had experience of getting a more simple wheel than this cut as a special job, and when, after much protest, I had at length paid the bill, it left me a sadder, but a wiser man! So I determined to cut a new gear myself on my 6 in. center lathe.

First, I got to work to find out what the wheel was as to pitch and angle of tooth. Those who have in any way studied skew-gearing know what an elusive term "pitch" is in this connection. This particular wheel had ten teeth, and was 2½ in. diameter over the tops of the teeth. The corresponding wheel on the camshaft naturally had twenty teeth, but its diameter was nearly the same measure, *viz.*, 2¹¹⁄₁₆ in.

The dividers, when set to measure the distance from one tooth to another on the pitch circle round the side of the wheel, gave a "pitch" of about ¾ in.; but taken on the face of the wheel, at right angles to the teeth, it was barely ⅜ in. These two different measures are respectively the "circumferential pitch" and the "normal pitch."

A very little thought shows that the circumferential pitch must vary within wide limits with varying tooth angle, even though the "normal pitch" remains the same. But the meaning of "pitch" is not yet exhausted, for a quite natural measure is the distance from crown to crown of the teeth in the line of the axis of the wheel. This is called the "divided axial pitch." When all that is said, there is still another pitch, *viz.*, that of the complete screw (if it were completed), of which the wheel is but a short section. This last is known as the "primary pitch," says *Model Engineer and Electrician.*

Where, amidst all these considerations, shall we begin to think of how to cut a duplicate of a worn screw-wheel, with no data but what can be obtained from it? Fortunately, there are two definite points at which to attack the problem. The first is, that where a pair of skew gears are to work at right angles to one another, the angle of the teeth of the one added to the angle of teeth of the other must be equal to 90 degrees. The other point of attack is the fact that, however the tooth angle varies, if the two wheels are to gear together, the "normal pitch"—that is, the measure at right angles to teeth—must be the same in both wheels.

Bearing these two facts in mind, I began operations by dismounting the wheels—an operation easily mentioned, but not so easily carried out—and then, with a protractor, measured as carefully as possible the angles which the teeth of each wheel made with their respective axis.

It was evident at once that there was a great difference, and equally evident that the 20-toothed wheel was in the neighborhood of 30 degrees from the axis, while the 10-toothed wheel was in the neighborhood of 60 degrees, and fairly closely so. I therefore felt justified in assuming that the wheels had been cut at such angles that one was 60 degrees and the other 30 degrees, together making 90 degrees. The next thing to find out was, with what kind of a tool had the teeth been cut? Was it any of the standard measures for cutting ordinary gears, or was it without any such restriction?

The "normal pitch" of the 20-toothed wheel was much more easy to see than the 10-toothed, since the former more nearly resembled an ordinary gear. It struck me at once that this normal pitch appeared very like the change wheels of my lathe: these wheels are 10-diametral pitch. Taking the 20-tooth change wheel and "sighting" it against the other, it looked a fair fit. More careful measurement convinced me that the tool used to cut the skew gears had been one which would cut a 10-diametral pitch wheel of 18 or 20 teeth.

I felt that I was getting on with the problem of what to go upon, but there still remained the very big question as to how the relative movement of tool and wheel blank was to be set to produce an angle of tooth of 60 degrees to the axis on a diameter of 2½ in., or perhaps 2 9/16 in., as the original size of the gear. The blank was, at this point, turned up out of mild steel, that being the material chosen, though the original wheel was gun-metal.

The diameter was 2 9/16 in.; the measure round the circumference was 8 1/16 in.; the width of face 1 5/16 in. Then I returned to the drawing-board, and striking off a rectangle *ABCD*, 8 1/16 x 1 5/16 in., had before me, as it were, the surface layer of the blank unrolled upon the paper (see Fig. 1). From the bottom right-hand corner, *A*, I drew a line, *AA'*, by the help of the protractor, at 60 degrees from the line *AB*, which corresponds with the wheel axis. Taking a pair of dividers, the line *A,D* was next stepped off into ten equal divisions by trial and error, and the ten positions (including the original *A*) marked. Lines were then drawn parallel with *AA'* from each point, and also from *X* and *Y* to complete the whole area.

If now this rectangle were cut out and wrapped round the gear blank, the lines would represent the tooth crowns, and the tool in making the teeth must follow them. What "pitch of screw," then, must the lathe be set to cut? We are very close to finding out, but it must be done at the drawing-board. On the line *CD*, it will be noticed that *D*, *F* and *E* represent the successive positions at which the screw threads (or wheel teeth) cut the axis of direction of advance. As there are ten threads, the one starting, say, at *D* will not re-appear on the same line of direction, *DC*, until the other nine threads have put in an appearance; so that if we again take the dividers, set them to the distance *DF*, and, starting

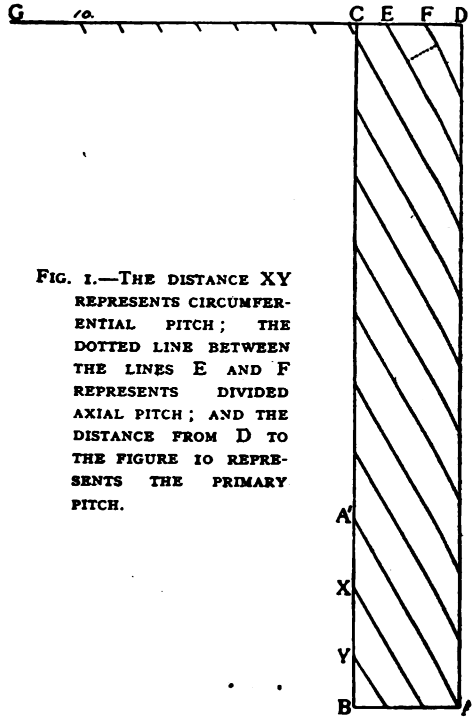


Fig. 1.—The distance XY represents circumferential pitch; the dotted line between the lines E and F represents divided axial pitch; and the distance from D to the figure 10 represents the primary pitch.

from *D*, step off ten points along the line *DCG*, the tenth point will show where the thread which started at *D* re-appears on the same axis of advance. In other words, it is the pitch of the screw, a small section of which we wish to cut. This measure was so nearly 4½ in. that again I felt justified in assuming that the skew gear had been cut to a "primary pitch" of 4½ in.

Now we know what is required of the lathe setting, *viz.*, to cut a ten-threaded screw of 4½ in. pitch. My leading screw is four threads to the inch; therefore, in order to cut a thread of 4½ in. pitch, the leading screw must make 18 revolutions to each one revolution of the mandrel. The following change wheels will satisfy the requirement:

Mandrel		Stud		Leading Screw
120	to	20		
		90	to	30

A wheel is chosen for the mandrel of a number of teeth divisible by 10, for the purpose of dividing the ten teeth to be cut. I rigged up the above; but found that, even with the back gear in, the change gearing could not be driven, so great is the proportionate speed of the lead screw, and, of course, the friction.

The only thing I could think of was to drive the train of wheels from the fast-moving end—that is, from the leading screw. The end nut of the screw was found to be tapped ½ in. gas thread. I had a pulley on a slow-speed dynamo, measuring 9 in. diameter by 2 in. on the face, and bored for 1 in. shaft. This pulley was requisitioned, a ½ in. gas socket connector obtained, and turned down to an outside diameter of 1 in. When this was screwed onto the leading screw end, in place of the nut, the 9 in. pulley was also easily fixed to it by its setscrew. I had a 4 in. pulley on the overhead shaft, and was fortunate enough to find in a box of belting scraps one or two lengths, which, when pieced together, made just the right length to go from overhead shaft pulley to leading screw pulley. I was pleased to find that the arrangement answered admirably, running quite smoothly.

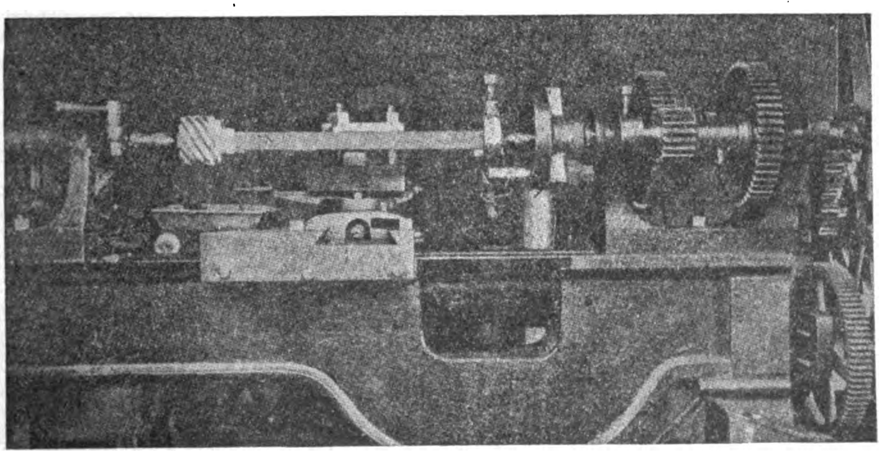
The next thing to do was to grind a cutting tool. I have a tool-holder taking ⅜ in. round tool steel, a diameter which would be wide enough for the gear teeth. A templet of a tooth of change wheel 20 teeth was made, and by fixing the tool steel in a file handle, the shape of the gear tooth was reproduced very fairly.

A moment's digression may be allowable here as to the contour of skew gearing teeth. I believe I am right in saying that these teeth are bound to be a compromise between at least three opposing conditions.

The respective angles which the root, pitch circle point and the crown make with the wheel axis should theoretically be three different figures for any given position. To satisfy this a most elaborate mathematical machine would be required, and, though I believe machines have been made the designers of which claim to fulfil in execution the theoretical requirements, the fact remains that the ordinary and excellent skew gear of commerce is cut with a tool found in practice to produce a good working article, even if it has a co-efficient of friction a little higher than a theoretically correct tooth contour should possess. Therefore, I made no attempt to produce theoretically perfect curves on my tool, but copied an ordinary gear tooth as nearly as possible.

This was put in the holder, laid on a surface plate, and the straight end of the cutter turned round in the holder, till it had a rake of 60 degrees, as measured by the help of one of the very useful small sheet-steel adjustable gauges made for purposes of setting screw-cutting tools to the correct rake.

The heel of the cutter was then backed off very considerably, so as not to foul either side of the thread when cutting full depth; it was then ready for work. But first we must calculate how far the saddle must move at each cut before stopping the lathe and disengaging the nut in order to return to the loose headstock end by the quick hand traverse. The universal rule is where the number of threads per inch to be cut will not



Showing the Lead Pattern Skew Gear as completed in the Lathe divide exactly into the number per inch on the leading screw, to turn the pitch to be cut into a fraction—in this case $4\frac{1}{2}=\frac{9}{2}$—then the numerator, or figure above the line, gives the least distance the saddle must move before disengaging the nut, in order to be able to engage again when returned to the starting position. In the case of very long traverses being required according to rule, there are, of course, ways of getting round it by special tooth marking; but with the quick motion we have to deal with here, it is best to allow the 9 in. run.

The saddle then, when the tool was fixed in the slide-rest, was run up against the loose headstock, and a chalk line squared across the bed, 9 in. in front of the forward edge of the saddle, then the leading screw was turned slowly till the nut would engage easily.

At this stage we make the last of the settings (apart from the slide-rest) by marking the teeth exactly in mesh on the mandrel wheel, and on the 20-tooth wheel to which it is geared. This shows the exact position when the saddle nut will engage the leading screw correctly. Then we want to provide for dividing the ten threads; therefore, as the mandrel wheel is 120 teeth, we count round 12 from the marked tooth (or space, as it happens to be—it was space in my case) and chalk again; 12 more, and so on; we then have 10 marked teeth on the mandrel wheel. When the first tooth of the skew gear is cut, the lathe is stopped with the marked teeth in gear, the quadrant is loosened and dropped till the 20-tooth wheel is out of gear, then the mandrel wheel is turned round so as to bring the second marked tooth into gear, when the quadrant is raised, and so on for all ten positions; the teeth then are accurately spaced.

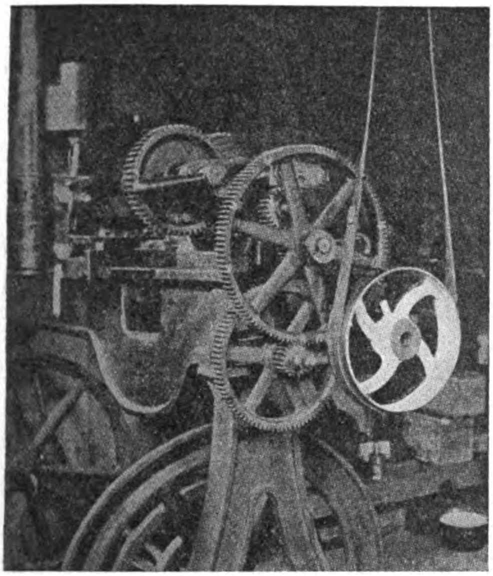
The photograph shows the arrangement, with pulley on leading screw, and the marked spaces on the mandrel wheel. The 20-tooth gear is rather too well-lighted to show the marked tooth very well. Secure the mandrel carrying gear blank against back lash by binding the carrier to the driving pin on the catch-plate with wire, and we are ready to start.

I made several traverses of the saddle, starting from hard up against the loose headstock, traversing the 9 in. along the bed to the chalk line, disengaging the nut, returning by quick hand motion rack work to starting position, engaging nut again, and again traversing before putting on any cut. It worked perfectly.

I then set the tool in by cross motion of slide-rest till it was just clear of the gear blank, and chalk-marked the collar of the cross slide screw to show the position when the tool was clear, as it is, of course, very necessary to bring the slide-rest back after each cut has been taken to the clear position before returning to starting position for another cut. Then, as each cut is set in, a mark is made to show the depth to which the tool has been set as a guide for the next set in.

Accordingly, with all prepared, I set the cross slide in for the first cut and started the lathe. It was a light cut, but was a clear indication as to whether all the adjustments and reckonings had been carried through correctly. Measured with a protractor, the angle was quite correct. Putting the old wheel alongside the blank, it was also evident that the trace of the future tooth space was so nearly exactly a reproduction that no difference could be detected. This was exceedingly pleasant, and I cheerfully withdrew the tool to clearance, returned to starting position, set in the second cut, and again started the lathe. But now a series of unforeseen difficulties occurred. I have said that the blank was of mild steel, and all who have worked this material know how very much difference there is between working it with a sharp-edged tool, with plenty of top and side rake and clearance, and working with anything at all closely approximating to a tool without top and side rake. It is easy to see that a tool cutting all over its profile, as a gear cutter must, cannot have side rake, and owing to the depth of cut being full ¼ in. and the necessity of giving great backing off at the heel of the tool, in order to obviate fouling either edge of the tooth-space, only a very small amount of top rake could be given.

As the second cut came on, I perceived by the sound of the change gearing, that very great strain was being thrown on it; but the cut carried through. I brought on the third cut, with still more ominous complaints from the train of gear wheels. At the fourth cut the tool started and travelled a short distance, then a series



Showing Arrangement at Fast Headstock, with Driving Pulley on Lead Screw, and Marked Teeth on Mandrel Wheel, and Pinion for dividing the Ten Teeth to be cut

of sharp cracks and flying gear teeth told me that something had stripped.

I drew the tool out of cut, eased back the whole lathe motion, and as I did so saw the gears turning back with blank space, where teeth ought to be; moreover, on carefully examining the change wheel end, I found the stud of the reversing plate had been distinctly bent.

Here, indeed, was misfortune. However, I had started in to make a skew gear, and intended to do it. Fortunately, cast change gears in the small sizes cost but a few cents, and they were the small ones which had gone, but the stud evidently required some looking into.

I dismantled the whole lot, and found that the stud, though nearly ¾ in. in diameter, was screwed ½ in., reduced for that purpose, and entered into a ½ in. tapped hole. It was decided to fit a stronger one, and, accordingly, with ratchet brace, that ½ in. hole (after filling it hard and tight with teak wood) was drilled out to take ½ in. gas thread; turned up a new stud, with the necessary sleeve for the gears, bored out the reversing plate to take the larger stud, bored, faced and trimmed the teeth of fresh gears, and once more was ready for work. I got in several more cuts, but could hear that the strain was enormous, and when at about the fifth or sixth cut I was again assailed by flying gear teeth, I began to realize why machines for cutting steel gears are so very, very massively built!

If I had not seen the results that appeared when I again dismounted the change gear train, it might be difficult to convince one of their absolute truth! The gears were stripped, sheared off; no result of gears jammed too closely together; for, recognizing that all ordinary strains would be reversed when driving from the lead screw instead of from the mandrel, I had taken most particular care to have ample clearance between gears, and what portions of them were left showed that all was in thoroughly good adjustment in that way. The new stud had borne the strain without flinching, but the feather (good steel, ¼ in. x ⅛ in.), which keyed two change gears to their sleeve, was simply drawn out as though it had been wire, as the photograph shows (see Fig. 2). The two portions which were actually within the bore of the wheels remained straight and practically parallel, while the space between was drawn round and stretched by the strain!

It was, therefore, clear that though my lathe is rather massive for a 6 in., it was not sufficiently so for cutting this skew gear in steel.

I made up my mind to take the opportunity of fitting mild-steel gears on the reversing plate, and did so, then returned to the work in hand.

The original skew gear was gun-metal; the new one might then be gun-metal also; but I wished to so arrange matters that the bulk of the metal to be removed should be in some more tractable form than even gun-metal. I got a length of square mild steel, 1 in. x 1 in. in section, centered it and drilled the ends for setting between centers in the lathe. Then two short lengths of round mild steel were driven through holes drilled at right angles to the length of the bar, and a "boss" of lead was cast on to these, about 3 in. diameter and 2 in. thick. This "boss" was then turned to the size of the skew gear blank, with a little extra allowance in size, and the job put in the lathe, once more fitted up with all adjustments as at first.

Everything now went splendidly. The tool could be set in for quite a considerable cut each time. In rather over half-an-hour I had the first tooth space completed. The quadrant was slacked and dropped, number two marked space on the 120 change wheel brought into gear and tightened up. The saddle nut went in exactly as required, and before the hour was much passed the second tooth space was finished, leaving a complete tooth. I almost raised a cheer!

This first completed tooth was very carefully examined as to its profile on the edge of the blank. It was found that it had, to a certain extent, the fault of leaning over from a truly symmetrical shape—a fault very well known in this class of work. However, as the lead blank was only to be used as a pattern for casting in gun-metal, and there was sufficient material in the completed tooth to allow of correcting the shape, the next tooth was worked, carefully watching as to which side of the cutter was lagging in its work. It was very soon discovered, and by quite minute adjustments of the tool as to its horizontal angle with *the axis of the lathe centers*. The fault was corrected, and subsequent teeth worked with quite a good and satisfactory shape.

A few hours sufficed to work the whole ten teeth, and by evening the lead gear, with all the burrs smoothed by the help of a rough file, was surrounded by plaster of Paris, and next day, on removing the lead gear, a plaster mould remained in which to have the gun-metal cast.

It is very necessary to dry the plaster mould as thoroughly as possible, at a considerable heat and for some time—two days in the domestic oven is none too much.

If any moisture is left, the molten metal will explode when poured into the mould. This plaster mould was sent to a local foundry in order to have the gun-metal casting done.

The lead gear had been sent first of all with a request for a casting, but apparently it was beyond the moulder to tackle. The gear was then sent to a firm of gun-metal founders in London, but they also returned it as an impossible job. This was distinctly discouraging; but a number of other difficulties had been surmounted, and as the professionals sent the job back, the amateurs must perforce try!

The smith's forge at a local motor repairing and engineering works was borrowed one Saturday afternoon, and about 10 lbs. of old motor brasses of good quality metal were bought for less than 15 cents per lb., and by surrounding a crucible with broken coke, held up by a few ordinary yellow bricks, some 7 or 8 lbs. of high quality metal were well melted in a few minutes over the half-hour. The crucible was lifted, the contents well stirred by a clean iron rod, and the plaster mould filled up flush. When cool, the rough bits of metal were chipped off, and a very fair casting came out.

In the lathe it was soon seen that the material had come out of the melting pot quite as good in quality as it went in. It was very nearly as tough as the mild steel, and very glad I was that most of the metal to be removed had been worked on the lead pattern.

After chucking the casting and boring out the center hole to the necessary diameter, it was mounted on a mandrel and in no very great length of time was a finished skew gear.

On being tested with the 20-tooth wheel which it was to work, it geared quite well at right angles, and with practically no backlash. So this very interesting job was brought to a successful conclusion.

A fireman was up for examination for promotion to the position of engineer. He passed a fair test on the rules and machinery, but during all of it the examiner was constantly lecturing him as to the need of economy in the use of fuel and oil, so that by the time he finished his examination it was pretty well on his nerves.

Having finished the technical part the examiner thought he would put the man in a critical position to see what he might do in an emergency. So he put to him this question: "Supposing you are the engineer of a freight train on a single track, and you are in a head-on collision with a passenger train, and you know that you could not stop your train; that a collision could not be averted. What would you do?"

The man, unstrung by the vigorous instruction he had received as to economy, replied in this way: "Why, I would grab the oil can in one hand and a lump of coal in the other and jump."—(From the *Atchison Globe*.)

BIG FORTUNES IN LITTLE INVENTIONS

Men Who Saw the Importance of the Apparently Unimportant—Many Inventions Hit Upon by Accident—Millions of Dollars in Seemingly Trivial and Commonplace Ideas

Every time anybody in the United States pulls the cap off a beer bottle or a soda-water bottle with the intent to quench a thirst, temperately or otherwise, he puts the fraction of a cent into the pocket of one William H. Painter, of Baltimore, writes William Atherton Du Puy in the *Scientific American*. A good many people have pulled these caps in the last few years and Painter is consequently an ever-increasing millionaire. Yet the cap for bottles is a small thing, an idea crystallized and patented. The patent is the source of the millions.

Painter, however, carried his patent in his pocket for six years before he succeeded in interesting capital in its manufacture. Then a man of means advanced the necessary capital in return for a half interest in the patent, and a company was formed. At the end of the first year he and Painter each had a net $27,000 in his pocket. Now the invention has crowded all other stoppers for fizzy water off the market, and a big factory in Baltimore turns out the caps by the million every day.

A MILLION-MAKING STOPPER

Before the time of Painter there was a man by the name of De Quillfeldt, who lived in New Jersey, and who invented a stopper that took the trade away from the corks of our youth. This stopper was of rubber and was tightened by a wire attachment which was pulled down as a lever on the outside of the bottle. A decade ago they were generally used on milk bottles. De Quillfeldt is said to have made $15,000,000 out of his patent. He might have amassed a competence had it not been for William Painter and another equally clever person who fitted a piece of pasteboard into the neck of a milk bottle and took the business away from him.

An idea that is perhaps simpler than the pasteboard stopper is the "hump" on the hooks that furnish so much employment for married men just before theater time. Women had been fastening their dresses up with hooks and eyes for a generation, and it is probable that some one had made a lot of money out of the original invention But hooks had a way of coming unfastened much to the chagrin of the neat and fussy. Then came the genius of the hook and eye. A man who was wide awake despite his residence in Philadelphia, bent one of these hooks so as to make a hump in it. He tried hooking it up and found that it remained hooked. He patented it and has monopolized the business through his "see that hump" advertisements ever since.

One day a man stood behind his wife while she put up her hair. The hairpins of those days were straight pieces of wire. They did not "stay put" very effectually. The woman in this case bent her hairpins before putting them in. Her husband saw her do it. The result was the invention of the crinkly hairpin which is today used in carload lots by the women of the world.

INVENTION OF THE TELEPHONE

So important an invention as the telephone was made by turning a screw one-fourth of one revolution. All the millions that have resulted from the invention of the Bell telephone depended upon this slight twist of the wrist of Dr. Alexander Graham Bell. There had been men before Doctor Bell who had come near finding a way to make female gossip and masculine commercial intercourse easier. The Reis patents came nearest success. But in the Reis patents the current was intermittent. It had to leap a gap. Doctor Bell closed that gap when he turned the screw.

But Doctor Bell was not trying to invent a telephone when he incidentally stumbled upon his secret. He was working on a method of making speech visible, for his wife was deaf and dumb, and he was seeking an easy method of conversing with her. Instead, he found the method of talking over a wire to people at a distance. He did not patent the idea, however, and it knocked about the house for months. Finally, he demonstrated it to some friends and they saw the possibility of its application. Upon their advice he patented the invention. His patent was filed at 10 o'clock in the morning, and at 3 in the afternoon another man applied for a patent on the same thing and lost a hundred million dollars by a nose.

THE SELDEN CLUTCH

Such are the stories that the veterans of the patent office gossip about in the moments of their leisure. They tell you, for instance, of the Selden clutch, which is one of the vital patents that has much to do with the control of the automobile business of the country. It is this clutch that enables the operator of the machine to stop and start without having to get out and crank his machine—sometimes. It is interposed between the running gear and the motor, where it keeps the car marking time while the crossing is blockaded.

This clutch was invented before automobiles were. For a decade after its invention there was no opportunity of applying it to any good purpose. Then the automobile was invented. In fact, George B. Selden was one of the early builders of automobiles, and it is logical to suppose that he built them that he might make an opportunity to use his clutch. Certain it is that he long had a clutch on the automobile business. Before his patent was declared invalid about $2,000,000 had been paid by nearly ninety automobile makers, who found it cheaper to pay than to engage in extensive litigation.

THE FAIRBANKS SCALE

Thaddeus Fairbanks was a New England farmer with long whiskers and much Yankee ingenuity. In his time old-fashioned steelyards were the only accurate means of weighing the produce of the farm. Platform scales were unknown, for nobody had ever worked out a method of arranging the lever that supported the platform in such a way that an object would pull equally no matter upon what part of the platform it rested. Old Thaddeus Fairbanks used to tell the story of the evolution of the arrangement of these levers. For a long time the problem was upon his mind. He used to lie awake nights and attempt to arrange those levers. It was in the dead of night that his thinking finally bore fruit. The arrangement unfolded itself and the Fairbanks scale was the result. So did a farmer practically monopolize the scale business of the world and so did he write his name upon platform scales wherever civilized man buys and sells by weight.

It is a man by the name of Hyman L. Lipman, likewise a resident of Philadelphia, who invented the rubber eraser that throughout our generation has been attached to the lead pencils in common use. It was in 1858 that the invention was made. In those times people talked in much smaller figures than nowadays. Lipman was, however, able to cash in his patents for a cold $100,000 when dollars went much farther than they do today.

So did a man by the name of Heaton, resident of Providence, notice that mother was occasioned a great deal of trouble because the buttons constantly came off the children's shoes. Heaton devised the little metal staple that holds on the shoe buttons of today, and realized a fortune for his pains. No less clever was a man of the name of Dennison, who pasted little rings about the hole in a shipping tag, and thus made an "eye" that would not pull out.

THE SEWING MACHINE

Elias Howe conceived the idea of placing a hole near the point of a needle, and under the encouragement of this small thought was the sewing machine developed. Howe was one of the Columbuses in the development of a machine to sew seams and deserves a monument from the women he emancipated from needlework. When he asked Congress to extend the term of his patent for a short time (one extension had already been granted) he admitted that he had collected $1,185,000 in royalties, but considered himself entitled to $150,000,000.

Howe had many followers who improved the sewing machine. One of the cleverest of these was the man who patented the stitch his machine made instead of the machine itself, and thus made infringements more difficult. Another man, Allan B. Wilson, a journeyman cabinet-maker of Pittsfield, Mass., exhibited the first model of what has since become known as the four-motion feed. He afterward founded the firm of Wheeler & Wilson, and became immensely wealthy. In the *Scientific American* of 1849, James C. A. Gibbs saw a picture of Wilson's machine. The working of the device was clear down to the point where the needle perforated the cloth. He wondered what happened after that. Finally he decided to make the needle work. After much thinking and infinite whittling he worked out the ingenious little revolving hook which became the important feature of the Wilcox & Gibbs machine and which made that firm wealthy.

THE CHEWING-GUM BUSINESS

There is a palatial mansion up the Hudson with a private yacht moored beneath the Palisades that is a monument to the millions that Adams made in the chewing-gum business. It was in 1871 that chewing-gum was patented and millions of willing jaws have wagged industriously upon it ever since.

Harry Hardwick invented an ingrain carpet with the threads of it so interwoven as to prevent wrinkling, and Hardwick is now **$4,000,000** better off for his pains.

Charles Edward McCarthy was a blind man and lived in South Carolina. He devised a method of attaching mule power to a cotton gin, and lived his life out in luxury and ease while the mules did the work.

R. R. Catlin, of Washington, invented a pattern cat that need but be stuffed with hay and sewed up to become a toy. Such figures as "Billiken" and such games as "Pigs in Clover" are always a fortune to the inventor if they become popular. The rubber return ball made much money, both for the inventor and likewise for an infringing manufacturer who fought him in the courts.

THE BRASS PAPER FASTENER

The brass paper fastener, which is still generally used for thick documents, was patented in 1867 by a governmental clerk by the name of G. W. McGill. Yet it was not new, for the Romans used a similar device two thousand years ago and the modern appliance was but a resurrection.

The patent for a typewriter lay dormant for half a century in France before it ever came into use. Then a man by the name of Sholes made a machine in this country and called it Remington. Another man named Brown made a different kind of typewriter and called it the Smith. The patentees immortalized other men by their work. They made millions and also made it much more pleasant for the editor who has to read copy.

The man who invented tin cans made it necessary for somebody to invent an opener. This was done and the money corraled. A can opener is not a very laborious thing in the using, but the public is always ready to pay for things that are made easier. So, just recently, an inventive genius made a can with a seam just below the top and when the owner wants it open he has but to strike it a blow where the seam breaks and the top is off. A single Chicago packer ordered ten millions of these cans as an experiment and others followed suit. The inventor has a fortune, and the thing is but just begun.

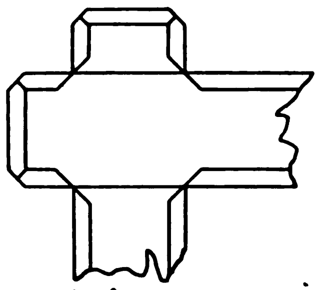
Cutting Plate Glass

It is quite a trick to cut plate or rolled glass, and the thicker the glass, the more difficult the operation. With the trade, however, the job is not so hard to do, as there are certain rules the workmen follow that nearly always lead to success. These rules are as follows:

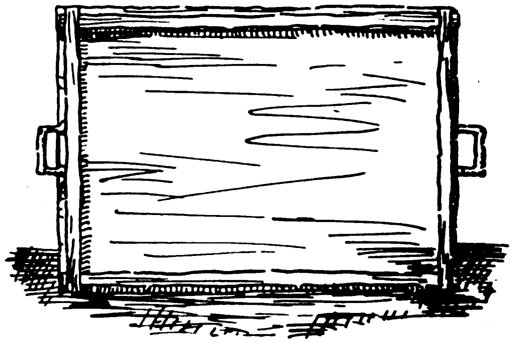
With a common glass wheel cutter, which may be purchased at any hardware store for 25 cents, bear rather heavily on the glass in the direction in which the fracture is intended; it will leave a white line across. With a very light hammer, one with a pein weighing about an ounce, commence to lightly and rapidly tap the glass immediately under the commencement of the line. In a short time a fine crack will be observed to start. This will follow the hammer along the line to the end, when a very slight pressure will cause the glass to separate. I have seen a workman use the rivet end of a 2 ft. iron folding rule for the tapping, but I find a very small hammer more convenient.

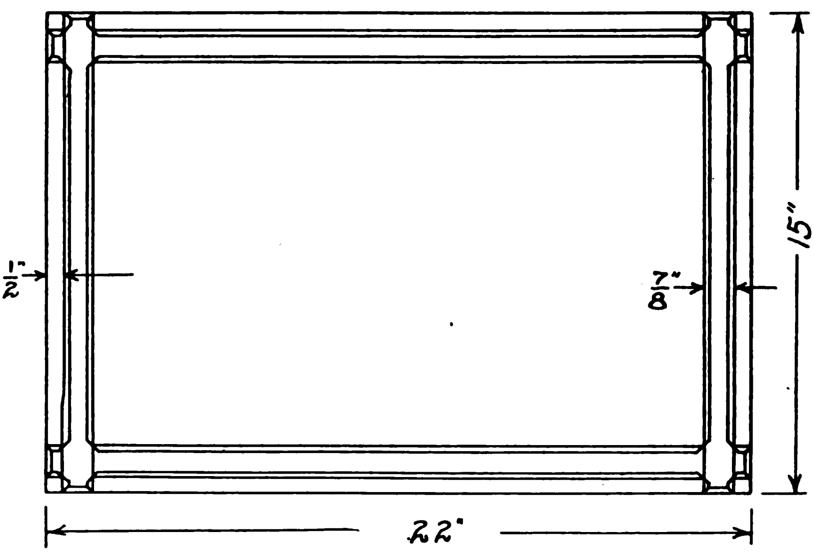
In the case of a ribbed plate glass the cutting must, of course, be done on the smooth side.—*National Builder*.

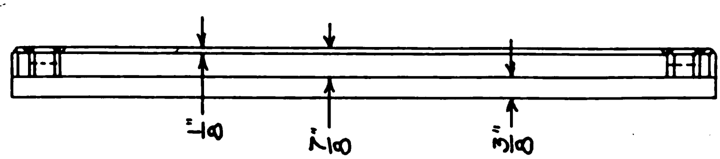
SERVING TRAY.



Detail of corner joint.







(20)

R.F.W. 1911.

THE HOME CRAFTSMAN

RALPH F. WINDOES

SERVING TRAY

A quarter-sawed oak serving tray finishes up into one of the most beautiful pieces of craftsman furniture which is possible to produce. It is very easily constructed, and anyone with ordinary ability to use tools should have no fear about attempting it. The material needed is as follows:

1 piece ⅜ x 15 x 22 in. quarter-sawed oak
2 pieces ⅞ x ⅞ x 15 in. quarter-sawed oak
2 pieces ⅞ x ⅞ x 22 in. quarter-sawed oak
Two brass handles.

The brass handles may be purchased at a hardware store. If they do not have them rigid, a pair of drawer pulls will do in their stead.

The corners of the small pieces are half-lapped. In cutting these joints be very sure that the holes cut are not wider than the finished pieces. The ⅛ in. bevel is laid out with the marking gauge, and as much of it planed as possible. That which cannot be reached with a plane can be cut out with a sharp chisel.

The bottom piece needs to be sanded perfectly smooth and the edges should be planed. The frame is fastened to it with screws, well countersunk.

The finish should be applied before the handles are attached. A piece of soft felt should be glued over the bottom, or at least around the edges, so that it will not scratch any surface upon which it is placed.

WASTE BASKET

No pen sketch can do justice to the appearance which this basket offers when it is completed. And it also presents new problems to the builder which he should try to solve; hence it is to be advised that every follower of these articles try this one. The material to order is as follows, planed and sanded to finished sizes:

4 pieces 1 x 1¼ x 12 in. quarter-sawed oak
4 pieces 1 x 1¼ x 10 in. quarter-sawed oak
1 piece 1 x 7½ x 7½ in. quarter-sawed oak
2 pieces ½ x 11¼ x 11 in. quarter-sawed oak
2 pieces ½ x 10¼ x 11 in. quarter-sawed oak
8 pieces 5/16 x 1 x 12 in. quarter-sawed oak
4 pieces 5/16 x 1 x 8 in. quarter-sawed oak

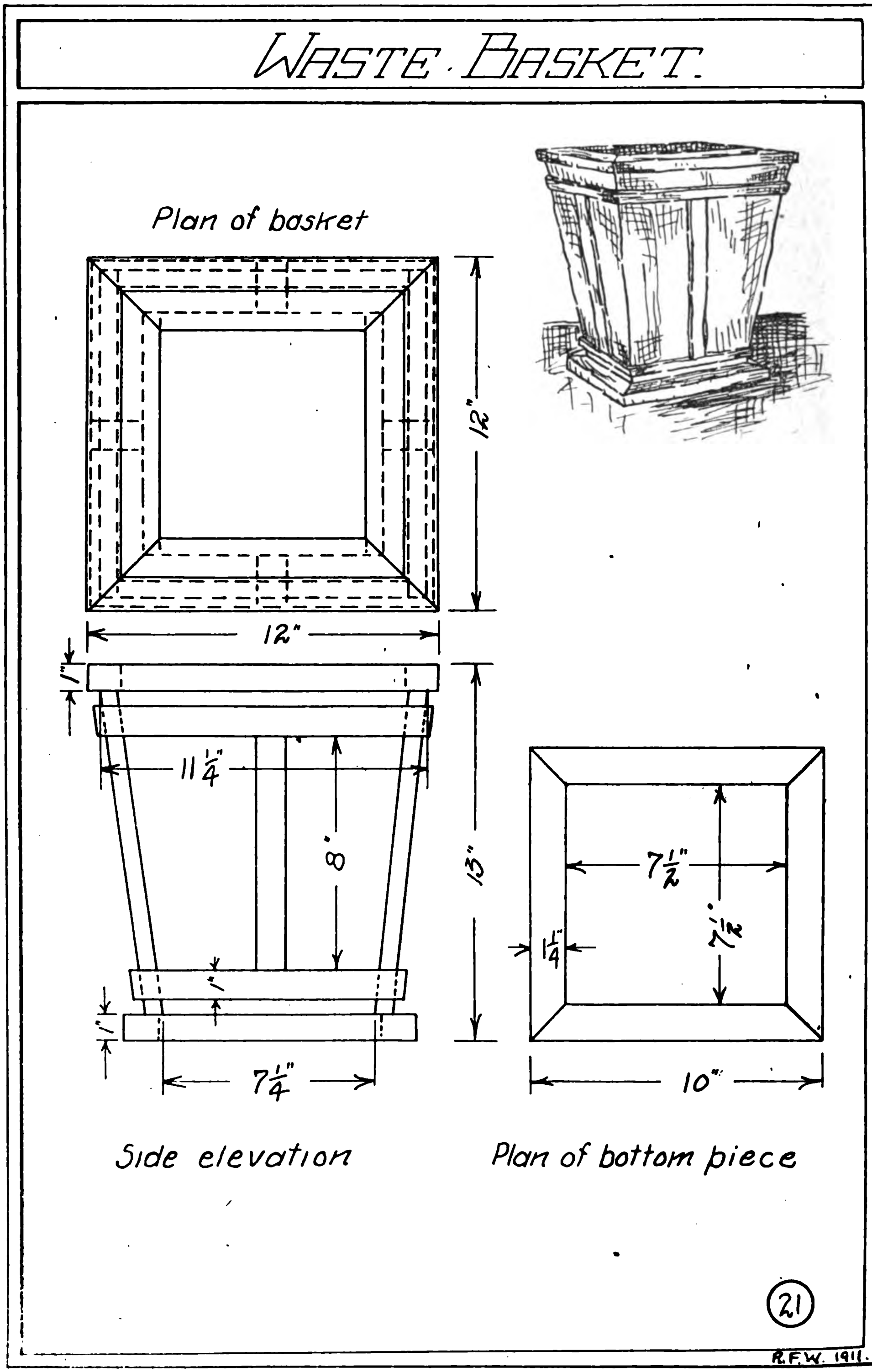
First shape the sides and glue them up. The two wider pieces need to be 11¼ in. across the top and 8¼ in. across the bottom, taking measurements from a center line. The narrower pieces are 10¼ in. across the top and 7¼ in. across the bottom. When these are shaped, glue and clamp them together. A few small brads may help to hold the pieces together, and if the craftsman cares to use them, no objection can be raised. Placing them at an angle this way makes it necessary to plane the top and bottom edges off so that they are parallel.

The top is made up of the 12 in. pieces mitered at the corners. The bottom is made up of the 7½ in. square piece around which the 10 in. pieces have been mitered. These two are fastened to the sides as shown.

The thin strips are used for decoration. They may be attached as shown, or in any manner which the builder so desires. They are mitered at the corner, and as this is on an angle, it presents a problem to the amateur. The most easy way to solve it is to cut the proper angle, then lay out the miter with the tee-bevel and cut it without the aid of a box.

(To be continued)

Steel tools put in a barrel of air-slaked lime will never rust. I have always kept my spades and such tools in lime.


WASTE · BASKET.
Plan of basket
12"
12"
1"
11 1/4"
8"
13"
1"
1"
7 1/4"
7 1/2"
7 1/2"
1 1/4
10"
Side elevation
Plan of bottom piece
21
R.F.W. 1911.

PULLEYS

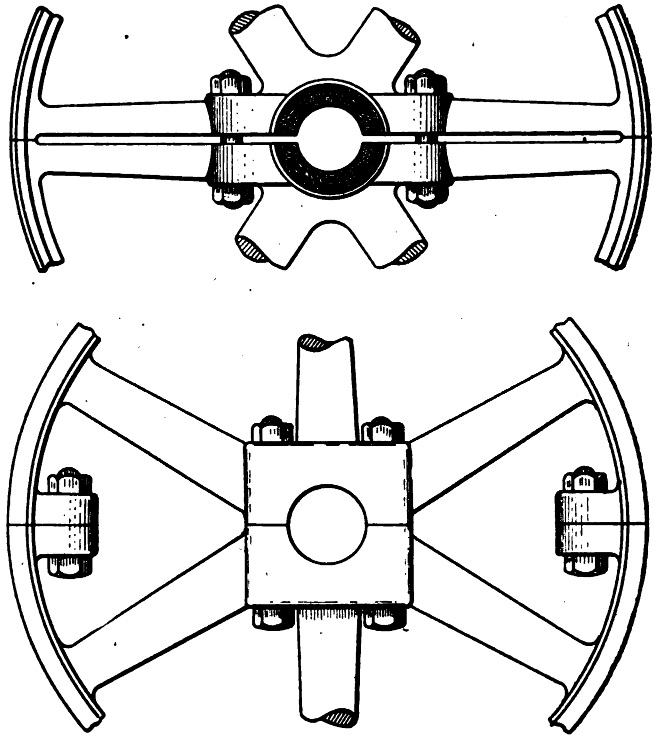


Fig. 1. Two Forms of Split Pulleys

In the installation of any system of mechanical power transmission, vital points to be considered are the pulley arrangement, size and material. There are many points, says *Practical Engineer*, which may be brought out and enlarged upon in order to show the saving and economy of certain classes of pulleys in preference to others for the particular work at hand. Numerous experiments have been performed with the various materials, types and shapes of pulleys, and their value for different installations has been quite thoroughly worked out.

MATERIALS

In the construction of pulleys the materials now common are cast iron, steel, cast iron with steel rim, wood, cast iron with wood rim, and paper.

The most common pulley now employed is made of cast iron. It presents the advantage that it is easily made, its belt friction is high, it is strong and its strength can be calculated with a certainty, the speed limit is high, balancing is easily done and the pulley is practically moisture proof. On the other hand the pulley may easily be broken by a shock or blow, and when so broken is not easily repaired. It is somewhat heavier than steel, wood or paper for the same service, the cost is high compared with wood or paper pulleys, and it is subject to internal strains due to temperature changes and improper casting.

Steel pulleys are made of either cast or forged steel in either split or solid form. The coefficient of friction is practically the same as for cast iron, but the weight and wind friction are reduced considerably from cast iron and the strength considerably greater as is also the speed limit.

Pulleys with cast iron hubs and arms with steel rims have become quite popular where high speed is a requisite. The points which recommend them for use are the strength, the light weight compared with cast iron for similar service, repairs to the rim are easily made, and, like the cast iron pulley, they are not affected by moisture of the atmosphere. On the other hand the cost of these pulleys is high, and the pulley is subject to strains due to temperature changes.

Split wood pulleys are becoming continually more popular owing to their low cost, absence of strain due to temperature, to their ability to withstand shocks and jars without breaking, their comparatively light weight, and the fact that they can be mounted upon shafts without keys or set screws. These pulleys, however, are seriously affected where moisture is present, the life of the pulley is not so long as that of the cast iron or steel pulley, nor is the strength of the pulley so great as that made of metal.

Paper and pulp pulleys are more recent developments and combine strength and durability with a high coefficient of friction.

In comparing the strength of pulleys

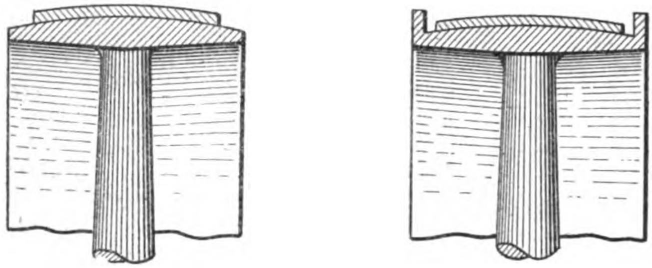


Fig. 2. Rims of Crowned and Flanged Pulleys

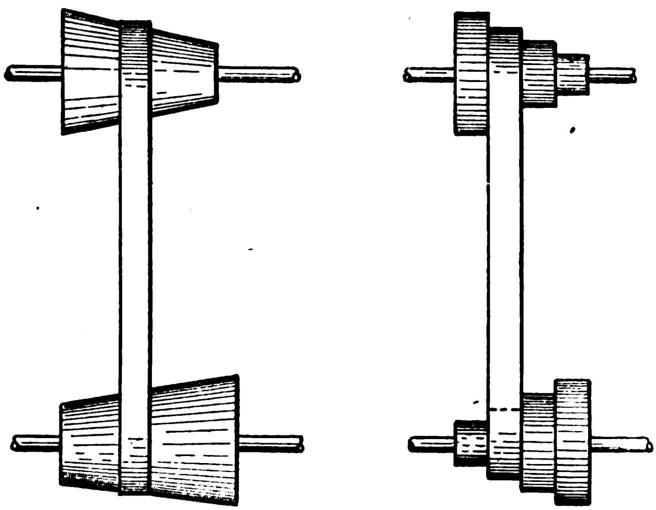


Fig. 3. Cone and Step Pulleys

the results of tests made at Purdue University are of interest, showing the bursting speed of several kinds of pulleys. Two tests on solid wood pulleys gave 285 and 267 ft. per second as the bursting speed. Split wood pulleys withstood speeds of 232 and 221 ft. per second. The results recorded for bursting speeds on paper pulleys were 295 and 307 ft. per second. Two split steel pulleys gave way at 235 ft. per second.

Tests made at Sibley College, Cornell University, resulted in the following maximum horse-powers per square inch of belt cross section of belt, which were developed at 3,500 ft. per minute; when the tension on the tight plus one-half the tension on the slack side equalled 180 lbs.; on a pulp pulley 5.4 h.p. was developed, a wood pulley gave 5.5 h.p. maximum, cast iron 8.5 h.p., and paper 10.7 h.p. When the tension on the tight side plus half the tension on the slack side equalled 300 lbs., the results were as follows: Pulp 10 2, wood 10.4, cast iron 16.7, paper 21.6 h.p. These maximum values occurred at about 4,500 ft. per minute speed of belt. Other tests at different belt tension showed about the same ratio.

FORMS AND PROPORTIONS

The class of work to be performed by a pulley determines largely the form and proportion which the pulley should have. A solid pulley is suitable for installing upon the end of a shaft, where it can easily be reached and taken off without interfering in any way with the alignment of the shaft or other machinery in the plant. These pulleys are set with keys or set screws, keys being used where the load to be transmitted is heavy and set screws only where the load is very light, set screws being spotted into the shaft.

When it is desired to place a pulley at the center of a shaft, a split pulley is most convenient, as it can be mounted without taking down the shaft and other pulleys placed upon it. These pulleys are generally made in two parts and may be set upon the shaft either with a key, set screw, or entirely by friction, the latter being preferable in all cases where it is possible, as no injury to the shaft is then necessary. Either the solid or split pulley may be made of nearly any material now used for pulleys, and the choice is largely a matter of opinion with the engineer in charge.

The type of rim adopted depends entirely upon the character of the work which the pulley is desired to do. The flat face, that is, where the face of the pulley is straight and parallel with the shaft, is commonly employed where a belt must frequently be shifted from one pulley to another, but for isolated work it is desirable to use a crowned pulley which keeps the belt at the center of its face, thus reducing the danger of the belt running off.

For certain classes of work where the

pulley is subject to considerable shock or jarring, the rim is flanged, thus keeping the belt from running over the edge. In some installations it is desirable that a small variation in speed is made possible during the running of a belt. In these cases a cone speed pulley is employed which consists of two cones of equal and similar dimensions, but sloping in opposite directions. A modification of this drive is the step pulley which permits a variation in speed from the line shaft to the machine operated, but these speeds are constant and cannot be changed during the operation of the machine.

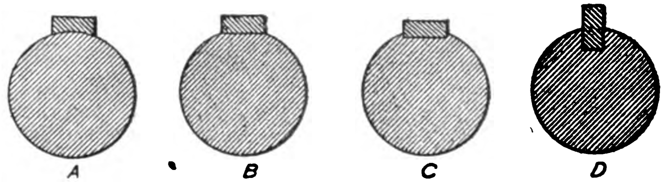


Fig. 4. Forms of Keys used for Pulleys

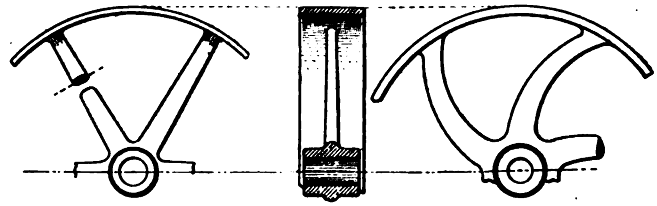


Fig. 5. Straight and Single-curved Pulley Arms

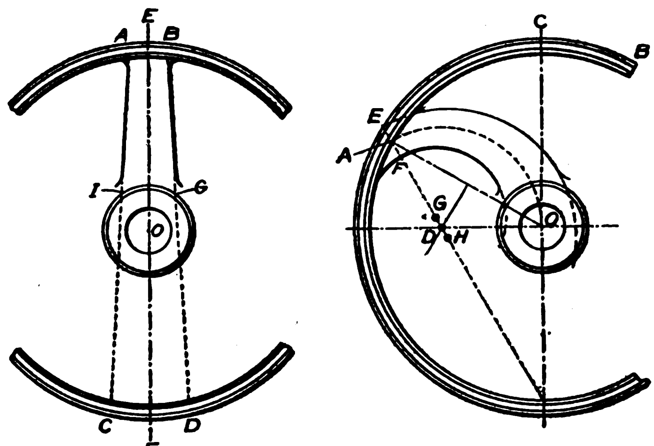


Fig. 6. Methods of laying out Arms

The rims of pulleys are frequently perforated, which, it is claimed, increases the friction between the belt and the pulley by letting out the film of air, thus giving more efficient operation of the belt.

The arms of metal pulleys are either round or elliptical in cross section and usually extend radially from the hub, but they may be curved or double curved, which makes the pulley more elastic. Frequently in small pulleys no arms are used, the pulley being made with a solid web in the place of arms. Split wood pulleys have various forms of arms, but the most common have parallel arms on either side of the dividing line, with the addition of radiating arms when the size demands a more solid pulley.

In order to secure the best operation of a belt drive, the diameter of the pulley should be equal to or greater than 36 times the belt thickness, but in the case of link belts 30 times the thickness of the belt. The ratio between the driving and driven pulleys should not be greater than 6 to 1, and the distance betweeen them depends upon the ratio of the diameter, thus where the ratio is 2 to 1 the distance should be greater than 8 in., 3 to 1, 10 in.; 4 to 1, 12 in.; 5 to 1, 15 in.

For best operation the convexity of a crowned pulley should be $1/20$ the width of the belt and for all pulleys the width should be equal to $5/4$ the width of the belt where an isolated pulley is employed. This may be made smaller where the belt is shifted from one to another running beside it.

The thickness at the edge of the rim for iron pulleys is usually taken at 0.01 the face width plus 0.08 in. The thickness of the rim at the center is equal to twice that at the edge, plus the amount of convexity. The rule taken for the thickness of the nave or hub is that this should be 0.4 in. plus $1/6$ the diameter of the shaft, plus $1/60$ the radius of the pulley, the dimensions all being in inches. The length of the nave should be equal to or greater than 2.5 times its thickness.

Keys employed for fastening pulleys to the shaft are of four kinds: the hollow key, as shown at *A* in Fig. 4, is used for light work and depends entirely upon

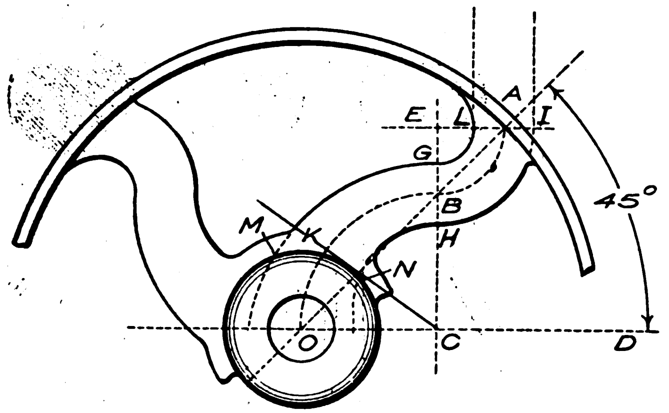


Fig. 7. Laying out a Double Curved Arm

friction to hold the pulley from turning. The flat key, as shown at *B* in Fig. 4, is used for medium service and requires that the shaft be marred if this key is employed. For heavy work a countersunk key is employed, this also requires that a key seat be made in the shaft. Feather keys are used where the pulley must be shifted along the shaft. The proportions of keys of different types are given in the article on shafting in another part of this issue.

ARMS

In iron pulleys the oval-shaped arm is most common, dimensions of the cross section being, for the large diameter, twice that of the small diameter, the large diameter being in the plane of the pulley. These arms may be either radial, curved or double curved. The rule for the number of arms employed is: Divide the radius of the pulley by the width of belt, to the quotient add 5, then divide by 2, the result will be the number of arms. The long diameter of the cross section of the arm is equal to 0.24, plus ¼ the width of the belt, plus the radius of the pulley divided by ten times the number of arms; this being the diameter of the nave, the small diameter is one-half this amount. At the rim the dimensions of the arm are taken equal to ⅔ the dimensions at the nave. These proportions are admirably adapted for large pulleys, but in smaller ones they should be increased in order to take care of slight defects in castings.

To lay out the profile of a straight arm, having determined the diameter of the pulley and the dimensions of the arm and nave, draw circles to scale representing the rim, nave and bore of the pulley, as shown in Fig. 6. Draw the diameter *EF* through the center *O*. Lay off *FD*, *FC* and *AB* equal to ⅜ the large diameter of the arm cross section at the nave. Draw the lines *AC*, *BD*, the parts *AI* and *BG* being the profile of one arm. The other arms are laid out in the same manner and equal to this one.

The manner of laying out a curved arm is somewhat more complicated. With a radius *OA* equal to the radius of the pulley scribe an arc which covers an angle of about 120 degrees. On this arc lay off *AC* equal to ⅜ the arc between arms of the pulley. Then draw the radial line *OC* and perpendicular to it at *O* draw the line *OD*. From the center of the line *OA* erect a perpendicular *ED* which intersects the line *OD* at *D*. From *D* as a center with *DO* as a radius scribe an arc *AO* which is the axis of the curved pulley arm. Locate *E* and *F* on the line *AD*, each at a distance equal to ⅛ the large diameter of the cross section of the arm from *A*, locate *G* and *H* on the line *AD*, each at a distance from *D* equal to half *AE*, now with *H* as a center and *HE* as radius, draw another arc extending from the rim of the wheel to the nave. This is the outer profile of the arm, and for the inner profile use the center *G* with the radius *GF*, and draw an arc from the rim to the nave of the wheel.

One method of laying out a profile of a double curved arm is as follows: Having drawn arcs to represent the nave and rim of the pulley, draw the radial line *OA* at 45 degrees from the line *OD*, Fig. 7. Take the point *B*, on *OA* at ⅔ the distance *OA* from *O*. Through *B* draw the line *EC* perpendicular to *OD*, then draw *AE* parallel to *OD*. The points *E* and *C* are the centers from which the axis of the arm is drawn. From *E* as a center and *EA* as a radius, scribe an arc *AB* and from *C* as a center and *CB* as a radius, scribe an arc *BK*. The line thus formed is the axis of the double curved arm. On the line *EA* extended, take *AI* equal to ⅛ the large diameter of the arm at the nave and *AL* of the same length, then

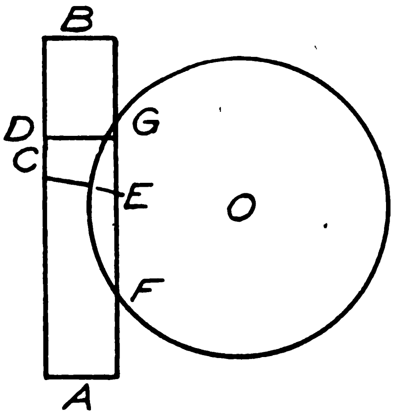


Fig. 8. Templet used in lagging Pulleys

from E as a center and EI and EL as radii, scribe arcs IH and LG respectively. Having laid out the large diameter of the arm upon the nave, find centers upon the line BC from which arcs may be drawn from G and H to the points upon the nave. This gives the prôfile of one double-curved arm and the rest of the arms are made similar to it.

To design a set of cone or step pulleys which will maintain an equal tension of the belt at all speeds of the drive, two equal and similar cones tapering in opposite ways are selected as the line of centers for the pulleys when crossed belts are employed. There are, however, few cases where it is advisable to use crossed belts for cone pulleys, owing to the severe wear upon the belts, and to design a set of pulleys for open belts, two similar conoids, tapering in opposite directions and bulging in the middle, are employed. The line representing the centers of the various steps is laid out according to the following rule, given by Rankine: The radius of the center pulley is equal to ½ the sum of the radii of the large and small pulleys of the cone, plus the square of the difference between the large and small radii of the cone divided by 6.28 times the distance between the axis of the cones. While this does not give an exact solution it is sufficient for all practical purposes, and an exact result requires the use of higher mathematics.

LAGGING PULLEYS

It sometimes becomes necessary to increase or decrease the speed of a line shaft, owing to changes in the power plant. Under these conditions it would be necessary to secure new pulleys of different diameters, or change the diameters of those pulleys employed under the old conditions. The latter method is quite readily accomplished by lagging the line pulleys when the speed of the line shaft is decreased or lagging the driven pulleys in case the speed is increased.

Pulleys made of any material may be lagged with wood, increasing the diameter even as great as 4 or 6 in. To do this, holes are bored into the face of the pulley into which screws are set to fasten the lagging firmly to the pulley. A templet for cutting the lagging is made as follows: With a center O, Fig. 8, and a radius equal to the radius of the pulley to be lagged, scribe an arc. On the edge of this arc, overlapping it 2½ or 3 in., tack a thin piece of board AB, then draw a radial line, EC, and the arc EF on this board. With a band or hack saw, cut this board along the line FEC. The board may be cut off at DG in order to make it easily handled. With this templet the boards used in lagging the pulley, are laid out and sawed accordingly. The lagging should be placed with the grain running around the pulley and glued

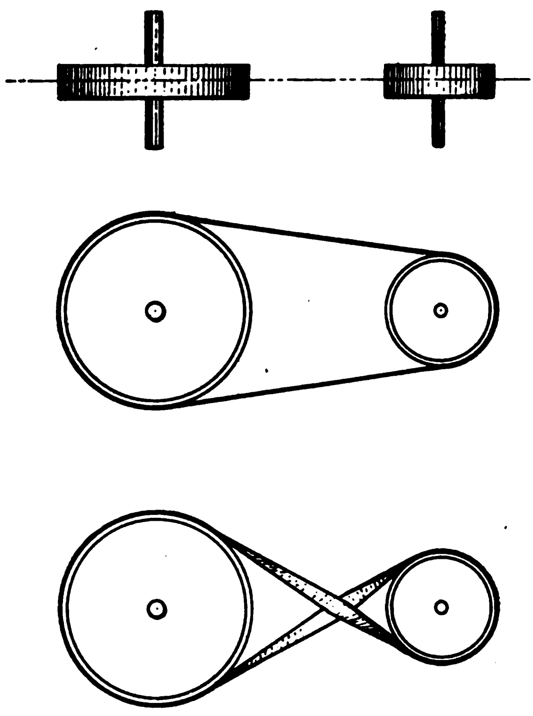


Fig. 9. Open and Crossed Belt Arrangement

firmly together when placed in position, then fastened with screws. The face should then be turned, and finished by giving it a coat of shellac or varnish.

One of the best methods of lagging a pulley where it is not necessary to increase the diameter a great amount, is by means of leather riveted to the rim. In this manner the diameter can be increased to the extent of an inch.

A rather crude method sometimes employed is to use rope wrapped upon the face of the pulley, but it can hardly be recommended for a permanent job.

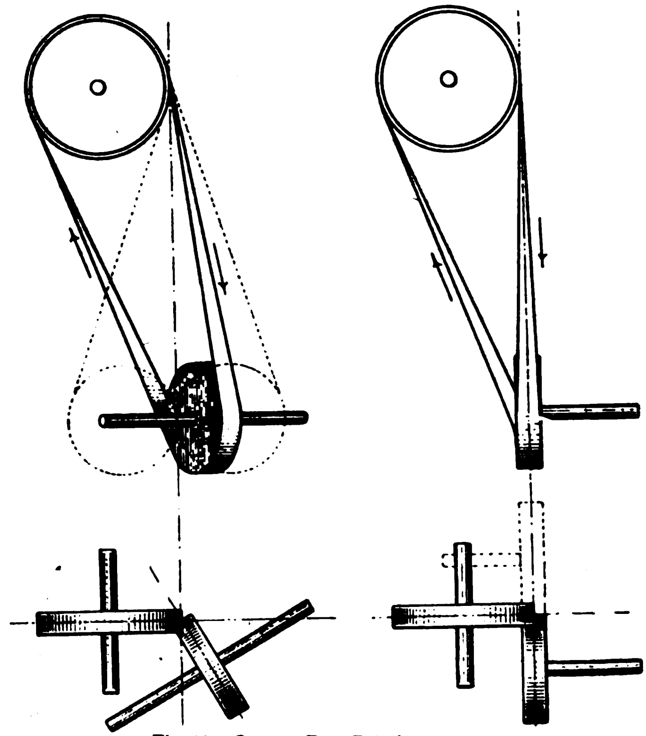


Fig. 10. Quarter Turn Belt Arrangement

SETTING PULLEYS FOR SPECIAL TRANSMISSION

As a general law for handling all cases of pulley setting in belt transmission, it may be stated that the direction in which the belt leaves a pulley must be tangent to the center line of the pulley to which the belt goes. Keeping this in mind the following solutions of belt transmission are readily apparent.

Where it is desired to transmit power between two parallel shafts the direction of motion being the same, an open belt is used, as shown in illustration Fig. 9. This is the simplest form of belt drive and that most commonly employed.

To secure opposite direction of rotation of two parallel shafts it is necessary to cross the belt, this arrangement also being shown in Fig. 9. In both these cases the pulleys are placed in the same plane and any ratio of speed up to 1 to 6 may be obtained.

When it is desired to transmit power from one shaft to another not in the same plane, a quarter turn arrangement is resorted to. The general solution of this problem is shown in Fig. 10, where variation in the angles of the two shafts is illustrated.

(*To be continued*)

The gasoline engine serves a very useful purpose, but do not expect it to run the whole farm.

Trans-Pacific Wireless

First Communication between San Francisco and Japan

Wireless communication between San Francisco and Japan, a distance of 6,000 miles, was established recently. This was the first time that a wireless message had been received across the Pacific Ocean. When the operator at Hill Crest station caught the signals he made them out to be the call for the *Chiye Maru*, a steamer that was then due at Honolulu. He answered the signal and learned that the call came from the Japanese wireless station on Hokushu Island, in the northern part of the Japanese archipelago. The operators exchanged messages for some time.

"Mr. Cleaver, how do you account for the fact that I found a piece of rubber tire in one of the sausages I bought here last week?"

"My dear madam, that only goes to show that the motor car is replacing the horse everywhere."—*New York Times.*

VALVE SETTING

F. L. BAILEY

Almost all eccentric rods have some means of increasing or decreasing their length, and a misadjustment or unintentional change of this device is probably responsible for as many valves incorrectly set as is the slipping eccentric. If the valve is of the plain *D* type, it can be easily told if anything is wrong with the rod adjustment. Simply remove the valve chest cover and mark the extreme travel of the valve on both sides, then measure from each of these marks to the steam edge of the adjacent port, and if the two measurements are equal you may be sure that the rod is not at fault and the trouble lies in the eccentric. The only exception to this rule is that in case of a vertical engine the lower port is usually given a slight advantage over the upper to offset the weight of the reciprocating parts. To set the D-valve, place the engine on dead center, using the method given later, and turn the eccentric or adjust the rod according to which is at fault until the port admitting steam behind the piston is opened to an amount guessed to be equal to the lead. Then turn the engine on the other center, and if the lead opening is the same, the valve is set.

It must be remembered, however, that the D-valve is not employed so universally as formally, and the chances are it will be a piston valve with which we have to deal; and in that case we must resort to measurements alone, for it is impossible to see just what the conditions are. Most piston valves carry the live steam between the pistons, so supposing that the one in Fig. 1 does let us see the proper methods employed in setting it. First remove the valve chest head and take out the valve. Then the dimensions marked *A*, *B*, *C*, etc., in Fig. 1, should be carefully taken. It is well to make a rough sketch of the valves and ports and substitute the exact dimensions instead of the letters, as shown in the figure. By preserving this diagram the valve may be set at any subsequent time without removing anything but the valve chest head. After taking the measurements replace the valve exactly as before, and turn the engine over until the *valve* reaches the highest (presuming the engine is vertical) point of its stroke. Then carefully measure the distance from it to the top of the valve chest and add the dimension *H*. Subtract this sum from *F*, preserving the remainder. Next turn the engine until the valve reaches its lowest point, and again measure from it to the top of the valve chest adding this time the sum of *H* and *A*, and subtracting the sum of *F* and *B*. If the remainders thus obtained are equal the rod adjustment is correct, and you may expect to find the trouble in the eccentric. If, however, they are unequal (with the exception of a slight allowance, as noted above in a vertical engine) the rod adjustment is certain to be at fault. In either case the next thing to do is to place the engine on dead center. This may be done accurately by the following method:

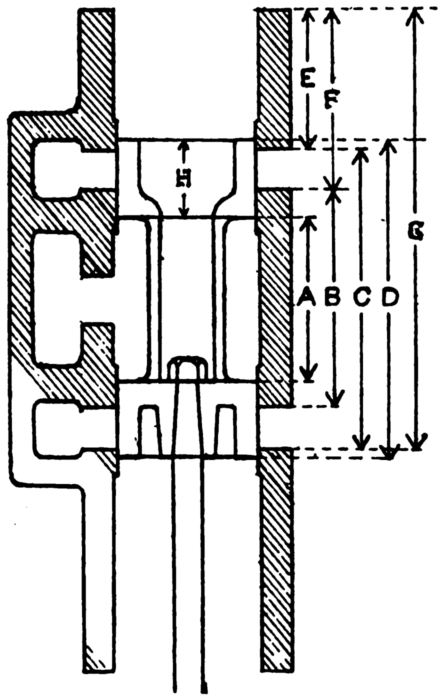


Fig. 1

Turn the engine about one-eighth of a revolution off center, and make a mark on the crosshead and guide in such a manner that the exact position may again be obtained. Then with a tram set on the floor or base of the engine at some finely-marked position make a mark on the flywheel. Next turn the engine back across center until the mark on the crosshead and guide again coincide, and with the tram, make another mark on the flywheel. Now bisect the space between the two marks on the flywheel and turn the engine until the bisection comes even with the tram, and the engine will be exactly centered.

Suppose the engine is centered with the crank nearest the cylinder, then, to set the valve take dimension H and subtract it from E, and then by turning the eccentric or adjusting the rod, as the case requires, make the distance from the valve to the top of the valve chest equal to the remainder. The valve will then be set "blind" or without lead. The amount of lead to gain the greatest efficiency will depend on a great many things, but in general, the higher the speed and the steadier the load the greater the lead should be. Experience alone and a close observation of the engine working under different amounts of lead will enable one to tell just how much should be given. Of course, more or less lead is given by changing the eccentric and not by adjusting the rods.

It would seem at first thought that it would be more difficult to set a valve on an engine fitted with a reversing gear, but it is really much easier, in fact it can often be done without taking any measurements or even removing the valve chest head. If, for instance, an eccentric slips on an engine with a Stephenson link gear it may be set correctly enough for all practical purposes by the following method. First, find which eccentric is at fault, and then set the reverse lever so that the valve will derive its motion entirely from the good eccentric. In other words if the "go-ahead" eccentric (in the case of a locomotive) has slipped, set the lever on the full backing position. Then turn the engine on dead center and make a mark on the valve stem where it enters the packing gland. Next move the lever over to the opposite side of the quadrant and turn the faulty eccentric until the mark on the valve stem is at the same position as before, and the valve is set. In the Walschaert gear one has simply to remember that the eccentric when properly set is either 90 degrees (one quarter of a turn) ahead or behind the crank, according to the kind of valve used, and whether the motion is transmitted direct or indirect. In the Marshall gear the eccentric is either right with the crank or directly opposite it, also depending on the type of valve and the way the motion is transmitted.

There is another way to set a valve which should not be overlooked, that is, by means of an indicator. Where an indicator is available this proves a most reliable method. The indicator is put on in the regular manner and the valve adjusted until the most perfect card is obtained. Sometimes most surprising facts are revealed by an indicator on an engine apparently all right. The writer at one time out of idle curiosity put an indicator on the high-pressure cylinder of a 40 h.p. cross compound vertical engine. The card taken showed fully twice as much work being done on the lower end of the cylinder, yet no one in the engine room dreamed but what the valve was set correctly. In this case the engine was fitted with a Rites governor, making it impossible for the eccentric to be wrong. The adjusting nut on the valve stem had gradually worked loose and turned until the above resulted. With the aid of the indicator it was but the work of a few minutes to properly readjust it.

To the novice valve setting is apt to seem an accomplishment to be acquired only after years of experience, and true enough one is apt to feel a little ill at ease upon first undertaking it, especially if a piston valve is employed, but if the theory is fully understood and all measurements accurately taken little trouble should be encountered.

Industry Buys Anything

The world was made for you. All that has gone before was that you might be. If you desire wealth, it can be yours. If you desire fame, it can be yours. But you must pay the price. Industry is the only coin acceptable at the gate of success. Our Roosevelts, our Carnegies, our Edisons, have bought their way to glory by hard labor. It's "the only way." The world and all therein is—that you want—is yours, if you pay the price in the free coin of the realm—industry.—GLEN BUCK.

No lie can last a long time.—HUBBARD.

WIRELESS TELEGRAPHY

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

CAUSES AND PREVENTION OF DETERIORATION OF WIRELESS DETECTOR

ERNEST C. CROCKER

It is common experience among wireless workers that, with but few exceptions, all wireless detectors of the rectifying type become less and less sensitive with time, even though they are only occasionally used. This deterioration means continual adjustment of the detector until its entire acting surface becomes "dead" and must be renewed. In practice, there are two general types of rectifying detectors in use—the electrolytic detectors and the so-called crystal detectors. We shall consider the causes of deterioration of each type separately.

The essential active part of an electrolytic detector is a small surface of platinum in contact with an acid. The arrangement of the platinum surface makes possible two styles of detector, one in which the platinum, in the form of a wire is adjustable vertically and just dips into the liquid, and the other in which the platinum wire is sealed in a glass tube, the end of which is ground off so as to allow only the end of the wire to be exposed.

If we have an electrolytic detector "tuned" in circuit for a strong nearby station and view the detector in the dark, we can often "read" the station's message by means of the little flashes of light which occur at the fine point. This effect is more powerful than one might believe, and it is often possible to see light at the point of a delicate detector, when the sending station is only of 2 k.w. power, and is 5 miles away; and even though one uses only a small antenna.

Where there is light there is usually heat, and when we consider the powerful action which takes place at the tiny point, we can scarcely wonder that the point is often ruined. If a glass tube is used, the heat cracks the glass, and in almost any case melts the end of the platinum into a ball or even volatilizes it entirely. Apart from this violent destruction of the detector, there is a slow loss of sensitiveness which is chemical in nature and is usually due to impurities in the liquid which dissolve away the platinum. Although considered acid-proof, platinum is slowly dissolved by hydrochloric (muriatic) acid, particularly if the acid is strong, or contains nitric acid or iron. Nitric or sulphuric acids alone, when pure, scarcely attack platinum.

What has been said in regard to heating also applies to the crystal detectors, although these will usually withstand rougher treatment than will an electrolytic detector. The chemical action, however, is more noticeable, even though the air is the only source of the disturbing chemicals.

In a crystal detector we have a point sometimes made of metal, sometimes of a mineral like chalcopyrite or bornite (essentially sulphides of copper and iron), and sometimes of an artificial compound such as iron monosulphide, which is in contact with a "sensitive" surface. The most prominent sensitive materials are: silicon (an element, Si), galena (lead sulphide, PbS), iron pyrites (iron di-sulphide, FeS_2), carborundum (silicon carbide, SiC) or zincite (zinc oxide, essentially ZnO). Of these latter materials, silicon and carborundum are artificially prepared and are fairly uniform in sensitiveness throughout a given piece. This, however, is not the case with the natural minerals, the sensitiveness of which depends largely on the particular way in which they were originally formed. In the case of the minerals, pyrites and galena, one may find it necessary to examine tons of material to obtain even a pound of active substance, so unusual is the active form of these substances. Not only is this sensitive material hard to find, but it is also rather easily impaired by the chemical action of certain components of the air.

The atmosphere is composed principally of nitrogen, oxygen, carbon dioxide and water vapor, and ordinarily we consider it as having no other components. None of the above substances, except water vapor, has perceptible action upon detector materials, but some of the minor constituents of the atmosphere, such as ozone, hydrogen peroxide and nitric acid vapor, exert a powerful destructive action. At a wireless station ozone is produced in considerable quantities, and much detector deterioration is due directly to this cause. Although the amount of these substances in the air is very small, they work continuously, so that in time they have a decided action.

The action of ozone or hydrogen peroxide upon galena is to transform the conducting sensitive surface of lead sulphide (PbS) into non-conducting lead sulphate ($PbSO_4$), thus producing a "sulphating" comparable with that of a storage battery. The action upon silicon (Si) is not so noticeable, however, but this substance is oxidized to silicon dioxide (SiO_2), which has the same composition and about the same conductivity as common sand. Zincite is already a mixture of oxides which cannot be further oxidized, but it is nevertheless quite sensitive to water vapor and dust. Dust almost always conveys some soluble materials, which, when they come in contact with the water which is held in the crevices and on the surface of detector materials, dissolve and make a conducting solution which shunts away the current and tends to make the detector useless.

The detectors which are most sensitive to wireless currents are generally sensitive to chemical changes caused by the air. The simplest way to obtain great sensitiveness with freedom from chemical disturbance is to cover the detector with a glass jar or to enclose it in a metal box, preferably the latter, for reasons to be presently explained. Inside the enclosure should be placed a little vial half-filled with either strong sulphuric acid or dry calcium chloride. The calcium chloride is cheap and clean and can even be used on shipboard where sulphuric acid could not be used. Enclosing the detector will do away with dust and harmful gases, and the drying agent will reduce the amount of moisture in the air in the box.

Very little can be done to prevent a distant station from "breaking down" a detector, except to use a detector which will withstand the strain. It is the action of one's own sending station which must be guarded against. The best way of eliminating this trouble is to surround the detector entirely with metal, even though it be no thicker than tin-foil, and to "break" the detector circuit at the surface of the metal box, or just within it. This breaking is best performed with an electromagnet so arranged that only after it has disconnected the detector will it be possible to turn on the sending current.

One source of detector trouble that is often overlooked is vibration. Every detector should rest on an under-base of felt or some such elastic material. Moreover, the spring which makes the tension between the elements should be fairly long and flexible and the proper tension secured by much tightening upon the adjusting screw, and not by a short or stiff spring which is lightly adjusted.

In summing up, it must be said that that the only way to have really satisfactory receiving is to choose a detector which is moderately free from electrical weaknesses and to enclose it in a metal box for its protection from the sending station's current on the one hand and from atmospheric corrosion on the other. This latter precaution is almost imperative in damp or dusty places. If the detector is properly protected from vibration, as well as from electrical and chemical troubles, it will scarcely ever need readjusting, so that the disadvantages of having it "boxed in" are more than compensated by its good behavior.

U.S. NAVAL WIRELESS TELEGRAPH STATIONS AND THEIR SERVICE TO SHIPPING

The following information, furnished by the Bureau of Steam Engineering, Navy Department, is published so that shipmasters and the shipping interests may see the advantages afforded by this service.

Wireless Communications between Commercial Vessels and Naval Wireless Telegraph Stations

The facilities of the wireless telegraph stations of the Naval Coast Signal Service, including those on the Nantucket Shoals and Diamond Shoals Lightships and the one soon to be established on the Frying Pan Shoals Lightship, for collecting and disseminating information useful to mariners, and for communicating with ships at sea where not in competition with private wireless telegraph stations, are placed at the service of the public generally, and of maritime interests in particular under the rules established herein, which are subject to modifications from time to time, for the purpose of:

(*a*) Reporting vessels and intelligence received by wireless telegraphy in regard to maritime casualties and overdue vessels.

(*b*) Disseminating hydrographic information concerning menaces to navigation, etc., sent out by the Hydrographic Office, or by a branch hydrographic office.

(*c*) Sending out storm warnings and weather reports as received from the Weather Bureau.

(*d*) Sending time signals for rating chronometers on vessels at sea.

(*e*) Receiving wireless information from ships for the Hydrographic Office concerning serious obstructions to navigation, such as derelicts, wrecks, ice, or any information that may be useful to the Pilot Chart or Hydrographic Bulletin.

(*f*) Receiving weather reports for the Weather Bureau of the Department of Agriculture.

(*g*) Receiving wireless telegrams of a private or commercial nature from ships at sea for further transmission by telegraph or telephone lines.

(*h*) Transmitting wireless telegrams to ships at sea.

Information Furnished to Shipping

This includes (*b*), (*c*) and (*d*) above, and is furnished gratis.

Hydrographic Information and Storm Warnings

Information concerning wrecks, derelicts, ice, and other dangerous obstructions to navigation, whenever received from the Hydrographic Office, or from a branch hydrographic office, and storm warnings received from the Weather Bureau, are sent broadcast four times daily, *viz.*, at 8 a.m., noon (immediately after the time signal, if sent), 4 p.m. and 8 p.m. Ships within range of a naval wireless station should be prepared to receive these hydrographic messages and storm warnings at the hours mentioned, and should avoid sending wireless messages at these times. One vessel sending may prevent several others receiving information necessary to their safety.

Naval wireless stations will furnish this information to passing vessels on request, whenever practicable, at other hours than those mentioned above. Should it not be practicable to send out this information on one of the hours scheduled it will be held until the next scheduled time, except that important storm warnings, reports of lightships off stations, etc., will be treated as urgent, and sent out as soon as practicable after each hour scheduled.

Time Signals

The following wireless stations send out time signals broadcast between 11.55 a.m. and noon every day, except Sundays and holidays, for the determination of chronometer errors, and hence time and longitude at sea: Portsmouth, Boston, Cape Cod, Newport, Fire Island, New York, Cape Henlopen, Washington, Norfolk, Beaufort, Charleston, Key West, Pensacola and New Orleans on the Atlantic and Gulf coasts; Table Bluff, North Head, Mare Island and Point Loma on the Pacific coast. This service has been suspended at St. Augustine and will be re-established as soon as practicable.

It is proposed to extend this service to the wireless stations at Guantanamo, Colon, and Tatoosh Island, if necessary arrangements can be made.

The signals are sent from the Naval Observatory, Washington, for the Atlantic coast between 11.55 a.m. and noon of the 75th meridian west of Greenwich, and from the observatory at the Mare Island Navy Yard between 11.55 a.m. and noon of the 120th meridian west of Greenwich for the Pacific coast.

The wireless sending or relay key in each wireless station is connected to the Western Union lines by a relay at about 11.50 a.m., and the signals are made automatically direct from Washington or Mare Island.

Time signals from each of the observatories mentioned begin at 11.55 a.m., standard time, and continue for five minutes. During this interval every tick of the clock is transmitted except the 29th second of each minute, the last five seconds of each of the first four minutes, and finally the last ten seconds of the last minute. The noon signal is a longer contact after this longer break.

(*Note.*—See diagram on back of Pilot Chart of the North Atlantic Ocean, No. 1400, of November, 1910, or North Pacific Pilot Chart for January, 1911.)

It is not necessary that an elaborate wireless telegraph installation be employed for the purpose of receiving these signals nor that a skilled operator be in attendance. Any vessel provided with a small receiving apparatus with one or two wires hoisted as high as possible and insulated from all metal fittings, or preferably stretched between the mastheads with one wire led down to the receiver, may detect these signals when within range of one of the seacoast wireless stations.

These time signals have been used successfully by vessels for rating their chronometers and have been used by surveying vessels in the accurate determination of longitudes.

Collection and Transmission of Information from Sea

All information for the Hydrographic Office and all weather reports received by any wireless station will be forwarded by wire direct to the

Hydrographic Office and the Weather Bureau, respectively, without charge.

Stations at isolated points, and other stations in important cases, will relay these messages to other wireless stations for further transmission if necessary.

Commercial Messages

All naval wireless telegraph stations with the following exceptions, *viz.*, those at the navy yards at Boston, New York, Philadelphia, Norfolk, Puget Sound and Mare Island, and the naval stations at New Orleans and Yerba Buena, San Francisco, will handle commercial messages under the following conditions:

(1) That no commercial station is able to do the work.

(2) That no expense is incurred by the Government thereby.

(3) That no money or accounts in connection with this business is handled by any person in the employ of the Navy Department.

(4) That the handling of the commercial messages shall not interfere with Government business.

The Government handles all commercial wireless messages without charge, but assumes no financial responsibility whatever for errors, delays, or non-delivery. Every effort will be made, however, to forward all messages accepted accurately and expeditiously by the best means available. Confirmation copies of commercial messages sent through naval wireless stations will be sent only when request is made in advance, or within thirty days after messages are forwarded.

Messages of all kinds received from ships at sea will ordinarily be forwarded by land wire, the land wire charges to be collected at destination.

In case of isolated stations, such as stations on Alaskan Islands and in emergencies, these messages will be relayed to other wireless stations for further transmission if necessary.

Position reports will be forwarded to owners or agents by land wire when request is made.

Messages received by land wire at a naval wireless station for a ship at sea will be forwarded by wireless when the ship comes within range. For this reason ships should ordinarily communicate with wireless stations while passing along the coast, giving their positions.

Messages received by a wireless station for a ship which cannot be delivered for any reason will be returned to the land wire company from which it was received.

The personnel of naval wireless stations are required to keep the strictest secrecy in regard to the contents of messages passing through their stations, and they are not permitted to communicate the fact that a message on any particular subject has been received.

All messages are kept on file, and senders and addressees may obtain copies of all messages as sent upon request.

Code

The Continental Code is the one used by the United States Navy, and is preferred for all wireless communication.

Changes being made in Sending Wave-Lengths of Naval Stations and Ships

All naval shore stations, except certain long-distance stations to be mentioned later, will have their apparatus adjusted for sending on a wave length of 1,000 meters as rapidly as possible. All sets will be "sharply tuned," so that it will be necessary for a vessel receiving to have her receiver very carefully adjusted for receiving a 1,000-meter wave. Otherwise the signals of a naval station may not be heard. A difference of 3 percent in wave length between the signals sent and received may be expected to cut down the strength of signals by one-half, and a receiver set for receiving on a 900-meter wave or on a 1,100-meter wave (*i.e.*, a difference of 10 percent), may not hear the shore station at all, depending on the distance. Vessels of the Navy are having their apparatus adjusted for calling on a 600-meter wave length, and may use other wave lengths for communicating with each other. When communicating with a naval vessel she may be expected to use a 600-meter wave having the same characteristics as the long wave described above. Shore stations and ships of the Navy may be expected to receive all calls from merchant ships using those wave lengths ordinarily in use at the present time. It is only the receiving by merchant ships which will be affected by the changes now being made, as described above.

The attention of all steamship companies, ship owners, masters of vessels and operators is invited to the advantages of transmitting apparatus capable of sending with a certain wave length with one sharp crest only. Signals from such apparatus can be readily "tuned out" if the desired signals differ sufficiently in wave length and the interfering ship is not too near. A change from direct to inductive coupling between the closed or oscillating (condenser) circuit and the open or radiating (aerial) circuit will accomplish this without loss of efficiency if two circuits are carefully adjusted by a wave meter and the proper coupling between the two inductances is used. A few experiments in tuning out any naval ship or station, properly adjusted to new standard tunes, especially those with high-pitched sparks, will show some of the possibilities of ordinary wireless working in the future.

Sharply tuned transmitters involve attentive receiving operators, in order that no calls may be missed. It is suggested that each line select a wave length under 600 meters and carefully adjust the transmitters of all its ships to that tune, as is being done with ships of the Navy.

Certain stations referred to above may use a wave longer than the standard (1,000 meter) for ship communications, and these exceptions will be published from time to time in "Notices to Mariners" and in the "List of Wireless Telegraph Stations of the World."

Working Rules for most Satisfactory Wireless Communication

A vessel wishing to communicate with a coast station should commence calling when about 100 miles from the station, having first "listened in" to ascertain that she is not interfering with messages being exchanged within her range.

The power and range of many stations, however, are being rapidly increased, and vessels should note at what distances they hear certain stations working with merchant ships in order that communication may be held over the maximum distance if necessary.

Calls should not be prolonged beyond fifteen seconds and should be followed by the letters of the station calling. Reasonable time should be given for an acknowledgment before repeating the call. A number of complaints have been received that vessels frequently call for long periods without pausing to hear whether or not their call is heard, or they are interfering with other communications going on. If, after making the call, a ship hears the signal "BK" or "XXXX" made, she should take it to mean that one station communicating with another is being interfered with by her calls and that she should wait.

As the use of longer wave lengths for avoiding local interference and for long distance and overland communication will be used considerably in the future, a vessel should listen on the longer wave lengths as well as those around 1,000 meters. Otherwise she may not understand why her call is not acknowledged immediately. While intercommunication is going on between two shore stations or between shore stations and naval ships with long wave lengths no ship calls will be heard.

After the station acknowledges the call the vessel should report her position. The following manner of reporting position, etc., is preferred:

(*a*) Distance of the vessel from the coast station in nautical miles.

(*b*) Her true bearing from coast station in degrees, counted from 0 to 360.

(*c*) Her true course in degrees, counted from 0 to 360.

(*d*) Her speed in nautical miles per hour.

(*e*) The number of messages she desires to transmit.

This will enable the coast station receiving a number of calls from various vessels to determine which one will pass out of range first in order that that vessel may be permitted to finish her business. When a coast station acknowledges she may state whether or not she has messages for the ship, and if she cannot communicate further with the ship at that time the ship will be informed of the length of the time it will be necessary to wait.

On receiving word to "go ahead" the vessel should send a message as follows:

(*a*) "HR" or "MSG."

(*b*) Number of message.

(*c*) Ship's call.

(*d*) Operator's sign.

(*e*) Number of words, excluding address and signature.

(*f*) Originating station and number, for relayed messages only.

(*g*) Original date, for relayed messages only.

(*h*) Route of message.

(*i*) Address.

(*j*) Message.

(*k*) Signature.

Notations in regard to wireless charges on board ship, land wire charges, or both, may be made after (*e*). In case it is desired that the message should be forwarded by a certain land line the fact should be indicated in item (*h*) by the initials "WU" or "PT," or other designation necessary. In an original message sent from a ship to a wireless station items (*f*) and (*g*) may be omitted.

In case of long messages the sending ship should get an acknowledgment after every twenty words, or thereabouts, before proceeding.

Communication may be interrupted at any time and the right of way given to a Government station or vessel, if necessary, or to any vessel in distress, or to send broadcast any important information.

All stations may be expected to be familiar with the methods of communication adopted by the International Wireless Conference of Berlin, of 1906, with special regard to the international signal of distress "SOS," and the signal "PRB," expressing the desire to communicate by means of the international signal code by wireless. Ships are requested not to use the letters "OS" preceding a position report, as the letters "OS" made rapidly and continuously might be mistaken for the signal of distress "SOS."

Shore stations in designating the order in which messages will be received from the vessels within range will be guided exclusively by the necessity of permitting each station concerned to exchange the greatest possible number of wireless telegrams. At all times business may be expected to be handled in the following order:

(*a*) Government business, *viz.*, telegrams from any Government Department to its agent aboard ship.

(*b*) Business concerning the vessel with which communication has been established, *viz.*, telegrams from owner to master.

(*c*) Urgent private dispatches, limited.

(*d*) Press dispatches.

(*e*) Other dispatches.

Reports to Navy Department

In order that the efficiency and reliability of the service may be steadily increased, it is requested that merchant vessels unable to communicate with any station open for public business report the matter in full to the Secretary of the Navy, Washington, D.C. The statements should be specific, giving date and hour, local conditions as regards atmospheric disturbances and wireless communications, distance from the shore station, and the statement that the wireless apparatus of the ship was in good condition, as evidenced by other communications effected at or about the same time, and that the receiver was adjusted approximately for the sending wave length of the shore station. All reports will be investigated and the cause of the trouble will be ascertained if possible. A reply may be expected after the matter has been investigated.

Notes on Certain Stations

Cape Elizabeth, Me.—Post-office address, Portland, Me. Telegraphic address, Cape Elizabeth, Me. Station uses new standard sending wave length or "tune" (1,000 meters). Manned by one operator only, who listens for calls from five minutes before the hour to five minutes after, from 9 a.m. to 10 p.m., both inclusive. He transmits messages at any time. Handles commercial messages.

Portsmouth, N.H. (*Navy Yard*)—Uses standard time. New high-frequency 2 k.w. set recently installed. Handles commercial messages.

Boston, Mass. (*Navy Yard*).—New high-frequency 5 k.w. set being installed.

Cape Cod, Mass.—Post-office address, North Truro, Mass. Telegraphic address, Navy Wireless, Highland Light, Mass.

Newport, R.I. (*Torpedo Station*).—New high-frequency 5 k.w. set being installed. Handles commercial messages.

Nantucket Shoals Lightship.—Post-office address, Care of Babbitt & Wood, New Bedford, Mass. Telegraphic address, via Torpedo Station Newport, R.I. Uses short-wave length. Communicates with ships and Newport only. Ships passing are requested to communicate by wireless or by international signals in order that they may be reported via Newport. Ships whose wireless apparatus permits should report to Newport direct.

Fire Island, N.Y.—Post-office address, Bayshore, Long Island, N.Y. Telegraphic address, Wireless, Fire Island, N.Y. New high-frequency set to be installed. Handles commercial messages.

Philadelphia, Pa. (*Navy Yard*).—New high-frequency 2 k.w. set being installed.

Cape Henlopen, Del.—Post-office and telegraphic address, Lewes, Del. Handles commercial messages.

Washington, D.C. (*Navy Yard*).—Handles commercial messages. High-power station being erected.

Norfolk, Va. (*Navy Yard*).—New high-frequency 5 k.w. set being installed.

Diamond Shoals Lightship.—Post-office address, Care of Clyde Steamship Company, Pier 36, North River, New York, N.Y. Telegraphic address, Via Wireless Station, Beaufort, N.C. Handles commercial messages. Communicates only with Beaufort.

Beaufort, N.C.—Post-office address, Beaufort, N.C. Telegraphic address, Beaufort, N.C. (Western Union only). Handles commercial messages.

Charleston, S.C. (*Navy Yard*).—Handles commercial messages.

Frying Pan Shoals Lightship.—Installation in progress. Will communicate with Charleston.

St. Augustine, Fla.—Post-office and telegraphic address, St. Augustine, Fla. Handles commercial messages.

Jupiter Inlet, Fla.—Post-office address, Jupiter Inlet, Neptune, Fla. Telegraphic address, Jupiter, Fla. (Western Union only). Handles commercial messages.

Key West, Fla. (*Naval Station*).—Handles commercial messages. Two high-frequency sets, 25 and 2 k.w., to be installed.

Pensacola, Fla. (*Navy Yard*).—Handles commercial messages.

San Juan, P.R.—Handles commercial messages.

Guantanamo, Cuba (*Naval Station*).—New high-frequency 5 k.w. set to be installed. Handles commercial messages.

Colon, C.Z.—Post-office address, Colon, C.Z. Telegraphic address, Wireless, Colon. Twenty-five k.w. high-frequency set. Handles commercial messages.

St. Paul, Pribilof Islands, Alaska.—Established July 3, 1911. Standard sending tune. Two operators. Hours of operation will be published later. Communicates with Nome and Unalaska by day and in addition with Kodiak and Cordova at night. Handles commercial messages.

Unalaska, Alaska.—Established August 10, 1911. On Amaknak Island. New high-frequency 5 k.w. set. Standard sending tune. Communicates with St. Paul by day and with Nome, Kodiak, and Cordova by night.

Kodiak, Alaska.—Established May 28, 1911, on Woody Island. Standard sending tune. Communicates with Cordova by day and with St. Paul and Unalaska by night.

St. Paul, Unalaska, and Kodiak transmit and receive messages to and from the U.S. Army Signal Corps station at Nome and the naval wireless station at Cordova, either direct or by relaying. The last-named stations are connected with the Signal Corps Washington-Alaskan Telegraph and Cable System, and messages to and from the United States are sent via cable to Seattle. Particular attention is invited to the necessity for providing for payment in advance, required by law, for any messages transmitted over the land lines or cables of the Washington-Alaskan Military System. Commercial concerns and ships intending to send messages to the United States or to the interior of Alaska through the naval wireless station at Cordova or the Army wireless station at Nome should make a deposit at the U.S. Army Signal Corps Office at Cordova or Nome to guarantee prepayment of charges, otherwise the messages can not be sent. For the present all naval Alaksan wireless stations are authorized to relay messages of all classes among themselves, but they are not expected to communicate with any station in the United States, except on rare occasions.

Cordova, Alaska.—Standard sending tune. On the Washington-Alaskan Military Cable. Communicates with Kodiak by day and with Unalaska and St. Paul by night.

Sitka, Alaska.—Standard sending tune. On the Washington-Alaskan Military Cable. Has not reliable communication with other Alaskan stations at present. Communicates with passing ships.

Tatoosh Island, Wash.—Post-office address, Tatoosh Island, Wash. Telegraphic address, Wireless, Tatoosh, Wash. Handles commercial messages, relaying to other stations as necessary. Communication by land wire for commercial messages will be arranged if practicable.

Bremerton, Wash. (*Navy Yard*).—New high-frequency 5 k.w. set being installed.

North Head, Wash.—Post-office and telegraphic address, Ilwaco, Wash. Handles commercial messages.

Cape Blanco, Ore.—Post-office address, Denmark, Ore. Telegraphic address, Marshfield, Ore. Handles commercial messages.

Table Bluff, Cal.—Post-office address, Loleta, Cal. Telegraphic address, Eureka, Cal. Handles commercial messages.

Farallon Islands, Cal.—Post-office address, via San Francisco, Cal. Telegraphic address, via Navy Yard, Mare Island, Cal. Handles commercial messages. Relays to Yerba Buena or Mare Island.

Mare Island, Cal. (*Navy Yard*).—New high frequency 5 k.w. set to be installed.

Point Arguello, Cal.—Post-office and telegraphic address, Surf, Cal. Handles commercial messages.

Point Loma, Cal.—Post-office and telegraphic address, San Diego, Cal. Handles commercial messages. New high-frequency 5 k.w. set to be installed.

Honolulu, T.H. (*Naval Station*).—Handles local commercial messages.

Guam, M.I. (*Naval Station*).—Handles local commercial messages.

Cavite, P.I. (*Naval Station*).—Handles local commercial messages.

Olongapo, P.I. (*Naval Station*).—Five k.w. high frequency-set to be installed.

Wireless Messages from Spitzbergen

The first aerial messages were exchanged recently between Spitzbergen, high up in the Arctic Ocean, and the European wireless stations. The new Spitzbergen installation, as the Norwegian periodical *Nordland* points out, is a creditable piece of quick construction work. It had to be, for the Spitzbergen summer is very short.

It was only in the spring that T. T. Heftye, the director of the Norwegian State Telegraph Department, obtained from the Storthing a grant of funds for the purpose. Building operations were begun about the middle of July and in September the whole station was finished, comprising dwelling houses for the operating staff, an engine house, big store-houses for provisions, motor oil, coal, etc.

Green Harbor, it was found, was the only suitable place in the archipelago for the erection of buildings, although the air waves to reach the nearest European wireless station, on the island of Ingo near Hammerfest, have to pass over a lofty mountain ridge, whereby they lose a good deal in power. This was foreseen and extra powerful machinery was installed.

Working conditions in Spitzbergen are somewhat peculiar, for the thermometer often records 45 degrees of frost. The engine room has, therefore, to be kept at an equable temperature by means of an ingenious heating system. There is also a double set of machinery, comprising two oil engines of 30 h.p., two 16 kw. dynamos, two 60-cell 725 ampere-hour accumulator batteries and two 10 k.w. motor generators.

The erection of the two 200 ft. trellis masts was a matter of considerable difficulty, as an enormous quantity of concrete for the foundations had to be shipped by sea all the way from Christiania. Spitzbergen has already contacted with the German station Norddeich and the British station of Poldhu in Cornwall, but the regular traffic is conducted by way of Ingo.

Wireless Goes 4,000 Miles

New Station at Coltano, Italy, transmits Greeting by Marconi to Glace Bay, Nova Scotia

Four thousand miles from Coltano, Italy, to Glace Bay, Nova Scotia, was covered in a greeting sent by wireless to the New York *Times* recently. This is the greatest distance a wireless message has ever traveled. It exceeds by 2,250 miles the news Marconigrams regularly sent from Clifden, Ireland. The brief message which was signed by Cavaliere Guglielmo Marconi, the inventor of wireless, marked the opening of the new station at Coltano, near Pisa, the most powerful in the world. It was transmitted over the land lines from Glace Bay.

John Bottomley, New York manager for the Marconi Company, explained that the Coltano station, which is a short distance from Pisa, had been planned to connect Italy with Argentine. A large proportion of the population of the South American republic is Italian, and it has been the inventor's hope to connect Italy with Buenos Ayres. Mr. Bottomley said that a new station was being built at Buenos Ayres for this purpose. The distance in an air line from Coltano to Buenos Ayres is approximately 7,000 miles.

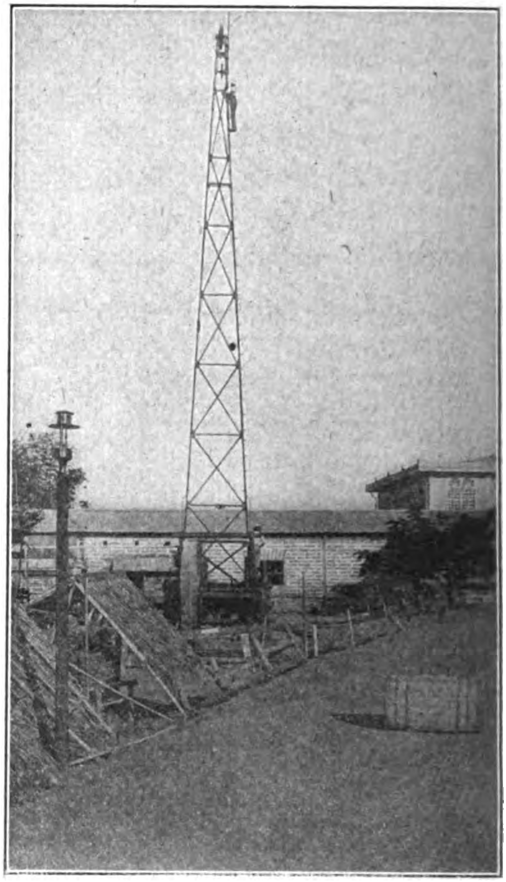
The next station at Coltano will transmit messages in all directions for distances corresponding to the 4,000 miles from Coltano to Glace Bay, but as yet, Mr. Bottomley explained, there are few long-distance stations ready to receive them. The English Marconi Company has recently taken over the Russian operations and is contemplating a number of large stations in the interior of the empire which would be in touch with Coltano and Clifden.

There are no long-distance stations in Africa, but the Italian fleet and army in Tripoli are in easy communicating distance with the home shores.

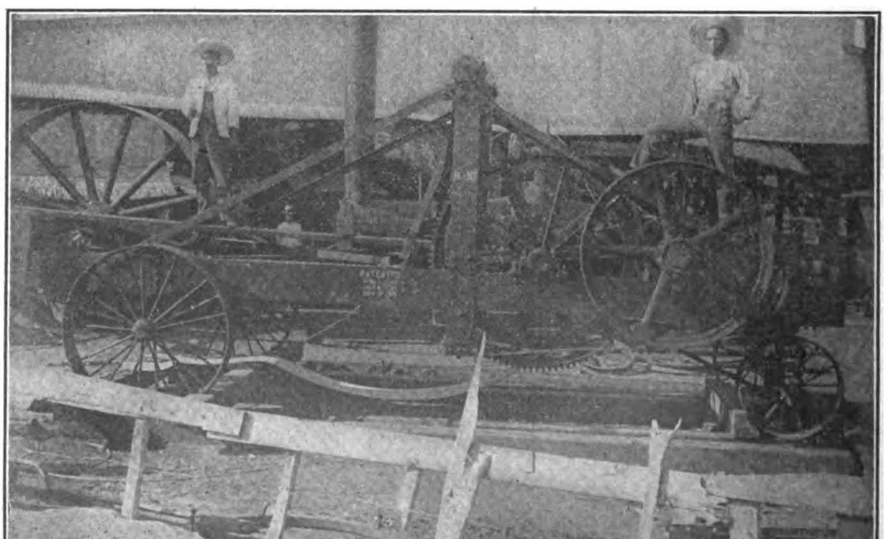
PHILIPPINE ARTESIAN WELLS

MONROE WOOLLEY

The artesian well is doing more, perhaps, than any other one agency to rid the Philippines of disease. Prior to American occupation the natives carried water in hollow bamboo poles from neighboring springs, creeks and sloughs, for drinking purposes. It was nothing uncommon in the early days to see a carabao or a pony wallowing in a pond where the lavandera did her week's washing, and from which the house muchacho carried the drinking and cooking water. This custom did not, of course, obtain in the larger towns and cities, nor among the better class of natives. Now, throughout the interior, the common people in most places have, through the medium of the artesian well, water equal in purity and quantity to any other community. The Bureau of Public Works has spent much time and money driving wells wherever needed. The well drilling crews, each having an American foreman and several native laborers, operate under the direction of Mr. Frank L. Irwin, who for many years worked in the oil fields of India. At first some of the more ignorant natives stood much in fear of the spouting fountains, not understanding how water could be forced from the bowels of the earth in a huge, steady stream. But finding the water pure, with no ill effects, and the supply never ending, they are now grateful for the accommodation.



Tower of Well Drilling Rig



Oil and Well Drilling Machine at Calumpit, Philippine Islands

A LARGE ELECTRIC CLOCK

A large electric clock will be located 220 ft. above ground-level in a tower of the Royal Liver Insurance Company's new offices, overlooking the Princes Landing Stage, London. The clock will have four dials, each 25 ft. in diameter, while the minute-hands scale some 14 ft. in length by 3 ft. at their greatest width. Each of these huge bands is of copper, strengthened by 9 in., gun-metal ribs, and they are designed to withstand the maximum local wind pressures with an ample margin of safety. It has been calculated that an ordinary gale will entail a total pressure of no less than 11½ tons on a single dial. Each of the latter is cast in several pieces, to facilitate manufacture, transmission and erection, and the white groundwork will consist of special translucent opal glass, which, although only ⅛ in. in thickness has proved capable of withstanding a test pressure of 600 lbs. per square foot without fracture. The hours will be indicated by twelve distinctive marks, each 3 ft. x 1 ft. 6 in., and a space of 1 ft. 2 in. will separate the minute divisions. It will thus be seen that the circumference of each dial at the "minute" divisions is no less than 70 ft.

The clock will be fitted with the "B.P. Patent Waiting Train" movement. This both drives and controls the progress of the hands in such a manner that a practically continuous movement is the result. The movement will be under the control of a precision time transmitter, of Gent's design, which is already extensively employed in observatories at home and abroad. The resultant control takes effect every half minute, thus insuring absolute accuracy in timekeeping, while a distinct advantage is the separation of the timekeeping from the hand-driving element, thus eliminating errors due to the effects of weather on the hands and other exposed portions of the mechanism. Another incidental advantage is that a number of smaller clocks can be distributed throughout the premises and driven from the same common transmitter, the whole system keeping good time simultaneously. The transmitter will be connected with Greenwich, and will thus be subject to automatic correction to Greenwich mean time.

The illumination of the dials at night involves an ingenious automatic switching arrangement, which will not only turn on the light at dusk, and switch it off again at sunrise, but is also compensated for the gradual change in the seasons. This result is achieved by a cam, acting through a simple reducing gear, revolving once only in two years. The error due to leap years is compensated so nearly that the resultant error is only ten minutes in thirty years, at the end of which period it can be corrected and reset for a subsequent run of thirty years, in less than a minute, and without the aid of tools.

The huge clock will thus be entirely automatic, and entail no periodical attention beyond that possibly required to replace a burnt-out lamp in the lighting system.

Protection of Workmen on Buildings

It has been but a few years that the safety of employees on buildings has received legislative attention, but the list of states having laws on this subject has attained considerable length, three—Louisiana, Montana and Oklahoma—being added thereto within the period covered by a review of this matter in a bulletin of the Bureau of Labor.

The act of the Louisiana Legislature, says the *American Builder and Contractor*, calls for the installation of such devices as will protect workmen below from falling objects and requires safety rails to be placed on scaffolds, elevator shafts to be guarded, the adoption of signals for hoists, the construction of secondary scaffolds and protective floors and the determination and observance of the loading capacity of joists during the construction of buildings.

A Montana law on this subject requires scaffolds to be safe and so built as to prevent material falling therefrom, protective shields to be erected above scaffolds if work is being carried on overhead, and that stairs and elevator ways be guarded. The Oklahoma statute relates to scaffolds, hoists, cranes and stays, which shall be "safe and suitable"; and directs the construction of protective floors during the course of the erection of the building if the permanent floors are not laid before the erection of the succeeding story.

AN ELECTRIC WATER TANK GAUGE

JAMES P. LEWIS

It is often desirable to know the quantity of water in a tank or cistern located some distance away, without the necessity of going to look in same. As, for instance, in the case of a small water system, with a cistern several hundred feet away, on a hill, supplying water to a home.

When the owner of the device to be described desires to know when his supply is getting low, etc., he merely presses a button at his house, and the gauge shows the exact number of feet or gallons remaining.

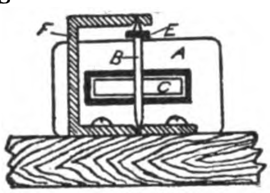


Fig. 1

There are many other instances where such a device will prove a great convenience and time saver.

The principle of the gauge is as follows: An instrument, which is really a simple form of voltmeter, is located at the house, or any place desired. A line of common telephone wire runs from it to a small rheostat on the tank. This rheostat is controlled by the height of water through a float and a simple system of levers, to reduce the motion. When the tank is full, all the resistance is cut out, and the pointer of the gauge reaches its maximum deflection. As the tank is emptied, the resistance is gradually introduced, the

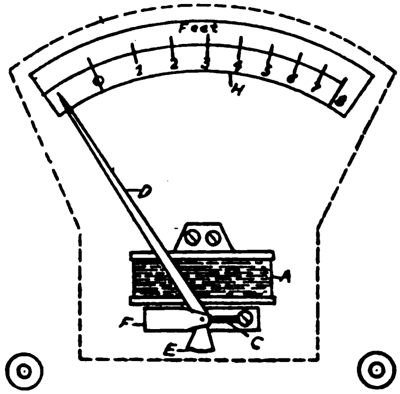


Fig. 2

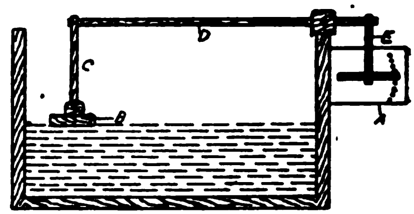


Fig. 3

gauge registering at all times an amount corresponding to the depth. The reading is taken directly from the scale, as the gauge is calibrated in feet (or gallons) instead of volts. A few dry cells are sufficient to operate same, as they are only used the short time during which the reading is being taken.

A simple and easily made form of voltmeter for the gauge is shown at Figs. 1 and 2. Fig. 1 is an end view of the coil and moving system; while Fig. 2 shows a plan view of the completed instrument.

The baseboard is a piece of 1/2 in. hardwood, 4 in. square, and finished as desired. On one center line, about 1 in. from the end, is fastened the coil *A*, which is constructed as follows: The ends are two pieces of 1/16 in. brass, 3/4 in. x 1 1/4 in. One of these has an extra lug, on one side 1/2 in. long and 1/4 in. wide. This is bent over at right angles, and is the means of fastening the completed coil to the base. Two or three small wood screws are used. In each of these pieces a rectangular hole 1/4 x 3/4 in. is cut. A strip of 1/32 in. brass 3/8 in. wide is bent into a closed form, so that the holes in the two end pieces just slip over the open ends of the form, where they are neatly soldered. The spool just formed is wound full of a fine gauge magnet wire, about No. 30 (single silk or enamel is best).

The moving system consists of the pivot *B*, which may be a portion of a large sewing needle, with both ends ground to a sharp point. Slightly below the center of this pivot and at right angles to it, is soldered a piece of soft iron, *C*, 1/8 x 11/16 in., and from 1/32 to 1/16 in. thick. The barest trace of solder is all that is necessary.

The pointer *D* is made of very thin spring brass, tapered nicely as shown.

This is soldered about 1/8 in. below upper end of pivot, and so as to make an angle of about 30 degrees with armature *C*. Aluminum is a better material, being lighter, only it is rather difficult to fasten securely, as it can not be soldered. A small weight *E* is used to balance the pointer and bring it into the correct position; that is, so *C* stands parallel to the hole in the coil. A U-shaped piece of brass *F* forms the bearings. This is 1/16 x 1/4 in. in cross section. The pivot turns in small dents, made with a smooth sharp-pointed instrument or end of a drill. Two blocks of wood are used to support the scale *H*, which is of heavy cardboard.

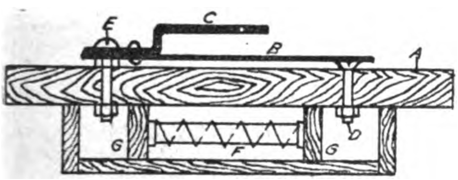


Fig. 4

A case of thin wood, or metal (not iron), should be made to protect the instrument from dirt and air currents. The outline of this case is shown in dotted lines, Fig. 2. The portion of case over scale being cut away, and a piece of thin glass or mica may be fastened on the under side of opening. The completed instrument must be fastened in a permanent upright position.

Figs. 3 and 4 show the rheostat at the tank end of the line. The baseboard *A* is about 6 x 8 in. Arranged in the arc of a circle, with *E* for a center, are a half dozen or more flat headed brass bolts *D*. A switch arm, pivoted at *E* by a small bolt, slides over them successively. This arm consists of two parts, the thin springy part *B*, and the heavier part *C*, to which is fastened the operating arm.

On the under side of the base are arranged as many resistance coils as there are contacts *D*–1. These are merely small cylinders of wood, fastened between the two wood strips *G*, *G*, and wound with about an ounce each of about No. 32 gauge magnet wire. The method of determining the exact amount will be described later.

Fig. 3 shows the tank, float and levers which operate the switch arm. The

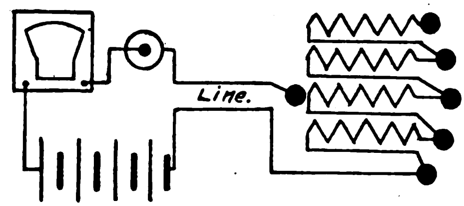


Fig. 5

rheostat being greatly enlarged out of proportion for the sake of clearness. The float *B* is a large block of wood. Levers *C* and *D* are light wood strips, pivoted at all connections with small bolts. *D* has a bearing near one end, on edge of tank. The position of this bearing will be determined by the depth of tank, and consequently the amount of motion to be reduced. A brass strip connects end of lever *D*, Fig. 3 and *C*, Fig. 4.

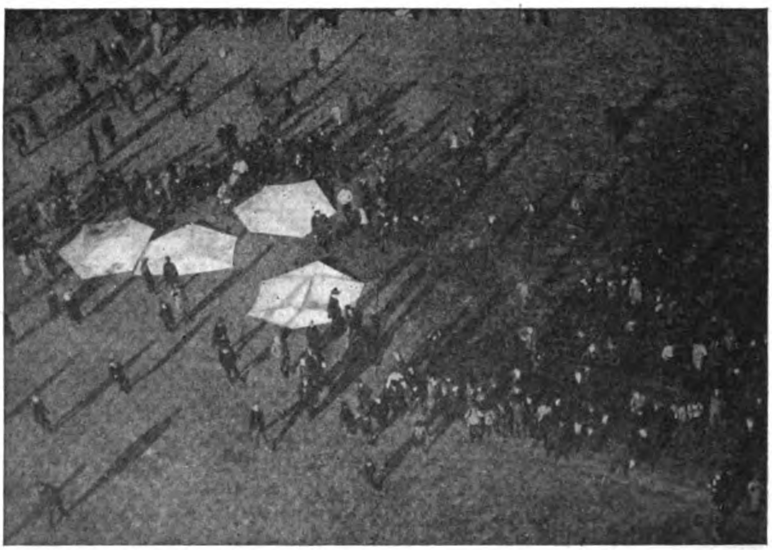
The rheostat should be protected by a cover of some kind.

Where this system of lever is for any reason objectionable, another method may be used to accomplish the same result. A stout cord is fastened to the float in place of the lever. This cord is run over a small pulley on edge of tank. The frame of an old clock is secured, with a train of two or three of the gears remaining. This frame is then fastened just above the rheostat, and the loose end of the cord is attached to a small drum on the fastest moving wheel of the train of gears. Another small drum is placed on the axle of the slowest moving wheel, and a cord run from it to the arm of the rheostat. With most clocks, two gears will give a reduction of 5 to 1; three gears 25 to 1. It will also be necessary to place a small weight on the rheostat arm, to keep the cords taut while they are played out by the float.

The number of batteries required will depend on the length of line, size of line wire and sensitiveness of meter. For a line about 500 ft. (each way) 6 or 8 cells will probably be sufficient. The correct number, and also the amount of resistance in the rheostat, is determined; and the calibration of the meter is accomplished in the following manner: The connections are first made as per Fig. 5 (except as the coils are not in the rheostat yet, it is short-circuited for the present). The button is now pressed to obtain a reading; with the tank full of water, the pointer of the meter should give a full scale deflection. If it does not lighten, counterbalance weight, add cells, or do both. If pointer of meter moves too far, decrease number of cells, until the desired result is obtained. The number of feet of water in tank is now marked on scale. The tank is now emptied, and sufficient resistance inserted in the circuit to give only a small deflection (say ⅛ scale or less). This position is marked 0 on scale. The resistance thus obtained is divided among the coils *F*, Fig. 4, in such amounts as to give fairly even scale divisions. The short circuiting wire being removed, the other positions can be marked on the scale with the water in the tank at various depths.

Although the diagram, Fig. 5, only shows four coils, there should be one or more for each foot of water to be measured.

Since for correct readings the voltage should always be practically constant, when the cells become nearly exhausted the tendency will be to give an under reading. But a correct reading can always be obtained by having an extra resistance coil, equal to the resistance of the line. Then before each reading a test can be made by switching this resistance in, in place of line. This is equivalent to the tank in full position, and the gauge should register same. If it registers less, the difference is noted. Now a reading is taken in the ordinary way, and this reading plus the difference just obtained will be the correct reading.



View from Man Flying Kite

Recently a practical demonstration has been made of the usefulness of the man-carrying kites to transmit wireless communications, messages having been sent from San Francisco to Los Angeles, California, and by means of the kite cable transmitted to the operator on the ground.

The altitude record made in California was 385 ft., this being also a duration kite record, the designer of these man-carrying kites staying up in the air for 90 minutes. The young Boston kitor owes his life to the fact that several of the many kites by which he was suspended at Los Angeles parachuted and prevented him from dashing to death on the earth. He was 200 ft. in the air when the accident occurred in which aviator Chas. Willard collided with and cut the cable with his biplane, thus severing all connection of the kites with the earth. Aviator Willard injured his front control, but was able to land immediately and safely. Although three kites were wrecked, kitor Perkins in dropping 200 ft. landed without serious injury, the remaining kite acting as a parachute.

THE MOST NORTHERN WIRELESS STATION IN THE WORLD

Editor's Note—Mr. Kline is one of our most enthusiastic readers, and it is certainly very interesting to receive a description of the station in which he is located. Being, as he is, upon the outskirts of civilization, Mr. Kline would no doubt be very glad to hear from a few of our many wireless readers.

The Mail Train Leaving for Fairbanks and Eagle

WAR DEPARTMENT
SIGNAL CORPS U.S. ARMY

Circle, Alaska.

My order of September 4th just received, and I am much pleased with the books which were sent. As soon as navigation opens I will try and make a larger order.

This station was opened in September, 1908, for commercial business, and since then we have worked daily with the best of results. Are using a 3 k.w. generator and a 6 h.p. gasoline engine. I am working with the two stations, Fort Egbert (about 100 miles) and Fairbanks (130 miles); but have heard Cordova plainly (250 miles from here); they are using a 2 k.w. outfit. The telegraph stations here in Alaska are controlled and operated by the U.S. Signal Corps of the Army. From what data I can gather this is the most northern telegraph station in the world and the only one that is entirely in log cabins. We are only about 20 miles south of the Arctic Circle. We are using the Counterpoise system of wires at a height of about 7 ft. above ground, 43 wires 200 ft. long (fan-shaped), 9 aerial harps 300 ft. long, and a steel tower 80 ft. high. I enclose a few snapshots of our station.

Yours very truly,
C. E. KLINE.

1. Engine Room 2. Telegraph Office 3. Location of Operator
Photograph was taken at 55 degrees below zero

AUTO DEPARTMENT

FROZEN AUTOMOBILE RADIATOR

N. M. HOWARD

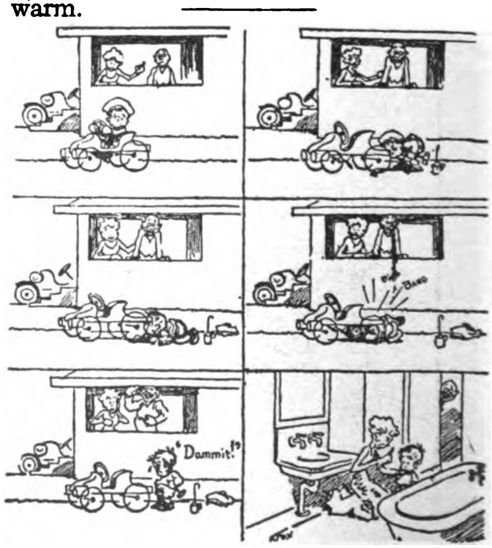
The season of the year when the autoist has to look out for frozen tubes in his radiator is here. Experience is a good teacher, but it is sometimes expensive, as we learned last winter. We intended to use the car only a few times during the cold weather and thought it would be the simplest plan to use ordinary water, without any freezing compound, in the radiator, and to drain the radiator after each trip. Well, we tried this, and it worked very well for a while, until one morning we went to fill the radiator and found that one of the tubes had burst. The drain cock was open, and apparently all of the water had drained out of the radiator. For some time we were at loss to determine the cause of the trouble but finally decided that it must have been due either to the water being retained in the tube by a piece of sediment becoming lodged in the bottom of the tube, or to the tube becoming air-bound and thus preventing the water from draining out.

This experience taught us that it is never safe to assume that a radiator is completely drained, simply because the drain cock is open and apparently all of the water has run out. After having our radiator repaired we used a mixture of alcohol and water and had no further trouble. We used about one part alcohol and two parts water. Replacing the evaporation with a larger percentage of alcohol, as the alcohol boils away much faster than the water.

When a radiator is injured by having one or two tubes burst, it can be repaired without going to the expense of having the radiator pulled to pieces and the defective tubes replaced with new ones, by simply plugging the defective tubes at each end. To do this, it is necessary to cut a hole in the back of the top tank and one in the bottom of the bottom tank, near the defective tubes. Then working through these holes plug both the top and bottom ends of the burst tubes with solder, using a soldering iron to melt the solder in place. Make sure the tubes are tightly plugged and then solder patches of sheet copper or brass over the holes that were cut in the tanks to allow access to the tube ends.

To test the radiator for leaks, fill it nearly full of water, plug up the openings and connect a bicycle pump to it. A few strokes of the pump handle will give sufficient pressure to force the water out in a fine spray through any leaks if they exist. Care should be taken not to put enough pressure on the radiator to injure it.

A radiator that has been repaired in the above manner is practically as good as new, as the loss of one or two tubes does not make any appreciable difference to the cooling surface; but, of course, if a large number of tubes are defective this method cannot be used, as it would reduce the total cooling surface of the radiator to such an extent that the circulating water would not be properly cooled, and in hot weather the engine would run too warm.



A TOO, TOO PERFECT IMITATION OF FATHER.

COST OF HYDRO-ELECTRIC PLANTS

GEORGE E. WALSH

The harnessing of our streams and waterfalls for the generation of electricity represents one of the most important industrial developments of the day, and there are hundreds of such power plants scattered all over the country; but aside from the large commercial hydro-electrical plants there are hundreds of comparatively small streams and brooks which possess all the possibilities on a limited scale that the big ones offer. The value of comparatively small streams running through a rich farming or manufacturing region is scarcely appreciated by many, and to utilize them to economic advantage is one of the opportunities that awaits the far-seeing man of affairs.

Theoretically, size is inconsequential in hydraulic development, but as a matter of practical electrical engineering small powers require very special treatment to secure good economic results. This applies with special reference to a plant under 500 h.p., and in particular to those of 200 or 300 h.p. There are literally thousands of brooks, small waterfalls and lakes scattered over the country that could be made to yield an output of several hundred horse-power, and the only question is one of economic development and operation. Such plants could be utilized for pumping water for irrigation purposes, for operating small factories, and for lighting houses and mills. Water is the cheapest of all power when properly harnessed; but, heretofore, attention has been directed chiefly to such big affairs as Niagara. It is remarkable what tremendous power can be developed from a small stream when its location is such that a steep vertical flow can be obtained. We know that in the Rocky Mountains there are mere brooks, which are today turning generators which furnish upward of 30,000 and 40,000 h.p. This is due to their great altitude when conditions are favorable for a steep drop at a point where the power horse can utilize it.

The cheapest development of water power is where the drop is vertical, for then the penstock need be little more than the height. With heads that range from 10 up to 2,000 ft., the cost of development is subject to wide variation. In fact, a complete water power development with its electric generation station costs all the way from $50 to $300 per kilowatt of capacity. Somewhere between these two extremes will be found the cost of the average hydro-electric plants of the country. If the bed of a stream has only a moderate descent of 5 or 10 ft. per mile, it will require larger waterwheels and electric generators than another which has a sudden drop of 50 or more feet. Consequently we have the rule that the cost of development per unit of power increases as the head decreases, other factors remaining the same; and for wheels and generators the weight per unit of output decreases as the speed of revolution increases, and this speed goes up with the head of the water.

The measurement of a stream with its water flow throughout the year is the first important step in considering the work of developing it. A good many small plants have proved failures in the past through lack of exact knowledge of the annual flow of water. Although the flow was good in the winter and spring months, in the summer it was so small that there was not sufficient power to run the wheels. A small brook only a few feet deep and 20 ft. wide that flows steadily the year round is of much greater value for hydro-electric development than a river ten times as large which practically dries up in the summer months. With a comparatively high head a relatively small brook fed by springs that never dry up is one of the most valuable assets for an electrical plant. Such streams with their sources among the hills and mountains are found in many parts of the country, and they could be harnessed with the minimum of expense for electrical generation.

To take a concrete illustration a stream which has a reliable flow of 100 cu. ft. of water per second located so that a working head of 25 ft. can be used should prove a good one for hydro-electric development. Such a stream might have a maximum flow of 400 cu. ft. of water in the rainy season, and a mean flow of

200 cu. ft. and a minimum flow of 100. The latter flow must be the one on which to base calculations for reliable power output.

Now what can be done with such a stream, and how much power can be developed, and what would the cost of installation be? These are the practical questions that many are asking today. They apply to nearly every part of the country. There are thousands of towns and villages, tens of thousands of individual farms and homes, and hundreds of mills and factories, which are interested in the development of such small hydro-electric power. The big streams and waterfalls require so much capital for their development that they cannot be utilized except by large companies and syndicates. Yet the smaller streams are of far more general importance to the whole country, and interest far more people.

The average flow of such a stream will develop just about 225 h.p. when utilized in a first-class turbine. The electrical product of this plant can be utilized for every hour of the twenty-four of each day throughout the year. For a good part of the year, say about nine months, twice this amount of power could be developed. But as few industries require continuous power throughout the day and night the plant would thus furnish far more electricity than would appear at first sight. Electric lighting power would be used only for half the time, and surplus power could be used or sold in the day time.

If the normal minimum flow was 100 cu. ft. per second or 6,000 ft. per minute, the working power for a 12-hour run could be doubled by storing some 4,000,000 cu. ft. of water. This would mean drawing-off a 100 acre pond 1 ft. of water at night and filling it up in the day-time when the power was reduced or entirely off. In a very dry season the water stored might be reduced to 2,000,000 cu. ft. in each twenty-four hours. Six inches on a 100-acre pond would take care of this for a day, so that if by putting flash boards on the dam the water could be raised 2 or 3 ft. in a 100-acre pond the plant would be made practically safe for over 300 k.w. steady output on its lighting load.

If 1,800 k.w. hours were thus stored in the pond for 1 ft. of depth, the distribution of the power could be made to suit the demand. One might draw off 300 k.w. for three hours, and still have 900 k.w. hours left for the rest of the night or day over and above the basic 150 k.w. from the minimum flow. This would allow a total output of 450 k.w. during the hours of heavy load, and would leave 2,250 k.w. hours for the rest of the night and for a small day load. Now a plant with a peak capacity of 600 k.w. is capable of doing the lighting work of an average city of 25,000 to 30,000 inhabitants, furnishing also in the day-time a fair amount of power for light mill and factory work. But as all of this output is based on the minimum flow, it is quite apparent that for seven to nine months of the year a very much larger output can be depended upon. This larger output would come at a time when our nights are the longest, and the demand for lighting the longest. It is also the busiest part of the year, so that the sale of current could be greatly increased.

But the safe way in figuring on hydro-electric development is to consider the dry season output or the minimum flow. If this is securely taken care of the rest of the season will give no trouble. Where the mistakes have been made in the past has been to figure on the mean flow and construct a plant accordingly. Also the condition of the season must be taken into consideration. We have our wet and dry seasons. A few years ago a plant was erected in Massachusetts where hasty and insufficient data caused a great loss. The minimum flow was based on the measurements of the stream for one summer. That summer proved to be an unusually wet season, and with no previous summer records of flow on hand the plant was erected on this insufficient data. The result was that the first season after the plant was put into service unusually dry weather followed, and instead of being able to develop 225 h.p. the plant could scarcely show 175. The plant was characterized as a fraud and failure, and the engineers were blamed for their optimistic statements and claims. It gave a black eye to hydro-electric work in that whole region. Many believed that electricity was an unreliable power, and others simply said that you had to discount electrical engineers' statements by a large percentage.

Not many such mistakes are made today, or there is no reason that they should be made. Reliable data and measurements are the foundation upon which every plant should be constructed. There can be no guess work, no reliance upon the statements of the oldest inhabitants that a certain stream has never dried up in their fifty years of recollection. Science does not go upon any such proceedings.

If there is any question about the minimum flow a little extra depth in the pond will take care of the difference. Some streams have a remarkable variation in the flow, ranging all the way from 100 to 600 cu. ft. of flow per second. The Massachusetts plant referred to above was one of these streams. It was found that by increasing the depth of the pond 1 ft. the amount of water storage would prove sufficient for all purposes; but to be on the safe side an extra depth of 2 ft. was made. This solved the problem satisfactorily, so that today even more than the rated horse-power can be developed and maintained throughout the dry season. In the event of an unusually long dry summer it is more than probable that the plant could still go on serving its clients without fear of a shut-down.

The development of small streams does not usually call for large expense. For the dam a well-ballasted timber crib proves the most satisfactory, with special attention given to secure foundations and abutments. Such a dam will last indefinitely and prove very satisfactory. The power house should be placed as close to the dam as conditions will permit. The shorter the penstock the better the work will prove. If the water must be conducted any great distance to the power house site it is far more satisfactory to conduct it there in a deep open canal or flume.

In arranging the number of wheels and generator units, consideration should be given to the question of possible use and breakdowns. Enough units should be developed so that the whole plant will not be crippled in the event of temporary crippling of one. For a plant of this size four 150 k.w. machines would prove more reliable than two. More than this number would increase the cost without any material gain, and anything less might cause too severe an overload in the event of a hot bearing compelling the shutting down of one machine.

Water wheel data shows that the required maximum power per unit, about 275 to 300 h.p., could be obtained from a single horizontal wheel under 25 ft. head at about 200 revolutions per minute, or from a combined pair of smaller wheels at about 300 revolutions per minute. Either combination with a dynamo would do well, but the single wheel would be a little cheaper.

A power plant of this size is almost too small to attract promoters and financial houses interested in bonds. It must therefore be the work of private concerns. But there is no more profitable investment of funds than in such hydro-electric plants where conditions for harnessing and selling the power are satisfactory. The farmers as well as the people of small towns and villages are interested in the harnessing of the small streams. Where irrigation pumps are to be operated and farm machines to be driven by some power other than hand and horse, the hydro-electrical question should be considered. There is not a farming community or a hamlet in the United States favorably situated in regard to streams that could not be enormously benefited by the construction of a hydro-electric plant. They are being installed all over the country nearly every year, and they are proving valuable assets. They are lighting houses and running mills, factories and farm machinery cheaper than can be done by any other known power. The capitalists may not care to bother with these little brooks and streams, and the big water companies overlook them; but they are an asset to the small village and individual farmers that are of incalculable worth. Some day they will be nearly all harnessed, but at present the opportunity is awaiting the progressive men who can utilize them.

A round file may be used as a reamer by inserting it in the hole to be reamed and turning to the right instead of to the left. By doing so the file will not bind, and excellent work will result.—*Penberthy Engineer and Fireman.*

Indecision can never think well; the field of thought is never ploughed by simply turning it over in the mind.

HOW TO MAKE A DIVIDING PLATE FOR LATHE HEADSTOCK

A. HALLETT

The following method of obtaining the exact positions for the holes in a dividing plate, as fitted to so many small lathe headstocks, will be found extremely useful when the required number of holes is a large one or a prime number. With ordinary care in the drilling, a plate can be made with any number of holes desired, with a degree of accuracy unobtainable by any other method I know of in which another divided head is not used.

Let us consider, for example, that we require a plate having 74 holes in it. First construct the small drilling jig, shown in plan and elevation at *A* and *B*, Fig. 1. This consists of a piece of steel plate 1 in. square and 1/8 in. thick. This is drilled for four wood screws, and also has drilled along one of its center lines two 3/16 in. holes 3/8 in. apart. These holes must be true to size, and their distance apart must be fairly accurate, although this is not of absolute importance.

This piece is screwed on to a piece of flat hard wood, with two strips of 1/16 in. brass or steel under its two edges, so as to leave a space under the center of it 1/2 in. wide and 1/16 in. deep. This will be clear from the drawings. A small steel peg, *C*, Fig. 1, must be turned from mild steel, having the parallel end 3/16 in. diameter and 1/4 in. long. The knob can be anything. A short piece of rod of 3/8 or 1/2 in. diameter, with a spigot on one end, of the above sizes, will answer quite well. This 3/16 in. peg must be a nice fit in the 3/16 in. hole drilled in our jig. A strip of brass will now be required,

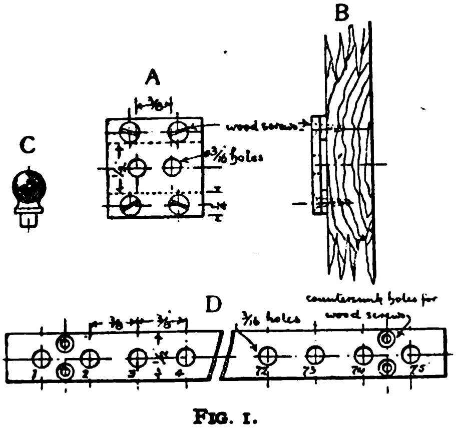


FIG. 1.

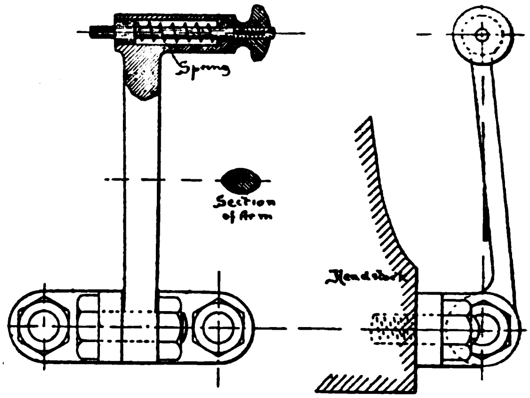


FIG. 2.

1/2 in. wide and 1/16 in. thick. Hard rolled brass will be the best for the purpose. This must be a sliding fit in the space under the steel plate of the jig already made. The length of this piece of brass for a 74-hole plate will be 28 3/4 in. One end of this strip is pushed under the jig until the end is about 1/4 in. or 5/16 in. clear of the nearest 3/16 in. hole. A hole is then drilled through the strip and the peg inserted in the hole. The second hole is then drilled, the peg taken out, the strip pushed along, and the peg inserted through the front hole of the jig and the second hole in the strip. A third hole is then drilled, and so on until we have the whole strip drilled with 75 holes, or one more than the number we require for our plate. The ends of the strip must then be cut off, leaving 1/4 in. beyond each end hole. The ends must also be beveled off, commencing from a point 1/4 in. inside each end hole to the end, so that when the strip is bent into a hoop, with the two end holes coinciding, the joint will be of the same thickness as the rest of the strip. Next take a piece of 3/4 or 7/8 in. pine or white-wood 9 in. square, and roughly shape it to a 9 in. diameter disc. Fix this to the lathe faceplate and turn it up on the edge until the strip, when bent round it closely, will have the two end holes exactly coinciding. The turning must be carefully done to ensure an accurate and close fit of the brass strip. The peg (*C*, Fig. 1) can now be pushed into the two end holes to hold the strip together, and holes drilled for wood screws in the strip at several points all round it to hold it on. Two had better be put in close to each end, as shown, to keep the ends down close together. A piece of stiff spring, having a peg of 5/16 in. diameter riveted into one end, must be clamped to the lathe bed, so as to act as a stop, the peg falling into the hole of the strip. The dividing plate can then be fixed onto the front of the wood disc on the faceplate, and secured centrally, or if it be a new plate we are making it can be turned up now.

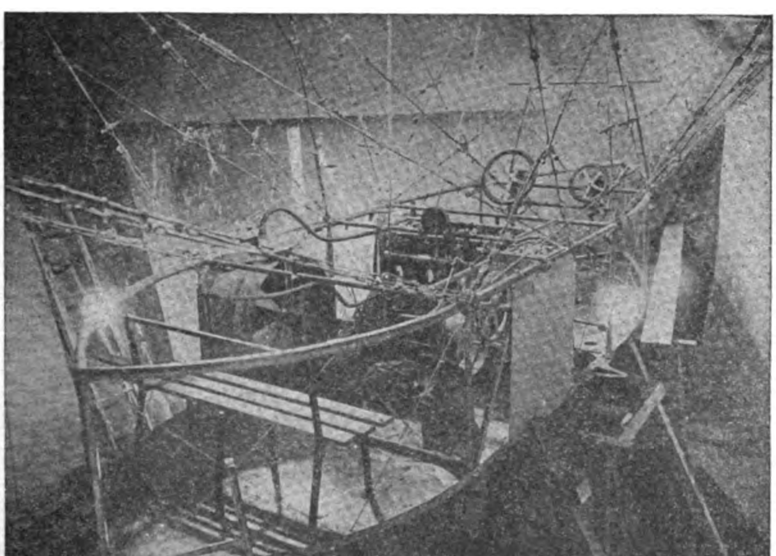
If we have a drilling attachment fitted to the slide-rest it is a simple matter to drill this plate; but if not, we must scribe a circle round the plate with a pointed tool in the rest, and mark this circle with the same pointed tool moved to and fro across the plate, moving the lathe round one hole between each mark. This latter method opens up a chance of error in the second drilling, which the use of a drilling attachment, if at all satisfactory, eliminates. Should more than one circle of holes be required on the same plate, it is necessary to make the strip, as above described, first for the largest number. This done and the plate drilled we can cut off a piece of the strip, leaving the correct number of holes for the second number plus 1, and so on.

The wood will then have to be turned down to take the shortened strip, and so on. Anyway, the strip can be kept, as it is always likely to come in for this purpose, if not required at once.

Fig. 2 shows a very serviceable spring stop for a dividing plate, and one which I have found stiffer in use than one made with a peg riveted to a piece of spring steel.

The arm and top end plunger casing is a malleable casting, or a steel forging drilled out to 1/4 in. diameter to take the plunger. This is of steel (double shear or silver steel), turned at its outer end to suit the hole in the dividing plate, generally 1/8 in., and at its inner end also to 1/8 in. A knob is turned and tapped to screw onto the end of the plunger, and a fairly stiff spring bears against the shoulder left on it and the back end of the casing.

The lower end has a boss drilled and faced up true, and has a 5/16 in. or 3/8 in. bolt holding it to a small bracket fastened to the headstock with studs. This allows the arm to swivel so as to bring the peg in line with the various circles of holes on the plate. The height, etc., will have to be arranged to suit the lathe under consideration, but I think the general idea is shown fairly clear.—*Model Engineer and Electrician*.



The Car of a French Military Balloon

Price of Platinum

The price of platinum has lately attained to the high level of $480 per lb. troy, for refined, a figure which it has only once before touched—namely in 1906. The recent advance is attributable to causes similar to those which operated in that year. Consumption continues to expand steadily as the result of the more widespread utilization of the metal in connection with the steadily growing electric lighting industry, the jewelry manufacturing industry, and the chemical, dental and photographic trades, while new uses are continually being discovered, which though comparatively small individually have a cumulative effect. A typical example of such new uses is to be found in the motor-car manufacturing industry, where the unique qualities of platinum have gained for it a use which even high prices do not seem sufficient to discourage. The world's annual consumption of the metal has been estimated at between 350,000 oz. and 370,000 oz., of which, however, roughly one-third is represented by metal recovered from scrap and remarketed. Practically the whole of the 350,000 oz. or 370,000 oz. is consumed in the four principal markets, France absorbing about 40 percent, Germany and the United States of America each 26 percent, and Great Britain 7 percent, the small balance remaining being consumed in Russia, which is practically the sole source of supply.

New Wireless Apparatus

Professor Cerebotani, an Italian inventor, gave a private exhibit of his wireless discoveries the other day before members of the French ministers of war, posts and telegraphs, and a large number of scientists, including M. Eiffel, the constructor of the Eiffel Tower, which is now a government station. Among the apparatus employed was a pocket wireless machine, a wireless telegraph printer by means of which messages are sent as readily as writing on a typewriter, and a wireless teleautograph which enables persons to sign their signature as far as wireless waves reach.

The pocket apparatus is a little larger than a pair of field glasses and is operated by attaching its antennae to a post or tree, which, at the height of 50 ft. enables communication to be made within a radius of two or three miles. The teleprinter, a local contemporary explains, is a simple little instrument with a keyboard like a typewriter, which can be fixed to any telegraph or telephone installation. This transmits messages which appear on printed slips at the other end, but it has the advantage of being infinitely more simple than anything yet invented, and, besides, can be used with wireless. This should be interesting to railway officials in particular, since such a machine could be put at the disposal of all signalmen, pointsmen, station masters, and others, permitting them to communicate quickly and accurately with the head office. It would be also exceedingly useful for small, out-of-the-way post offices, since no special training or practice is necessary to operate it.

The teleautograph is a most simple apparatus, which can also be affixed to any telephone or telegraph line. By this a signature, a drawing or a holograph manuscript written with a pencil fixed to a flexible carriage is copied exactly on a machine at the other end. Hence a man in Paris could sign a document in Algiers or a signature in Algiers could be verified from Paris. As if these wonders were not already sufficient, we are further assured that the greater the distance the better the machine will work, although we have not been told why this should be so. The tracing of one's signature seems to be no more difficult than with a pen, and a pencil repeats it automatically wherever we want it, even should it be at the Antipodes.

Another invention of the professor is an instrument for preserving the secrecy of wireless messages. As is well known a message sent out by a wireless station is received by all stations within a certain radius, although it be only intended for one of them, because the Hertzian waves sent out affect all receivers alike. This new machine, however, allows each of a large number of stations to have its identification number, and when the Hertzian waves are set going with the transmitter at a certain number, only the station bearing the corresponding number can receive the message, all the others being cut off by a short-circuit arrangement.

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.

1716. **Storage Battery.** W. B., West Orange, N.J., asks for directions for charging a storage battery, and if a generator made from a telephone magneto will be suitable for the purpose? *Ans.*—In our last July *Electrician and Mechanic* appeared a very complete article on this subject, the diagram given in Fig. 13 being the one you should particularly study. Instead of using a shunt field rheostat for controlling the dynamo, you will need to adjust the speed or interpose a resistance in the main line. You must allow considerable time for charging, for the case is like that of filling a large tank when you have only a small pump.

1717. **The "Henry."** H. P., Upper Troy, N.Y., asks (1) for an explanation, with example, of this electrical unit. (2) What is a "resonator" when applied to electrical apparatus? Ans. —(1) There is a quality connected with electrical circuits that is analogous to inertia in mechanical matters. A balance wheel objects to being started in motion, but when finally in motion it objects to being stopped. Similarly, the presence of "self-induction" in an electrical circuit hinders the growth of the current and at the next instant hinders its decay. So when contact is made, say with a spark coil for gas lighting, an appreciable time is required for the current to attain its final value as required by Ohm's law. All this time while the current is increasing, the production of the magnetism is constantly inducing a counter electromotive force in the winding. When the current reaches its final value, no increase in magnetism takes place, and this counter effect stops. Now at the break of the circuit the magnetism disappears, but in getting out of existence these lines cut through the coils and induce in them an electromotive force in the direction to prolong the current, and so vigorously as to hold a momentary flash across the gap. The energy stored up in the magnetic field is similar to that stored in a fly wheel. If you try to stop the wheel instantly there will be a crash, and it is this electric crash with the coil that you wish for the ignition. Such an abrupt break is carefully avoided, however, in case of dynamo machinery, for the momentarily great electromotive force may readily puncture the insulation. If you multiply the number of turns of wire in a given coil by the number of magnetic lines of force passing through it, and divide by the number of amperes, and then by 100,000,000, you will get the number of henries. This will usually be a fraction. (2) You will find a description in Chapter XXV, in the Engineering Series, in the July, 1908, magazine.

1718. **Magneto Generator.** E. K., Richmond, Va., has substituted No. 27 wire for No. 36 on the shuttle armature of a telephone magneto, and now the machine completely fails to work. Also, an induction coil, made of Nos. 18 and 31 wire, and intended to give ½ in. sparks, gives only 1/16 in. ones. What is the reason? Ans.—The winding of a shuttle armature is about the simplest of electrical arts, and you ought not to fail where thousands of amateurs have succeeded. Perhaps you are expecting too much from the present winding, possibly the brushes—if you have used a commutator—are in the wrong position, or perhaps you have failed to insulate the winding from the iron. The sharp corners that are the hardest to protect are the most important places. Use cloth over these edges and corners before covering the easy parts. See if you can get a circuit between iron and wire. Perhaps you have wound the armature for alternating currents, and therefore maintained the "ground" on one end of wire. Of course there must be a ground nowhere else.

1719. **Molding.** G. E., Brooklyn, N.Y., asks for directions for making molds that can be used for casting, and yet not crack as does plaster of Paris from action of the heat. Ans.—You give no hint as to the sort of metal you are casting, so we cannot advise you as directly as we wish. If you are casting lead, antimony, or any of the easily-melted metals, and are making a large number of pieces, you will find it economy to make a cast-iron mold. If only a few castings are desired, and these of brass or copper or thelike, sand molds will be necessary; of course requiring new work for every casting. This labor is regularly reduced in brass foundries making large quantities of small pieces by use of "gate" patterns, whereby a number of similar parts are made in each flask.

1720. **Small Dynamo.** W. K. B., New York City, has the parts for an enclosed "Apple" ignition generator, and wishes data for winding it for experimental purposes, speed to be about 1,200 revolutions per minute, other specifications not being particularly definite. Ans.—We would suggest a shunt field winding, and the armature for 6 to 8 volts. With an armature core of the size you mention, 2⅝ in. long, 2½ in. diameter, with 12 slots 5/16 in. diameter, you should be able to get fifty No. 21 wires per slot, twenty-five turns per coil for each half winding. Let the two field coils be wound with s.c.c. No. 24 wire—all you can get room for—even when bending the coils to conform to the spherical space. If you wish a compound winding, wind the coils to about three-quarters their full size with No. 25 wire, the remaining space being allowed for the series portion of No. 16 wire. It would be well, however, to wind the series portion first, perhaps two layers being sufficient. If you wish a purely series motor, let the entire space be filled with No. 15 wire.

1721. **Small Dynamo.** C. K., Warren, Ill., asks: (1) What would be a suitable armature winding for a small dynamo of the following general dimensions: diameter of armature core 3 in., length 2½ in., with 12 slots ½ in. in diameter; field magnet of Edison type of steel castings, cores being 1½ in. in diameter and 2½ in. in length; bore, 3¹⁄₁₆ in., arc, 135 degrees; winding, 11 layers 50 turns per layer, of No. 22 d.c.c. wire. A current of 5 or 6 amperes is desired, and speed not to exceed 2,500 revolutions per minute. (2) Is it practicable to generate a direct current by a method analogous to the rotary field alternator, using an alternating current to excite the field, but with a different winding on the stationary armature? The excitator alternator would, of course, be driven synchronously. Ans. —(1) With the field winding you have employed, the voltage should not exceed 10 or 12. If there is room for more wire on the field, you could then wind for a few more volts. It would have been better if you had made the magnet cores about 2 in. in diameter. Use No. 18 wire on armature, all the turns you can get. A 12-segment commutator would be much better than one with 6. (2) Your proposition is a dream that no inventor has yet realized. The induction motor driven above synchronism, and called the induction generator, is the nearest realization, and some of these in sizes above 5,000 k.w. are in operation. Of course they generate alternating currents. The "homopolar" direct current machine is suggestive of possibilities, but thus far attended with disappointment.

1722. **Electro-plating.** C. J. G., Lewiston, Idaho, asks: (1) What is the best solution for plating with lead, and how is it made? (2) Can a person plate with the following alloy: 9 parts of lead, 2 of antimony and 1 of bismuth? (3) Where can antimony and bismuth be obtained? Ans.—(1) Zinc and tin articles can be coated with lead by immersing them in a solution formed by dissolving litharge (one of the oxides of lead) in water and caustic potash. Similarly, iron will become coated if dipped in a solution of acetate of lead. A battery current, though very weak, can be used to encourage the deposition from the caustic potash solution, but this must be prepared by saturating the boiling hot potash and water with litharge. The process has no commercial importance. (2) Antimony and bismuth may separately be deposited upon articles, either by simple immersion, as with lead, or by the action of the electric current, the first from a tartar-emetic (potassio-tartrate of antimony) solution, the second from the double chloride of bismuth and ammonium. We cannot find, however, that the alloy can be successfully operated, and from the indifferent results from working separately with the three constituents, think your proposition rather doubtful of success. (3) Since Missouri is the source of so much of these metals, we think you could well obtain it there. Write to the postmaster for the address of some retail dealer.

1723. **Wireless.** D. W. D., Montrose, Col., asks: (1) Which is better for an aerial, hard-drawn or soft-drawn copper wire; and is a six-strand aerial 50 ft. long and 50 ft. high run slanting on a slant of about 45 degrees very good? (2) I am building an open-core transformer of the following dimensions: core 1 x 10 in.; primary two layers of No. 12 d.c.c.; secondary of 6 lbs. of No. 30 enameled wire wound in 12 sections ½ in. thick and 3½ in. in diameter. What is rating in kilowatts of this coil, using proper voltage and amperage? (3) I shunted a small condenser around the spark gap, the condenser containing 120 sq. in. of tin-foil when using only three sections. The condenser emitted a hum. Why was this? No spark went across the gap. (4) Are there any large stations in Colorado? If so of what power in kilowatts? Ans.—(1) Use hard-drawn copper on account of its strength. A slope of 45 degrees is not fatal to good working, although the antenna will receive a little better in the direction opposite to which it points than in any other. (2) Such a coil would take probably 10 amperes at 110 volts, safely, but its actual output would be only about ⅛ or ⅒ k.w. (3) Like electrical charges repel, unlike charges attract. You have plates close together which bear opposite electrical charges, and hence attract each other. Since the attraction is periodic, it causes a hum. (4) We cannot find any station listed which is even at a communicable distance from Colorado.

1724. **Quenched Spark.** G. S. C., El Monte, Cal., asks: (1) In the article "The Quenched Spark System," I do not find any statement as to the number of sets of discs to use for any certain voltage, for the modification of the Telefunken gap. I note this is given for the Von Lepel generator, but I prefer the Telefunken system. (2) Using this gap on ordinary 60-cycle 110-15,000 volt wireless transformer is the note produced clear and high and penetrating, or is this high note the result of using high-frequency current (high cycle) in primary? (3) What do you think of the idea of designing and building and using a transformer, with quenched gap, with a secondary voltage of only 1,000 to 2,000 volts, and consequent high amperage? I understand the army is using a set with transformer secondary voltage of only 500 volts. Do you think this idea practical? Ans.—(1) Use as many gaps in series as is possible and still get regular sparks. (2) In regular practice, a generator of 400 to 500 cycles per second is used in order to get the high note. It is possible to get a sort of ragged high note from 60-cycle current when you have the circuit containing the secondary of the transformer in "resonance" with the high pitch. (3) Yes, one may easily use as low as 500 volts and obtain a high efficiency, but since the current thereby used is large, the gap must have excellent heat-radiating arrangements.

1725. **Wireless.** R. H., Springvale, Me., sends sketches and notes. Ans.—(1) The antenna you illustrate is directive, but very inefficient. The part reaching downwards from the top should be omitted. (2) The second type is much preferable, but is no more efficient in the direction you wish than if you connect to the center of the horizontal part.

1726. **Electrolytic Rectifier.** H. S., Santa Barbara, Cal., asks for some information as to construction of rectifying current apparatus. Ans.—An electrolytic rectifier was described in the August, 1909, number of this magazine. The electrolytic rectifier is the only kind of arrangement which can be made by an amateur. The General Electric Company will surely send you all the information about mercury-vapor rectifiers that you wish.

1727. **Transformer.** R. B., Oak Park, Ill., asks: The size and dimensions of core, number of "pies" size and pounds of wire in secondary; size and pounds of wire in primary winding insulation. This is for a 2 k.w. closed-core transformer to run on a 60-cycle 110-volt alternating current circuit. Ans.—You do not state what use is to be made of the transformer. If it is for a wireless station you will need a much smaller core and primary winding than if it is for continuous "line" work. We do not know of any 2 k.w. transformer designs. A ¼ k.w. transformer was described in the June and July, 1909, numbers of this magazine. It is not usual for private individuals to build transformers of such large size as 2 k.w.

1728. **Telegraph.** E. H., St. Paul, Minn. On page 68, January number, you recite the troubles of "E. H." at St. Paul. Ans.—I feel sure that his trouble is due to none of the causes you suggest, but is undoubtedly due to his having the poles of one of his batteries reversed. That is, in plain language, he has "copper to line" in one, and "zinc to line" in another. These two batteries then neutralize each other and the "through" line cannot work. If he will trace the current and see that it all runs one way + or — I think his trouble will disappear at once.

1729. **Perpetual Motion.** H. M. A., Cambridge, Mass., asks: What progress has been made with the perpetual motion picture machine up to the present time? What has been the closest that anyone has come to striking the idea? Is the machine possible and probable and what do scientists say concerning it? What is Edison's view? Ans.—The doctrine of the conservation of energy, that is, that we can never take out of any system more energy than is put into it, has been experimentally tested in hundreds of ways, and is, as far as human intellect can discern, one of the immutable laws of nature. Perpetual motion without consumption of energy is *impossible*, and no attempt comes nearer to a solution than any other. We have not consulted Mr. Edison as to his view, but have no hesitation in saying that he would speak practically as we have above.

CORRESPONDENCE

Gentlemen: I beg to hand you the following for your correspondence column, should you consider same sufficiently interesting.

The subject of transmission of thought, or telepathy, has occupied many minds for many years. I have seen and read a great deal in connection therewith, but do not remember ever to have heard even a plausible explanation of the phenomena. For many years I doubted its existence altogether, thinking that its votaries must be either victims of coincidence or that some trick like so-called Spiritualism must be responsible for their delusions. However, during recent years I have myself seen, skeptic though I am, instances of this wonderful manifestation which I could not explain on the above lines, to my own satisfaction.

Latterly an idea has come to me, call it a wild fantasy, if you will, which has been growing in its insistence until I have concluded to put it to paper in the hope that it might start abler minds thinking along the same groove and possibly eventually evolve something tangible.

The wonderful realization of wireless telegraphy, through which by the use of some instruments our thoughts can be projected through space for a thousand miles, has suggested the above idea. If man, in his clumsy way can build an instrument which will do this wonderful thing, why should the infinitely more wonderful machine, the human brain, not do infinitely more wonderful things? The instances in which transmission of thought has ostensibly occurred are always between persons who have been closely united by one means or another; for instance, between brothers or sisters, husband and wife, lovers, etc., persons, let us say, whose minds, have been "tuned" in exact unison. It was recently shown by some scientist, by the use of photographic plates, that the living human body radiates electric energy of some kind, as an impression was made on the sensitive plate by it, which a corpse would not produce. If then the mind is strongly concentrated on a certain subject, it is only reasonable to suppose that this great brain activity radiates strong "thought waves" which another person whose mind is working on the same subject, and consequently tuned to receive same, should get the message.

Could we not get Messrs. Tesla, Edison or Marconi's opinion on this?

Respectfully,

GEO. W. WEINGART.

Gentlemen:—I, and many others of your readers, I believe, would be interested in a drawing of an appliance to hold small twist drills while being ground. Every mechanic uses twist drills, and it is impossible to grind them true by holding them in one's hands. Hoping to see such a drawing soon in the *Electrician and Mechanic*, I am,

Yours truly,

JAS. F. THURSTON.

Wish to say I wait for your paper every month, as there are a good many articles in same which are a great help to me. Hoping you get a larger circulation and keep up your well-written articles, I remain,

MARTIN BOISEN, JR.

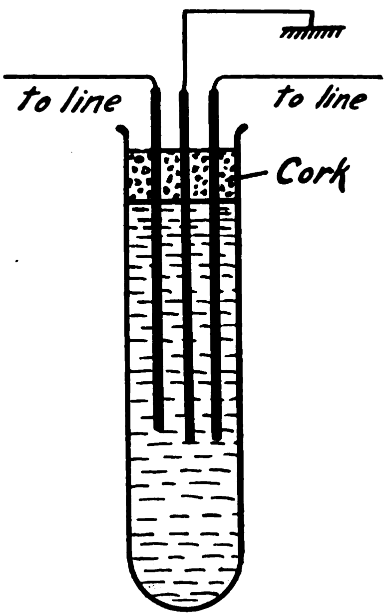
To the Editor of the *Electrician and Mechanic:*

Dear Sir: I will continue to read your magazine every month as I did in the past, only I will have to buy it here from the newsdealers, and just as soon as I am able to renew my subscription, I will do it without delay. Since I have started to be one of your readers I have learned more from your magazine than from a set of text-books that I have had for the last three years.

I will close now, hoping to renew my subscription soon and wishing you all possible success with your magazine, the *Electrician and Mechanic,* I remain very respectfully yours,

A. E. B.

Dear Sirs:—I am dropping you a line to congratulate you on your last issue which is one of the best I have seen. I have been looking for something on the von Lepel and Telefunken Stossesgerung systems in my three magazines for almost two years now. I experimented with the von Lepel (in the spring of 1910 I think



it was) and was very much impressed with its remarkable adaptability to the amateur's use. I used a transformer wound for 600 volts, 1 ampere a.c. on the primary side (110 watts that is) and an aerial 20 ft. high. I was able to work some 5 or 10 miles, talking over the city but had some trouble with raggedness of the spark. I may remark that this would be the chief difficulty of the experimenter working on a.c. It requires a remarkably exact adjustment of the condenser and the coupling between open and closed circuits to overcome it. I have noticed from time to time several weird combinations of "micrometer" gaps, condensers, choke coils, high resistances, etc., described in your magazine, as infallible cures for static on the primary of the transformer. I have found a small electrolytic lightning arrester, simply made of three pieces of aluminum wire dipping into a test tube full of sodium phosphate, to work admirably.

Yours,
R. K. FREEMAN.

Dear Sir: The *Electrician and Mechanic* is better today than it ever has been. Yes, Mr. Wanner, you are right. You *are* a crank. A broad-minded wireless operator, electrical engineer, aviator or any man of any trade, or profession, takes pleasure in reading short articles out of their general routine. An up-to-date mechanic takes pleasure in talking intelligently upon any subject in the mechanical line.

ISAAC E. WORTS.

Dear Sirs: In reply to your recent editorial, I would like to express a few of my personal views on the subject mentioned.

I disagree with Mr. Wanner in his notion that the *Electrician and Mechanic* has decreased in value, so will be one of the "five" that prefer the "new style."

I am in favor of specializing to a certain extent. I would not care to have this magazine specialize on "Wireless," as I believe that should be left to a magazine treating wireless alone, where plenty of space can be had. I would prefer it treated as before, with such articles as cannot readily be found in popular books on the subject. Every wireless enthusiast should have at least a few books for reference.

I have the same views on aviation. Its treatment in *Electrician and Mechanic* has been satisfactory to me.

Of the mechanical topics mentioned in the editorial I am especially interested in steam, gas and water turbines, oil-consuming engines, marine engines and automobiles.

Most all electrical articles are interesting, as my interest lies chiefly in that line. Aside from practical articles, an occasional one like "Some Unexplored Fields in Electrical Engineering," by Steinmetz, adds interest by treating the theoretical side. Also articles on electrical development, as, "The Growth of Electricity on Railroads," by A. C. Lescarboura, are interesting.

The "Home Craftsman," "Show-Card Writing," "Wood-Carving," and articles on the making of furniture are not so interesting to me.

Do not decrease the electrical department to make room for another. Increase the size of the magazine and raise the price first. To make things short, the magazine has been very satisfactory.

Thanking you for your time and attention, I remain,

Sincerely yours,
HOWARD A. BAXTER, Jr.

Gentlemen: That wireless department of this new January issue is certainly the thing. I have tried to find that information in others, but failed.

As to the elementary character of the past articles I wish to say that I would like to see some articles on damped and undamped oscillation and others of that nature, and an historical article on the beginning of the wireless telephone.

All I can say is that you are sticking up for the name of the magazine, and as long as you don't go out of that alright.

Very truly yours,
WILLIAM BOLLES.

Dear Sirs: Complying with your request for opinions from your readers, I must say that you are treating on some subjects which are very uninteresting. Do not by any means discontinue your splendid articles on wireless, such as furnished by Mr. Getz and others. Keep on the progressive track in wireless; new ideas are what we want. Another subject which will give ginger to your magazine is a "Photographic Department." "Mechanical Drawing" is interesting, but it would be of no use to those who have taken the course at high school.

Respectfully yours,
W. P. HUSBY.

Dear Sirs: I want to voice the sentiments of Mr. Wanner, whose letter appears in the January issue of your magazine, as I have been very much disappointed several times back when I bought your magazine, expecting to find something in it worth while. I buy it principally for the wireless items, and I am no kid either, having pounded brass for about thirteen years. I think the suggestion for more wireless telegraphy and telephony a good one, but think your Auto Department is a frost and would knock it in the head while it is young. There are so many good Auto magazines published that an Auto Department in your magazine is out of place. More of the Questions and Answers would be more acceptable than plans for an "inlaid table" which only an expert could make. Drop the boys a hint that the government gets out a real Wireless Blue Book for 15 cents. I suppose it is hard for you to please everybody, and if I don't like the magazine I can quit buying it, which I will if it doesn't brace up. Your article by Marconi was bully. More of that sort would be appreciated.

Hoping for a change,
Yours, etc.,
R. L. PATCH.

Dear Sirs: I heartily agree with Mr. Wanner in the January issue. In my estimation, your magazine is not what it was one year ago. You say in your editorial that you have covered all branches of wireless telegraphy. On such a comprehensive subject as that I take it that the elementary articles must have been published at least six or seven years ago. Many of your subscriptions can hardly date back that far. May I suggest that you begin a new series for the benefit of your later subscribers.

In my opinion many of your articles are too technical for the average reader. All of your readers I am sure are not electrical or mechanical engineers. Give us plain, simple articles on how to make wireless apparatus and woodwork.

Of course I don't mean to make your publication an entirely amateur magazine, for I realize that you must strive to please all classes.

Give us some good articles on elementary wireless and mechanical drawing, and watch your subscription list increase. Continue as you are and watch it decrease.

I would like to hear the opinions of other readers through these columns.

Yours truly,
CHAS. I. GINGRICH.

Nome, Alaska.

Gentlemen: Your magazine has just arrived here after traveling these thousands of miles over white trail, and has been duly studied and praised by our crowd of young mechanics. "It's the best yet," is the unanimous verdict. Set me down for two years' subscription.

With several members of our "Aero Club," I am working on a motor driver sled with which we hope to shorten the mail-time one-half. Will let you know the results.

Very respectfully,
PERCY L. SCHOOF.

Portland, Ore., Dec. 27, 1911.

"The Oregon State Wireless Association" has just been formed with the following officers: Charles Austin, *President*; Joyce Kelly, *Secretary*; Edward Murray, *Sergeant-at-Arms*; Clarence Bischoff, Lents, Ore., *Corresponding Secretary and Treasurer.*

They have two officers, George Schwartz and Herbert Slocum, who handle operating tests with each member in order to ascertain their efficiency at sending and receiving. The members are then given a certificate showing their ability, and then at the end of a year they are again tested to show their improvement. They desire to regulate unnecessary interference, such as testing out sparks, etc., after nine p.m.

They would like to have any of the other clubs correspond with them so that they might benefit by one another's experience.

Address all communication to the Corresponding Secretary.

CLARENCE BISCHOFF,
Corresponding Secretary of the Oregon State Wireless Association.

Gentlemen: I wish to protest against the kick of Mr. Cecil A. Wanner. I think the work of the *Electrician and Mechanic* on wireless is very satisfactory as it is. I do not know where the amateur or experimenter would go to find anything more or better.

The articles I like best are those telling how to make wireless apparatus, motors, how to solder, how to use glue, or how the experimenter may by any means adapt common materials and tools to his ends.

I am least interested in the woodwork and the engineering articles, but I do not intend this as criticism; others may like them. Naturally I would hope that the price be not increased.

Very respectfully,
H. T. VAN PATTEN.

Dear Sir: Page 68 of January number contains an article from a Mr. Wanner on the benefit of specializing in a magazine for craftsmen, on the next page is an editorial offering suggestions for future articles. As the two articles are interrelative, I will treat it as one subject.

When the average city-bred man, bookkeeper, clerk, salesman or whatever he may be, sows his wild oats, and having taken a better half and settled down to housekeeping, there comes a time when he feels the need of using his hands for the use or adornment of his home. This is due, no doubt, to heredity, and dates back to the ages when all men were craftsmen of sorts, they had to be, as they could not 'phone for a carpenter, plumber, or electrician in those days, but had to do their own jobbing.

Finally he makes up his mind, prompted by his better half, who wants a small table for the parlor, that he will make her one. He therefore sallies out to the nearest hardware store, and gets saw, plane, hammer and a gimlet or so, also some wood, and blithely sets about fabricating this table. Alas for him, he finds he can't saw a straight cut, the plane digs in, the gimlet with fiendish malignity either goes crooked, or splits the wood, and while he nurses his blistered hands (and temper), consigns the ghastly imitation of a table to the woodbasket.

Not losing heart, however, he thinks he will try something easier, and goes about among his friends, thirsting for information. One of them introduces him to the *Electrician and Mechanic*, and in the pages of that magazine he gets a light, he sees descriptions of little things in ornamental brass work, woodwork, electrical work and others, all along the lines he wants; also a description of just such a table as his good lady desires, all described with a fullness of detail and instruction, that he feels it's a cinch to do it. Another friend enlightens him as to what tools he really needs, and shows him how to use and keep them. He gains courage and purchases more wood and tools that he finds advertised in the magazine. He learns to plane and saw, and finds a joy in seeing the wood grow to shape in his efforts; finally, comes the task of assembling the table, he reads, "put the sides together with dowels, etc." This gives him pause. Now what on earth is a dowel? Turns up the ever ready *Electrician and Mechanic* and lo, he finds an article descriptive of dowels, and another of gluing up the aforesaid dowels and other shapes, and he is comforted. He sends for a few back numbers of the *Electrician and Mechanic* (on his friend's advice) and sees he has struck a mine of richness. Here is a scheme by means of incising, chip carving, etc., to ornament this little table. With renewed ambition, he goes on improving the work of his hands, and delighting himself and his friends by the little things he makes, and getting the sense of satisfaction that a true craftsman feels in seeing the finished article grow from the raw material.

I have only instanced the woodworker here, but the same thing applies to the worker in art metal, the worker in the mysteries of electricity, etc.

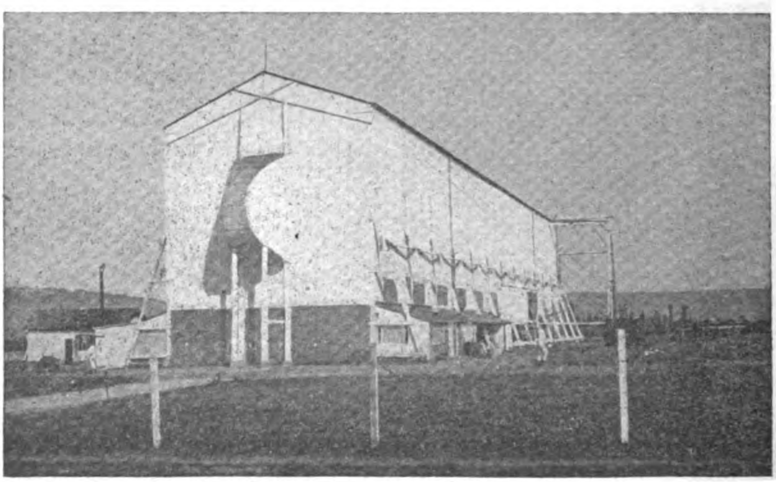
The journeyman also sees in this magazine articles of the deepest interest to him, that he does not learn in the shop and at the bench, that tends to his usefulness and education; and so, from the making and mounting of a telescope, with which to study the magnificence of the heavens, to the making of a desk set, in thin metal, all kinds and conditions of men can find something to amuse and interest them; and while one man buys the magazine for the woodworking articles and another for the art metal work, yet, they read it all through and in so doing widen their views, and see how many other things are done which, while they may never need or use them, tends to a broader vision and makes him feel in touch with his fellows in craftsmanship.

So, Mr. Editor, my opinion is, Go to it, cover everything, so long as it is done as in the past, fully and completely, so the neophyte may feel that he is watched and helped by those who know and are willing to help the learner for the sake of craftsmanship.

Let the man who wants to specialize, buy a magazine that specializes; there are plenty such.

Yours truly,

J. C. JENNINGS.



How a Military Balloon is Housed

BOOK REVIEWS

Modern American Telephony. By Arthur Bessey Smith, E.E. Chicago, F. J. Drake & Co., 1911. Price, $2.00.

This interesting handbook on telephony is clearly and accurately printed on substantial paper, is well illustrated, and is strongly bound in black leather. The telephone is without doubt one of the most useful of inventions and the author has carefully described the various parts of both the telephone and the telephone system. Two of the most interesting chapters are on Wireless Telephony and the Automatic System of Switching. The Automatic switchboard has come into widespread use and since it is installed in more than eighty cities in America, many people will doubtless be interested in reading a description of the various types of automatic systems.

TRADE NOTES

The L. S. Starrett Company which has one of the largest manufacturing establishments of fine mechanical tools in the world has recently increased its capital stock to $3,500,000, of which $1,500,000 is to be six percent cumulative preferred stock, and $2,000,000 common stock. The Company was incorporated in 1900, succeeding to the business established by L. S. Starrett in 1880 and conducted by him individually up to the time of its incorporation. The capital stock of the incorporation was $100,000 in 1900, since which time the business has increased far out of proportion to the original capital. Mr. L. S. Starrett, himself, continues in active control of the business.

Henry Disston and Sons, Philadelphia, Pa., have just issued a beautifully illustrated and printed booklet describing their line of Crosscut Saws. In the booklet is described the Raker or Cleaner Tooth which is used on these saws, and reasons are advanced showing why such teeth are of value. The booklet contains some fifty pages, and there are many illustrations shown of the various types of Crosscut Saws. Copies of this most interesting booklet may be obtained by writing to the company.

The plans completed for the motor car exhibitions to be held next midwinter provide for two national shows in New York and one in Chicago. These are the twelfth annual displays made by the industry to show its progress from year to year and the schedule of dates is as follows:

Jan. 6–13—Passenger Car Exhibition, Madison Square Garden, New York; Jan. 15–20—Commercial Vehicle Exhibition, Madison Square Garden, New York; Jan. 10–17—Combined Passenger and Commercial Car Exhibition, Grand Central Palace, New York; Jan. 27–Feb. 3—Passenger Car Exhibition, Coliseum and First Regiment Armory, Chicago; Feb. 5–10—Commercial Vehicle Exhibition, Coliseum and First Regiment Armory, Chicago.

More than two months before the opening date of the first of these national displays, a total of 113 different manufacturers of private passenger cars and 86 makers of commercial vehicles had been allotted space in one or more of them. Sixty-four of these are new exhibitors, having made no displays at the national shows last winter in New York and Chicago. Of the 64, 39 are builders of trucks and delivery wagons and 25 make pleasure cars.

During the two-weeks show period in New York more than 100 different makes of passenger cars and 70 makes of work vehicles will be on exhibition simultaneously. In Chicago more than 90 makes of pleasure cars will be shown during the week of Jan. 27 to Feb. 3, and the following week more than 60 different makes of business machines will be exhibited.

Exhibits will include almost every type and size of power vehicle designed for use on the public roads, from motorcycle parcel carriers and delivery wagons of 500 lbs. capacity to ponderous trucks of 10 tons capacity. Besides the more common types of trucks and wagons, there will be a number of dump trucks for contractors' use, trucks fitted with power winches for hoisting, self-emptying coal and lumber trucks, machines with special bodies for special purposes, self-propelled fire engines and combination chemical and hose wagons, police patrols, ambulances and other types for municipal and public service purposes.

In addition to complete vehicles and chasses without bodies, there will be comprehensive displays of motor car parts, equipment and supplies by more than 200 manufacturers that will fill all available space in the galleries. Large sections at Madison Square Garden and the Chicago Coliseum will be occupied by the exhibits of a score of motorcycle manufacturers.

It is only at these national shows that all the different makes of cars having more than a local sale and reputation are brought together for inspection. Without loss of time the engineer as well as the individual purchaser can study and compare the constructional characteristics of the various makes and models under practically one roof. The show promoters have recognized the importance of the time element and have segregated the exhibits of industrial, commercial and municipal vehicles, giving a separate week to them, thereby enabling the business man to look them over in a few hours and talk to exhibitors without getting into the crowds of visitors attracted by the pleasure cars or having his own and the exhibitors' attention distracted.

The two consecutive weeks' display in Madison Square Garden is under the same management that has conducted it for the last seven years. The show committee consists of Messrs. George Pope, Charles Clifton, and Alfred Reeves, with M. L. Downs acting as secretary.

The other New York show, which is to be held concurrently with the Garden exhibition, and embraces both private passenger cars and commercial motor vehicles, will open on Thursday of the first week and close Wednesday night of the second week of the show at Madison Square Garden. It is to be staged in the new Grand Central Palace, recently completed a few blocks north of the Grand Central Station now under construction. For the first time this exhibition is to be under the auspices of the National Association of Automobile Manufacturers and the management of Mr. S. A. Miles, who has conducted the Chicago show for more than a decade—ever since such shows were inaugurated, in fact.

The Coliseum show in Chicago will be, as usual, under N.A.A.M. auspices and Miles management.

Briefly, the trade situation with regard to the several exhibitions is this:

The Garden show is restricted to members of the old Association of Licensed Automobile Manufacturers and makers of electric vehicles who have been consistent exhibitors at Madison Square Garden for the last five years or more. The Grand Central Palace show is "open" to all manufacturers but will not include displays by makers who have exhibits in the Garden. All manufacturers are eligible also for the Chicago show, which is the only one that will be held in that city, and it will include exhibits by most of the makers who display at both the New York shows.

We are in receipt of a small and attractive pamphlet from the L. S. Starrett Co., Athol, Mass., describing their excellent line of vernier calipers. The pamphlet also includes directions for reading the vernier. The scale of the tool is graduated in fortieths, or 0.025 of an inch, every fourth division representing a tenth of an inch, being numbered. With the aid of the vernier it is possible to read in 1,000ths of an inch or on the calipers with metric divisions it is possible to read in 50ths of a millimeter. A copy of the pamphlet may be obtained by writing to the L. S. Starrett Co.

The State Water Supply Commission of New York State has published a pamphlet entitled "Water Power for the Farm and Country Home," by David R. Cooper. This pamphlet describes a few of the many ways in which water power may be utilized on the farm, and how by employing a water wheel to drive a dynamo both light and power can be obtained whenever needed.

The General Electric Company has just placed on the market a new piece of apparatus known as a Battery Truck Crane, which the Company describes in its Bulletin No. 4892, recently issued.

The machine is a short, heavy, storage battery vehicle, having mounted on its forward end a swinging crane, the hook of which is raised and lowered by a one-ton hoist operated from the vehicle battery.

The vehicle is used in loading, hauling, and unloading trailers, loading and unloading cars, hoisting and carrying on the hook boxes or barrels, and for stacking. The running of the vehicle, hoisting and carrying, are controlled by one man.

The crane is equipped with special attachments to suit the carrying on of the work contemplated, and the height can be made to suit local conditions.

The bulletin contains illustrations of the truck and crane in use, and describes also various pieces of apparatus used in connection with it.

In Bulletin No. 4912, recently issued by the General Electric Company, is a collection of several articles devoted to the use of this new piece of apparatus for air purification. Various applications of the apparatus are illustrated.

The Rubel School of Aviation, located in Louisville, Ky., has issued a most interesting little pamphlet, describing their Aviation Park and the course of instruction given by their school. The school was opened on December 15th by the firm of R. O. Rubel, Jr., and Co., which for more than three years has been engaged in the manufacture and sale of aeroplanes and their component parts. The equipment of the school is of good size, and they have at present three monoplanes, three biplanes, one hydroplane, one wind wagon and one glider, all of which are housed in one large hangar. The school guarantees to secure engagement to those aviators whose ability and connections are satisfactory. The school and aviation park are located just two and one-half miles from the city of Louisville, and the park comprises one hundred acres of clear, unobstructed level ground which has been completely tiled to effect perfect drainage. Surrounding the park is thousands of acres of clear, level fields.

The Tufts Wireless Club

With the installation of the antennae of the wireless outfit on the top of Robinson Hall, the Tufts Wireless Club has started active work in the field for which it was formed. The use of the outfit, which is a 1-10 k.w. set, has been tendered the club through the efforts of Professor Harry G. Chase, head of the physics department at Tufts. It is the one used during the maneuvers this last summer by the Signal Corps, M.V.M., of which Professor Chase is captain.

The club, well backed by the faculty, is in charge of three very capable and experienced men of the undergraduates. Its president, Harold J. Power of Everett, has had exceptional practice for a sophomore at college. He was operator on Colonel Astor's yacht this past summer, and on the *Harvard* the one previous. In addition to his regular college work, he is now teaching telegraphy and wireless three nights a week at the Everett High Evening School. Walter L. Kelley of Arlington, the vice-president, has been employed during the past two years in the engineering department of the Edison Company and previous to that in one of the power houses of the Boston Elevated. He now has the supervision of all electrical apparatus on the campus and in the college buildings. Joseph A. Prentiss, the secretary-treasurer, has done a large amount of research work in the last two years, and is now in charge of the installing of the outfit at Tufts.

The club intends to go into research work, and in view of that it is now testing the wireless outfit of the Signal Corps, the results of which are to be sent to the Signal Corps authorities at Washington. To add interest to the meetings, a series of twelve instructive lectures will be given by the officers of the club on the following subjects:

(1) Mathematical determination of wave lengths and calibration of meters; (2) Advantages of a rotary spark gap at a wireless transmitting station; (3) Transatlantic telegraphy; (4) The work of a commercial operator; (5) Government requirements for a wireless operator; (6) Alternating current generation; (7) Armature winding; (8) Steam turbo generators; (9) Automatically controlled high-tension switches; (10 The ideal sub-station; (11) Balanced antennae; (12) Quenched spark gap.

The outfit now erected will, after testing, be replaced by a larger set which will be capable of sending from 500 to 1,000 miles and receiving from any distance.