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February, 1910

ELECTRICIAN & MECHANIC

Working Distances of Wireless Stations

Elements of Automobiling

Making a Nest of Drawers

Interior Electric Light Wiring

Forging for Amateurs

Thousand Mile Receiving Station

Shocking Coil

Box with Secret Opening

Making Blue Prints

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Electrician and Mechanic

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WORKING DISTANCES OF WIRELESS STATIONS

W. C. GETZ

In looking through the technical inquiry portions of this and contemporary magazines, the reader will find invariably that fully 75 per cent. of the questions asked about wireless telegraphy are of the "How far will it work" type. At first glance this may seem a logical question to the uninitiated, but upon a moment's reflection the utter worthlessness of any stereotyped or cut and dried data based on such insufficient information as the height of the aerial or capacity of the spark coil, without a detailed knowledge of the operating conditions and environment, is easily apparent.

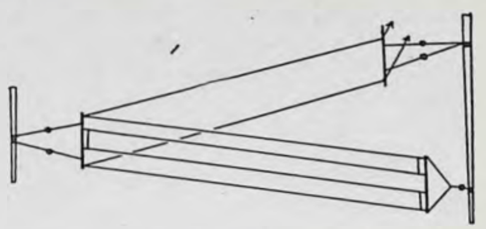
While heretofore the editor has probably answered these questions basing his deductions upon performances of similar apparatus that has come under his observation during his greater or less experience in the wireless field, it is now time to bring to the attention of the experimenters, and particularly to the young amateur who has an extremely limited knowledge of electricity and who is therefore more greatly imposed upon by irresponsible firms, the futility of such inquiries and subsequent answers.

Such questions as these, while asked in good faith, cannot be answered any easier than a hypothetical question recently asked the editor of a photographic journal—the party writing wishing to know if the editor considered a man weighing 180 lbs., and owning a dress suit, competent to lecture on "Color Photography," without the editor ever knowing any more about the man than was stated in the inquiry. Individual conditions alter all cases, and it is the purpose of this article to show the great many conditions that enter into the subject of wireless telegraphy and which, unless carefully studied and complied with, may greatly alter the results from what was expected.

The efficiency of a wireless station depends on the following general points:

1. System or "Hook-up" used.
2. Locality of Station.
3. Height of Aerial.
4. Capacity of Aerial.
5. Sensitiveness of Apparatus.
6. Intelligence and care used in connecting and adjusting the necessary apparatus.

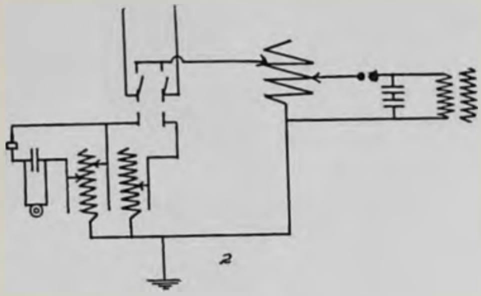
Each and every one of these points will cause a difference in the working distance of a station, and as it is hardly



possible that there are two stations exactly alike in all of the above points, it is therefore manifest that no formula or rule can be derived that will cover the effective range of any and every station.

A brief discussion of some of the above points may serve to enlighten the experimenter on certain details which may be the cause of some inefficiency of the particular station in which he is interested.

The system or wiring diagram used causes more controversies than any other of the above points enumerated. Fundamentally, every wireless circuit contains a variable or constant inductance, and a variable or constant capacity. Various combinations of these have been evolved into different systems, each so-called "system" having its stanch adherents, who set forth claims of unexcelled superiority in "selectiveness," "long distance," etc., that may be really due to a fortunate combination with the local conditions in any particular case. It is well known to the majority of experimenters that certain "hook-ups" seem to work better at one station than at another, and as no rule can be assigned to cover this, the experimenter getting the best results is usually the one who is not content with one diagram, until he has



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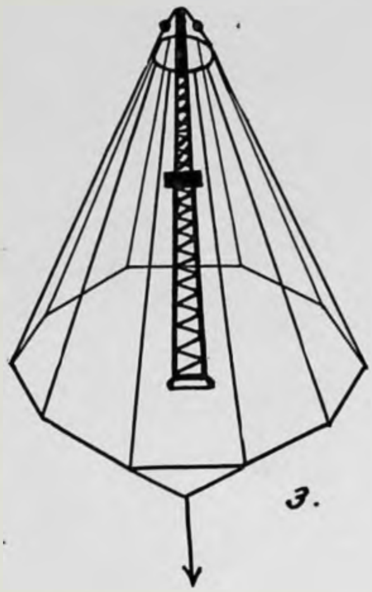
thoroughly tried out all. Such diagrams have been issued both in book and blueprint form for the past year and a half, and the amateur who neglects obtaining the best and most recent copies of these diagrams is usually the one who never has "results" with any apparatus.

In considering the second point—the locality of the station and its effect on the working distance, we must depend upon the experience of others and base our assumptions accordingly. On water, it is conceded that wireless can be worked over twice the distance for a given equipment than can be done over land. While nearby mountains do not cut out the waves as was first



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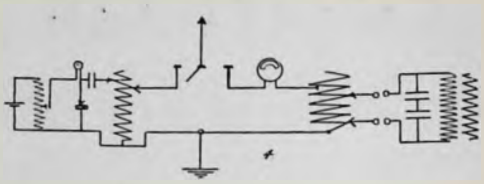

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assumed, it often happens that in mountainous regions a good ground is hard to obtain. And again, ore-bearing mountains, if near at hand, in some instances have noticeably reduced the efficiency of a wireless set, especially where the ore is of a magnetic nature.

Water itself does not always form such a good ground, as the resistance of clear water containing mineral or vegetable residue is very high. The best ground is a copper plate or wire netting placed in loam that is permanently moist. A ground plate buried

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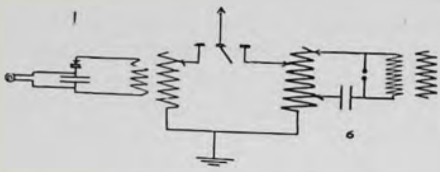
in clay is usually inefficient, and sand, unless wet, has a very high resistance. A station in the woods will lose much of its transmitting energy, if the aerial is near any trees. For this reason, when it is necessary to guy the antenna to trees, strain insulators should be cut into the guy wire at equidistant intervals to reduce this leakage factor.

Where static is prevalent the receiving efficiency is somewhat decreased at times owing to the inability of the operator to read through static. By shunting a variable condenser around the detector this annoyance may be greatly reduced, but at the expense of receiving radius. The proximity of power wires sometimes causes electromagnetic induction in the receiving set. The use of the "loop" form of aerial greatly eliminates this trouble.

The height and form of aerial also varies the distance of operation. There is no rule governing the relation between the aerial height and the effective radius of communication, although Marconi at one time stated that the distance was proportional to the square of the height of the antenna, for a given set. This of course does not hold good with the present type of wireless apparatus, as the instruments now on the market have many times been successfully used over distances one hundred times greater than the aerial height squared.

The main consideration is to have the aerial perfectly insulated. The number and size of the wires used in



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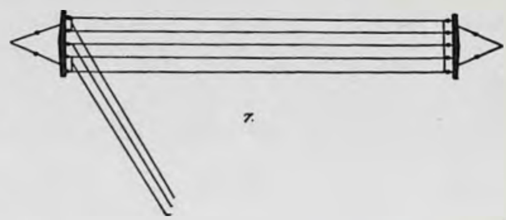
the antenna depend entirely upon the capacity of the station. When a brush discharge is observed from the aerial, it is generally a safe sign that more aerial wire is required.

The form of aerial, whether straight "cage," "flat-top," "loop," "umbrella," etc., can only be determined after a thorough trial is made of each and the results classified so that the one giving the best results for the individual and particular station is ascertained. The capacity of the aerial varies according to the different forms and dimensions used.

The relative sensitiveness of the instruments used is a subject that the writer would like to omit, as there is bound to be a difference of opinion on the same, and this is intensified by the fact that every manufacturer differs radically in certain designs, and each has an abundance of testimonials to show that his is the only right and efficient way. However, the writer has tried to take a view of strict impartiality, and trusts that if he unknowingly wrongs anyone they will write and inform him of the case. As there are now several score concerns making and selling wireless apparatus, and thousands of amateurs are also making their own instruments, certain well known and standard types will be discussed, and the experimenter may govern his conclusions in proportion to which his instruments approach these standards in efficiency.

It is not to be supposed that an instrument costing but a few cents will give as good results as a well made and reasonably but higher priced instrument. For instance, the so-called silicon crystals sold to experimenters by some wireless concerns will not give 50 per cent of the efficiency of the Improved Silicon Detector, which is designed and tested for sensitive work. The crystals in the latter are selected from specially imported silicon, and many lumps are rejected before a sufficiently sensitive piece is found. In a like manner the efficiency of any other instrument depends upon the sensitiveness of the individual instrument itself, more so by far than on the type of instrument.

On the receiving side the detector is the vital part of the set, without



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which it is impossible to operate. In the order of their sensitiveness, the following types of *standard* detectors have been classified:

Class A. Electrolytic (Silver Plate Wire, .0001 in. / .00002 in.)
Perikon.

Class B. Silicon (Improved)
Pyron.
Ferron.

Class C. Molybdenite.

Class D. Carborundum
Magnetic
Electrolytic (Silver Plate Wire, .001 in. / .0001 in.)

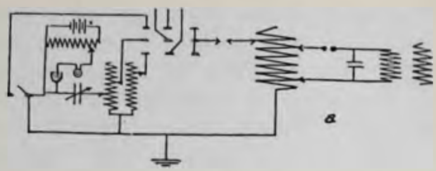
Class E. Carbon and Steel.
Aluminum and Steel.
Coherers, etc.

The Perikon detector is the most extensively used type for sensitive work, as it may be easier adjusted and kept in adjustment than any other used in practical work.

The telephone receivers should be of high resistance with a maximum amount of ampere turns per ohm resistance. In this respect enamelled wire is far superior to silk insulated wire, and a number of progressive firms are following in the track of the writer who had used enamelled wire for receiver windings for the past several years. Low resistance receivers are of no use whatever for sensitive work.

The tuner may be of the inductive type, or of the familiar "auto-transformer" or single winding type. The latter may have one, two or three sliding contacts. It has been the writer's experience that excellent results were always obtained with the double sliding contact tuner. The use of a third sliding contact is now being advocated by certain manufacturers who claim better selectivity with same. The inductive type of tuner is considered to be the most sensitive.

Apropos of the discussion now being waged among the several manufacturers regarding the use of enamelled wire on tuners, the writer has used a number of tuners wound both with bare, enamelled, and cotton insulated wire, and he could not notice any marked difference in the respective efficiencies.



Condensers should have about from .001 to .005 M.F. capacity. The potentiometers should be at least 300 ohms resistance, when two or more cells of battery are used.

On the transmitting set, the relative efficiency of the induction coil or open core transformer and the closed core transformer seems to depend upon the reliability of the builder. Both work well when properly and intelligently used. Where only direct current is available, it is not advisable to use the Wehnelt Interrupter, as it gives very poor results on wireless work. By no means use it on alternating current, as the best results are obtained when the primary is connected direct to the A.C.

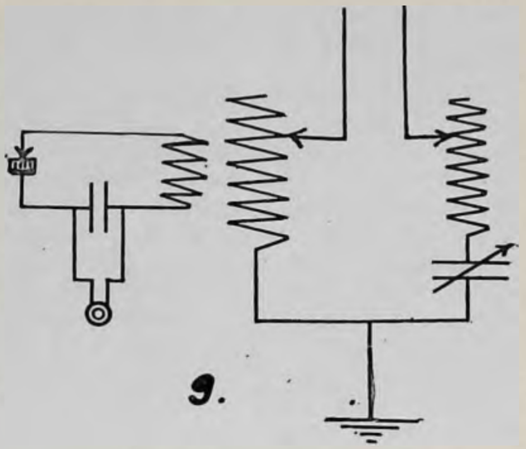
Example No.	Local Conditions	Ground	Atmospheric Conditions	Height of Mast	Type Aerial Sketch No.	Diagram No.	RECEIVING				
							Detector	Tel. Rec.	Tuner	Condenser	Potentiometer
1.	On Hill 3 miles from Tide Water	To City Water Mains	Static in Summer	40 ft.	Fig. 1	Fig. 2	Silicon (Improved)	2, each 1,650 Ohms No. 40 Wire	1 Single and 1 Double Slide Tuner	.002 M.F.	None used
2.	On Rocky Hill 500 feet from Water	Poor Copper Plates in Sand	Good No Static	100 feet (iron)	Fig. 3	Fig. 4	Perikon	2 each 2,000 Ohms	Double Slide Tuner	.006 M. F.	270 ohms
3.	On Rocky Land 1 mile from River	To City Water Mains	Good	60 feet	Fig. 5	Fig. 6	Ferron	2 each 1,600 Ohms	Inductive Tuner	.004 M.F.	None used
4.	In Country near Woods	To Pipe in Well	Static Prevalent	80 feet (2 Trees)	Fig. 7	Fig. 8	Electrolytic .0011 in. 1.00002 in. Wire	2 each 1,000 Ohms	1 Single and 1 Double Slide Tuner	.0001 to .010 Adjustable	350 ohms
5.	Near City 10 miles from River	Moist Earth in Cellar	Good	50 feet	Same as Fig. 1	Same as Fig. 4 Rec.	Electrolytic and Silicon (Low Grade)	2 each 200 Ohms	Double Slide Tuner	.004 M.F.	Graphite Rod
6.	In Valley near Bay	Moist Earth	Fair	15 feet	Same as Fig. 1	Fig. 9	Perikon	2 each 1,600 Ohms	Inductive, also 1 Single Slide Tuner	Adjustable .006M.F. and 1 Fixed	None used

mains, suitable resistance or impedance being inserted in series if necessary.

The sending inductance, spark-gap, and transmitting condenser, can be of any make that uses the general proportions of the standard types. The wire of the sending inductance should not be on less than a 3 in. radius, and should be No. 14 B. & S. gauge wire or larger. The spark gaps should have electrodes of zinc, or of some other approved alloy containing a sufficient amount of zinc to produce the characteristics that accompany the use of the zinc gap.

The current supply for the transmitting side should always be sufficient for the maximum amperage required by the transformer or coil when operating, in order that the spark may be maintained smooth and regular.

The adjustment and tuning of the transmitting apparatus really is the hardest part for the experimenter to accomplish. It means that he should



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try constant changes of his inductance and capacity and compare the readings of his hot wire meter in the aerial leads with the distinctness in which surrounding stations are able to receive him. If this is done in a systematic manner, each receiving station making a record of the clearness, and condition of spark,

INSTRUMENTS		TRANSMITTING INSTRUMENTS							
Battery	Receiving Radius	Coil or Transformer	Inductance	Condenser	Spark Gap	Source of Power	Watts used	Transmitting Radius	REMARKS
None used	300 miles	1 in. Spark Coil	No. 12 Wire 5 turns 18 in. Diam.	Leyden jars, 2 each 6 x 2 in. Diam.	Zinc ¼ in. Electrodes	Storage Battery	200	10 to 15 miles	Tuning Good
1 Cell 1.1 Volt	350 miles	1 K.W. Open Core Trans.	No. 6 Wire 12 turns 10 in. diam.	26 Plates each 10 x 12 in.	Zinc ¾ in Electrodes	110 Vo t A.C.	1100	35 to 50 miles	Metal Mast—absorbed energy greatly.
None used	600 miles	1 K.W. Open Core Trans.	1-10x1-2 in. Strip Copper 20 turns	20 Plates 8 x 10 in.	Zinc ¼ in. Electrodes	110 Volt A.C.	1200	40 miles	Transmitting side not well tuned.
3 Cells Dry Battery	850 miles	¾ in. Spark Coil	No. 8 Wire 20 turns 12 in. diam.	10 Plates 6 x 8 in.	Brass ¼ in. Electrodes	Dry Battery 8 cells	60	15 miles	Tuning of transmitting side excellent.
3 Cells Dry Battery	20 miles at greatest	1 in. Coil	None used (Untuned)	None used	Brass Balls ½ in. diam.	12 Fuller Cells	100	¼ mile	Poor instruments, no tuned trans., and careless adjusting. Used properly, would work better.
None used	370 miles	No Transmitting Apparatus							Extremely selective. Intelligent adjusting. Careful experimenter.

etc., thus being noted, the actual tuning may be easily and accurately accomplished.

A small power station tuned properly will probably work four or more times as far as one of double its power but not in tune. The main consideration is to know what you want to try, and then try it in the simplest and most systematic way possible. The personal element of good judgment and care in making the connections good, is more responsible for some of the record results accomplished by certain experimenters than the type of apparatus employed.

The following information has been prepared for the use of the experimenter who wishes data on some stations that may have conditions somewhat similar to his particular station, and while this is only compiled from the operation of certain particular stations, the facts may be of use in "doping" out the probable results of apparatus that is to be installed. The experimenter is again cautioned that his results may differ widely from those given herein, and that the only way to get the best results is to experiment with as many "hook-ups" and instruments as you can, until the happy medium is obtained.

THE HIGH-SPEED ELEVATOR ESSENTIAL TO THE SKY-SCRAPER

In the last analysis it has been only the high-speed elevator that has made a practical possibility of the tower building, and successive efforts have culminated in elevators which travel the 546 ft. of the Singer Building tower and to the forty-fourth story in the tower of the Metropolitan Life Building. Such a journey in the elevators used but a few years ago would have required from ten to fifteen minutes, which of course would have rendered the upper floors of such a tower unavailable for rental; but today even when the speed of an elevator is limited by the building regulations of 600 ft. per minute, it is possible to secure safe and speedy service. Indeed, many engineers think that this restriction is a most wholesome as well as liberal provision, and it is so found in actual practice, for it is not the time spent by the car in travel that counts, but that required for the ingress and egress of passengers, amounting often to 75% of the time required for a trip. Therefore small cars running with moderate velocity are usually more advantageous than large cars of greater speed, while as a result of experience it is stated that one elevator is needed for every 25,000 ft. of rental floor space. Now for the requirements of the very high building two types of elevator have been evolved, both of which in actual use have been found satisfactory. These are the plunger elevator, in which hydraulic pressure acts directly on a long plunger working in a cylinder and carrying the car at its extremity, and the cable-drive elevator, which is based on the direct traction principle and is operated by an electric motor.—*American Review of Reviews.*

Gum Arabic Mucilage

To make a mucilage of gum arabic that will not become sour or mouldy, neutralize the free acid in the gum by using a mixture of 20% lime water and 80% distilled water for dissolving the gum, or the lime, naturally present in the gum, may be precipitated as sulphate of lime by adding a few drops of sulphuric acid to the gum solution; allow this precipitate to settle and pour off the supernatant fluid.

It is probable that the four tunnels of the Pennsylvania Railroad Company between Manhattan and Long Island will adopt a track system consisting of treated red oak blocks, set in the concrete lining, on 20-in. centres. The blocks will be anchored to the concrete by expansion bolts; and the 100-pound rails, 60 ft. in length, will be laid on 7 in. by 12 in. plates, ¼ of an inch in thickness. The plates will be fastened to the blocks by two lag screws and the rails will be held down by clips and screw spikes.

ELEMENTS OF AUTOMOBILING—Part I

J. F. H. MCHUGH

CHAPTER I

INTRODUCTORY

Consider for a moment how a bicycle is made to go. The foot pushes down a pedal. This turns a crank. With the crank a sprocket turns. A chain passes around the sprocket and around a gear on the hub of the rear wheel. As the sprocket is turned, the wheel is turned; and the bicycle moves. The power of the rider's muscles has been transmitted to the wheels. Also, if the sprocket is twice as large around as the gear on the rear wheel hub, we will get two turns of the wheel for one of the crank.

The running of a gasolene automobile is almost as simple. A mixture of air and gasolene vapor is exploded in the upper part of an engine cylinder. The force of the explosion drives a piston down. A rod, called the piston rod, turns a crank. The crank is fitted to a shaft called the crankshaft. With the crank the crankshaft turns. The crankshaft, connected to the transmission gear by a clutch, sets the transmission gear turning. A driving shaft, or chain, joins the transmission gear to what is called the differential gear on the rear axle. This turns the axle, and the wheels, being secured to the axle, and turning with it, also turn. Then the car moves.

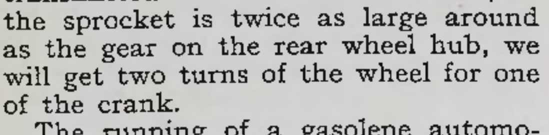

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Fig. 1 shows the arrangement of the cranks on the crankshaft of a four-cylinder engine. Notice that the first and fourth cranks are down or up together, and the second and third are together in the opposite direction.

So much for general principles. It is now proposed to tell in detail, first, what the explosive mixture is; secondly, how it is got; thirdly, how it is made to pass into the cylinder; fourthly, how it is made to explode at the right moment; and, fifthly, how the burned gases are got rid of, to make room for a fresh supply.

Other details will be taken up in their order; but a thorough understanding of the engine and its parts is the basis of knowledge of the automobile.

Gasolene.—Gasolene is a liquid manufactured from coal oil. We need not trouble ourselves so much about what it is as about what it does. First of all, it gives off vapor freely at ordinary temperatures. This vapor is like coal gas in many ways. Its usefulness for our purpose lies in the fact that if it is mixed with air in a closed vessel, and the mixture is set on fire, a powerful explosion is got. The force of this explosion depends upon the proportions in which the air and gasolene vapor are mixed in the closed vessel. The exact strength of mixture needed for the best results varies with weather conditions.

Remember, the vessel in which we want to get the explosion must be closed. If the mixture is not confined in some way when the light is put to it, it will merely flame up without explosion. Also, the vapor must be mixed with air. Pure gasolene vapor will burn like coal gas.

When there is an explosion of a mixture of gasolene vapor and air, great heat is caused in the vessel in which the explosion takes place. This fact makes a cooling system necessary for gas engines.

Gasolene vapor is heavier than air. Any which escapes from the tank it is stored in, in shop or garage, will go toward the floor.

If the properties and characteristics of gasolene, as here described, are borne in mind, it should be easy to provide against those garage fires we read about from time to time.

Every car carries its supply of gasolene in a tank of metal, called the fuel tank. Place for the fuel tank is usually found under one of the seats. A narrow pipe connects the fuel tank with the carburetter. The gasolene runs into what is known as the float chamber of the carburetter. When the gasolene has risen in the float chamber to a certain level, the float will have risen so that a needle valve, so called because it is like a needle, sticking up through the middle of the float, will stop up the small hole through which the gasolene has been flowing. As gasolene runs out of the float chamber, the float sinks with it, and the needle valve is again opened, allowing more gasolene to come from the tank, until the needle again stops up the hole. In this way, the gasolene in the float chamber is kept at a practically fixed level.

From the float chamber the gasolene runs into a smaller chamber through a pipe. The pipe sticks up in the smaller chamber to a height slightly above the level of the gasolene in the float chamber. At the end of this pipe is a little nozzle, called the spray nozzle. The suction of the engine piston draws the gasolene from the spray nozzle in the form of vapor. Air is drawn from an opening, and the mixture goes into the engine cylinder, ready to be exploded.

The carburetter has been called "the heart of the automobile." It will be considered in greater detail later.

CHAPTER II

THE MOTOR

Two Types of Gasolene Engine.—The gasolene engine, or motor, is made up of one or more cylinders. Each cylinder is complete in itself. There are two types of engine, usually called "two-cycle" and "four-cycle." They should properly be called "two-stroke cycle" and "four-stroke cycle" respectively. A cycle is defined as the chain or series of events or strokes occurring within the cylinder. The series must be completed before any one event or stroke can occur again. In the two-cycle engine, it takes a down and an up stroke of the piston to complete the cycle. In the four-cycle type we have two down and two up strokes.

Four-cycle Engine.—As most cars use the four-cycle engine it will be described first. Let us assume a mixture of gasolene vapor and air, called "the charge," drawn into the upper part of the cylinder, and the piston pushed up to its highest point and ready to be driven down. At this moment an electric spark is produced in the cylinder. This fires the charge. The charge explodes with great force, and the piston is driven down. This is the power stroke. As the crank swings around, it pushes the piston up again. The "exhaust" valve opens, and the burned gases are driven out. This is the exhaust stroke. The piston again goes down. This time, the exhaust valve having closed, another valve, the "inlet" or "intake" valve, opens, and the suction of the piston going down draws a fresh charge from the carburetter and air inlet into the cylinder. This is the inlet stroke. Again the piston goes up. This time the valves have closed, and the charge is compressed in the upper part of the cylinder. This is the compression stroke. The cycle of events is now complete, and all is ready for repetition, beginning with a fresh power stroke. Thus we have had four strokes in this order: power, exhaust, inlet and compression.

Fig. 2 shows the four strokes in the

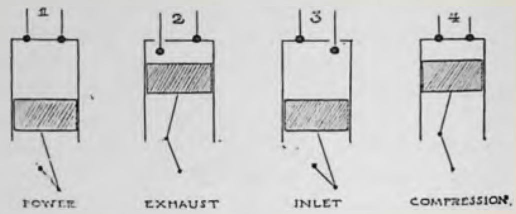


Fig. 2

cylinder of a four-cycle engine. Note the position of the valves at each stroke.

The cylinder of a four-cycle gasolene engine is a piece of metal bored inside. The end toward the crank is open. The other end, which for convenience will be spoken of as the upper end, is closed, but has two holes or ports, fitted with valves. These valves are the inlet and exhaust valves, and the ports are the inlet and exhaust ports. One port opens from the pipe leading from the carburetter, and the other, the exhaust port, opens into the pipe which carries the burned gases to the muffler, through which they pass into the air and are scattered.

Each cylinder is also provided with one or more pet cocks or relief valves, useful for various purposes.

Piston.—The piston is a hollow, cylindrical piece of metal, open at the crank end and closed at the other by a flat or slightly hollowed piece of metal. The piston must fit the engine cylinder accurately, but not so tightly as to be prevented moving up and down freely. It must be long enough not to "wobble" on its travels up and down. Escape of gases from the upper part of the engine cylinder, or fuel chamber, is provided against by means of piston rings. These are steel rings each broken in one place and sprung on the piston, which is grooved to receive them. They are so fitted that the broken ends of each ring, which do not quite meet, are well out of line.

A wrist pin, a stout piece of steel, passes across the inside of the piston, through the centre. To the middle of this the piston rod is fixed in such a way as to swing freely. The lower end of the piston rod is secured to the crank in the same way. The crank is part of the crankshaft. The crankshaft is a round steel bar broken, or, as it is called, offset, at intervals to provide a crank for each cylinder. It lies horizontally under the cylinders, which are in line. A heavy fly wheel is keyed to the end of the crankshaft. The fly wheel is needed to keep the shaft turning between power strokes.

Exhaust and Inlet Valves.—Exhaust and inlet valves open and close at the right moments with the aid of cams. The cams are keyed or fitted to a shaft which runs parallel to the line of the crankshaft. This is called the camshaft. To learn what a cam is, picture a circular piece of polished steel, about 1 in. in diameter and ¼ in. thick. Now picture it only ⅔ or ¾ circular, the circumference bulging out the rest of the way in a hump or projection. That is a cam. (See Fig. 3.) It is fixed to the camshaft in such a way that at a certain point the hump or projection, as the shaft turns, will strike a steel rod, connected with the valve, and cause the valve to open. A strong spring holds the valve closed the rest of the time.

Fig. 3

The camshaft is turned by means of a set of two to one gears connecting it with the crankshaft. That is to say, a gear or cog-wheel on the crankshaft fits into one on the camshaft, having twice as many teeth. So, when the crankshaft has turned once, the camshaft has made half a turn. One full turn of the camshaft is made therefore for every cycle of the engine. The cams are so fixed as to open the valves at the right times in each cycle.

Sometimes the inlet valve is worked automatically. That is to say, the suction of the inlet stroke acts against the spring which holds the valve in place, and causes the valve to open. During the other three strokes, the valve is held closed by the spring.

CHAPTER III

THE CARBURETTER

We come back to the carburetter, or vaporizing apparatus. The type known as the float feed is in practically universal use. It will not be necessary to consider any other.

The carburetter is the little brass vessel which is fastened to the car at some point between the fuel tank and the engine. It consists of a float chamber which holds a float of cork or hollow brass, and a vaporizing chamber. The purpose of the float is to regulate the flow of gasolene into the carburetter. Without such a device the flow of gasolene would be unchecked, and we could not get the proper mixture for the engine. The mixture would be too "rich."

The Float.—The float is a circular piece of cork or hollow brass, which fits loosely in the float chamber. A thin rod, the needle valve, sticks up through the centre of the float. (In some carburetters the gasolene flows in at the bottom of the float chamber. In these the needle valve points down, and a device is used to push it further down as the float rises.)

The float rises when gasolene flows into the float chamber, until the needle valve stops up the inlet, and the flow of gasolene is checked. As gasolene runs out of the float chamber into the vaporizing chamber, the float is lowered, the needle valve is drawn from the gasolene inlet, and more gasolene comes in. The float again rises, and the needle again stops up the inlet.

Flooding Valve.—The float chamber has another valve, called the flooding valve. This is a device used to push down the float, for the purpose of "flooding" the carburetter with the gasolene, to get what is called a "rich" mixture, useful in starting the engine.

Spray Nozzle.—A thin pipe leads from the bottom of the float chamber into the vaporizing chamber. It sticks up in the vaporizing chamber and ends in a nozzle, called the spray nozzle. The spray nozzle is at a level slightly higher than the level of gasolene in the float chamber. If it was not higher, the gasolene would overflow, making it impossible to get the right mixture.

Delivering the Charge.—When the piston of the engine goes down on the inlet or intake stroke, it causes a strong suction, which draws the gasolene vapor from the spray nozzle toward the cylinder. At the same time air is drawn into the intake pipe by what is known as the air inlet, and the air mixes with the gasolene vapor on the way to the engine cylinder. Thus the charge is delivered to the upper part of the cylinder, or, as it is called, the compression chamber.

Adjusting Valve.—Now, to get the best results, in the shape of the most powerful explosion possible, it is necessary that there should be just so much air and just so much gasolene vapor in the mixture. The proportion changes according to the weather. Therefore, an adjusting device is needed. This is the adjusting valve. It is in the pipe through which the gasolene flows to the spray nozzle, and is worked by a screw outside and at the bottom of the vaporizing chamber. As this screw is turned one way or the other, the quantity of gasolene in the pipe becomes greater or less, and the mixture changes accordingly. The mixture that gives the best results at the time being is found by a series of tests while running the car, preferably up hill.

Throttle Valve.—The throttle valve is usually, though not necessarily, part of the carburetter. It is simply a brass slide which, if closed, would cut off the fuel mixture from the cylinder. It is never quite closed. When the car is running on the level and at a moderate pace, the mixture that is being drawn into the cylinder is comparatively small. When more power is wanted, for speed or hill climbing, the throttle valve is opened more, and the result is quickly seen. The valve is worked either by a pedal, called the accelerator, at the driver's foot, or by a lever on the steering wheel.

Auxiliary Air Valve.—When the speed of the engine is increased, the suction of the piston on the intake stroke becomes stronger. The vapor is drawn from the spray nozzle in larger quantities, while the quantity of air drawn in by the air inlet does not increase at the same rate. We are beginning to get too rich a mixture. The force of the explosions is lessening, and there is loss of power. The auxiliary air valve comes to the rescue. This covers an extra air inlet and keeps it closed with the aid of springs. When the suction of the piston gets strong enough, owing to the greater speed of the engine, to overcome these springs, the valve opens, and an extra supply of air rushes in to balance the extra supply of gasolene vapor.

The principle of the float feed carburetter will be readily understood by reference to Fig. 4. A is the float. B is the pipe by which the gasolene passes to the spray nozzle. C is the intake pipe through which the fuel charge is drawn into the engine. The arrow marks the air inlet. The auxiliary air inlet is on the opposite side.

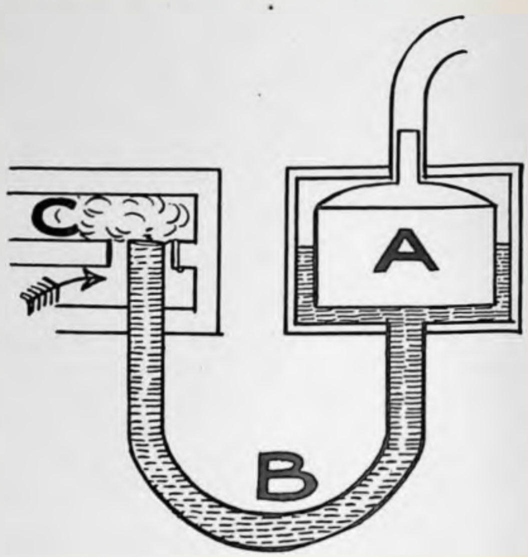


Fig. 4

It is closed by a valve under normal conditions.

The Muffler.—To deaden the disagreeable noise which would otherwise follow the explosion of the charge (or rather the escape of the burned gases after each explosion), the muffler or silencer is used. A typical muffler is a pipe about 3 ft. long and 4 in. in diameter, with some perforated thin metal tubes inside. This is connected with the exhaust pipe, and, as the burned gases are driven out of the cylinder, their expansive force is gradually broken as they find their way through the holes in the perforated tubes. Muffling involves some loss of power, and a device is provided by which the muffler can be cut out when more power is needed, while hill climbing or at any other time. The "cut-out" is usually worked with a pedal at the driver's foot.

Two-cycle Engine.—Two-cycle engines are used on some cars, and on most small motor boats. In these an explosion occurs at every second stroke of the piston. That is to say, there is a power stroke for each turn of the crank instead of, as in the case of the four-cycle, a power stroke at every second turn. In the two-cycle engine the suction of the up stroke of the piston draws the charge into the lower part of the cylinder, or crank case. The valve which lets the charge into the crank case is opened by the suction of the piston as it goes up. A passage through the side or wall of the cylinder leads from the crank case to a hole or port opening into the upper part of the cylinder. This is the inlet port. It is covered by the piston during the piston's up stroke. Higher in the cylinder, and usually on the side opposite to the inlet port, is another hole, the exhaust port. Through this the burned gases are driven out.

Now, this is how the engine works. When the piston is at its highest point in the cylinder, it covers both exhaust and inlet ports. The charge is exploded and the piston is driven down. As it goes down, it first uncovers the exhaust port and some of the burned gases escape. Next, the inlet port is uncovered, and the pressure of the piston going down causes a fuel charge to travel up through the passage in the cylinder wall and by the inlet port into the upper part of the cylinder. As the piston goes up again, it closes the inlet and keeps pushing the burned gases out of the cylinder by way of the exhaust port. A metal plate or screen is fixed at the upper end of the piston to keep the fresh charge, as far as possible, from mixing with the burned gases which are being driven out.

Fig. 5 is a set of diagrams showing the working of a two-cycle engine.

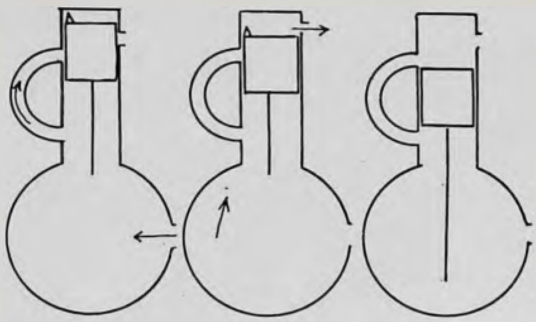


Fig. 5

The drawing to the left shows the piston pushed up as far as it will go. Exhaust and inlet ports are covered by the piston. A mixture of gasolene and air has been drawn into the crank-case below by the upward movement of the piston.

The middle drawing shows the piston on the way down just after the power stroke. The exhaust port has opened, and the exploded charge begins to rush out. The left hand drawing shows the piston down as far as it goes. The fresh fuel mixture runs up from the crank-case through the inlet port into the top part of the cylinder and will be compressed by the upward stroke of the piston and made ready for the next explosion.

Such is the two-cycle engine. The intelligent student will see for himself its advantages and disadvantages as compared with the four-cycle. The two-cycle engine can be reversed by changing the time at which the spark is produced to fire the charge. Many dealers advertise their engines as reversible. Two-cycle engines are reversible, and four-cycle engines are not. Reversing on an automobile is done with the aid of gears in the transmission apparatus.

CHAPTER IV

COOLING SYSTEMS

Great heat is produced within the engine cylinder at each explosion of the fuel mixture or charge. This heat is enough, if unchecked, to make the cylinder red hot in time. This would lead to all kinds of troubles. The charge would be fired at the wrong time; the lubricating oil would burn; the piston would cut the cylinder, and, in fact, the engine would soon be only good enough for the scrap heap.

There are two ways of cooling the cylinder. One way is with air, and the other way is with water. Each has its advocates, and each has its advantages.

Air-cooled Cylinder.—The air-cooled cylinder is fitted outside the upper part—that is to say, around the part inside which the charge is exploded—with metal flanges or broad, projecting pieces; or, instead of flanges, it may be fitted with a number of metal spikes or quills, these being sometimes hollow and open at the outward end. Whether flanges or quills are used, the purpose is the same, namely, to give as large a surface as possible for the cool air to act on. The rush of air upon the cylinder is helped by a revolving fan with propeller blades, hung in front of the engine, and turned by a strap or belt which passes around a grooved wheel on the crankshaft.

Water-cooled Cylinder.—A water-cooled engine has the cylinder head "jacketed," instead of being fitted with flanges or quills. The "jacket" is an outer casing. Between this casing and the cylinder head is a space in which water circulates.

Again, every water-cooling system has a radiator in front of the engine through which the water passes before it is drawn to the cylinder jacket through a pipe. After this water has passed around the cylinder head, it flows by another pipe back to the radiator. The radiator is a metal tank pierced, or "honeycombed" by a number of small tubes. Air rushes through these tubes as the car moves along, and in this way the water is kept fairly cool.

There is another type of radiator, which consists simply of a tube with many bendings, fitted all the way with thin metal fins, which serve the same purpose as the flanges of the air-cooled cylinder, namely to give as much surface as possible for the air to act on, keeping the water in the radiator fairly cool. In the case of the air-cooled engine, the air cools the cylinder. In the case of the water-cooled engine, the air helps to cool the water which cools the cylinder.

Before going further, it is well to explain that the cooling system does not make the cylinder cold; nor is it intended or desired that it should. It merely keeps the cylinder from getting so hot that the oil would burn, and so on. Below that point, the hotter the engine is the better it will run.

Thermo-Siphon Method.—Water is kept moving around the cylinder head, and out of the radiator and back again, either by what is called the thermo-siphon method or by pumps. The thermo-siphon method is based first of all on the principle of the siphon. If we fill a bent tube with water, and put the shorter end into a bowl of water, the water in the bowl will run out at the longer end of the tube. The second principle is that, if the bottom of a vessel full of water is heated, the water in the lower part of the vessel will rise toward the top of the vessel, and the cooler water will go down. A pipe connects the lower part of the radiator with the lower part of the jacket at the cylinder head. Another pipe leads from the upper part of the jacket back to the radiator at a point slightly higher than that at which the pipe has left the jacket. The highest part of the radiator is at a higher level than the highest part of the cylinder; so, when water is poured in to fill the radiator, it also fills the jacketed space around the cylinder head.

The engine is started. The heat of the explosion heats the water in the jacketed space, and this heated water rises through the upper tube and flows into the upper part of the radiator. The siphon principle now begins to work, and water from the lower tube flows into the jacketed space to prevent a vacuum which would otherwise result from the heated water flowing out. This fresh supply of water is heated in its turn, and so the circulation is kept up. It is evident that water in the radiator, where the thermo-siphon system is used, must be always enough to cover the end of the upper tube which carries the heated water to the radiator, otherwise our siphon would not work. Therefore, when a certain quantity of water has boiled off, put more in.

Pump Method.—When a pump is used to make the water run from radiator to cylinder head and back to radiator, the centrifugal type of pump is most commonly used. A fan wheel, worked by gears on the crankshaft, turns inside a small circular metal casing. Water runs from the radiator into the casing and is whirled around by the blades of the fan and driven through the pipe which leads to the cylinder jacket and then through another pipe back to the radiator.

MAKING A NEST OF DRAWERS

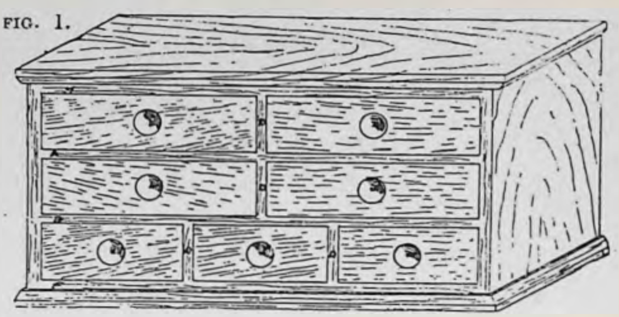
Obtain seven empty cigar boxes that have held fifty cigars; take same carefully to pieces, and remove all paper from both inside and out. Plane the end pieces of all seven boxes to the same width as sides, and put four of same together again.

The remaining three must be made smaller so as to form the smaller drawers, the size of two of which are 4⅛ in. wide by 5⅜ in. long, and the other one, which is the centre drawer, is 4⅛ in. wide by 5⅛ in. long. Care must be taken in putting these together to see that they are square.

Next purchase a good sound floor board with as few knots as possible, 5 in. wide by ¾ in. thick, and 4 ft. 5 in. long; also another 5½ in. wide by ½ in. thick, and 5 ft. long. Cut off two lengths from the ¾ in. board 7¾ in. long, plane both sides, edges, and shoot both ends square, so that the finished boards are exactly 7⅜ in. long by 4½ in. wide by ½ in. thick. These form the sides; also cut one length 1 ft. 5 in. long; plane this both sides, edges and shoot both ends square, the finished size being 1 ft. 4⅞ in. long by about 5 in. wide.

We now take one of the end pieces (or sides), and having marked the face edge and face side, we mark off from each end ⅜ in., drawing a line across the face side, and producing same to a ¼ in. on the face edge. Now draw a line ¼ in. from the face side, on the face edge, and continue same across the end and along the other side and end, so that we have a line drawn all round, and in the centre of the edges and ends. Next mark off 2½ in. from the end on the face side; then ⅜ in., 2⅛ in., ⅜ in., 2⅛ in. and ⅜ in. we have already marked. Square these across the face side and edges, so as to meet the line we drew previously. Now, with a fine tenon saw, cut ¼ in. deep through the lines which form the ⅜ in. grooves, Fig. 4, and with a sharp ⅜ in. chisel pare the wood out, and leave the grooves clean, being careful not to cut below the line.

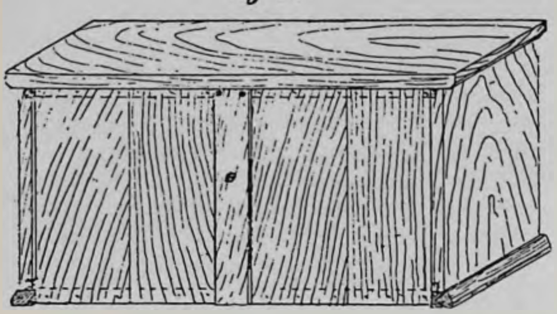
FIG. 1.



The first groove, it will be noticed, does not go right across the board, but only ¾ in. The other side is treated in the same manner.

The 1 ft. 4⅞ in. board, which is the top, only needs three edges bevelled. This is done by drawing a line ¼ in. from the face side, along the face edge and ends. Turn the board over face side downwards, and draw another line ¼ in. from the face edge and ends along the face of board. Keeping the face side of board down, plane the edge or corner of board down to meet the lines. Note: The back edge is not bevelled. See Figs. 1 and 2. Cut two strips from the ½ in. board, 1¾ in. wide by 18 in. long; plane both sides, edges and shoot both ends square, so that the finished size is exactly 16⅜ in. long by 1½ in.

Fig 2.



wide by ⅜ in. thick. Take one of these strips, and from one end on the face side mark off 8½ in., ⅜ in., and 8½ in. Produce lines across, and continue to face edge, and ⅛ in. on same from face side; also make a line cutting the two ½ in. from face edge on face side. The under side is marked out in the same way, and with a ⅜ in. chisel remove a piece from each side, as shown in A, Fig. 5.

On the opposite edge to the face edge, 3 mortises have to be cut ⅛ in.

Fig. 3.

wide by ¾ in. deep and 1½ in. long, the mortise being ⅛ in. from each side, in the centre. See Fig. 5.

Next cut four pieces 3¾ in. long by ½ in. thick and 1¾ in. wide; plane both faces, edges and shoot both ends square, so that finished size is 3½ in. by 1½ in. by ⅜ in., ¾ in. from one end, and on both faces cut tenon which is ¾ in. long by 1½ in. wide by ⅛ in. thick, and which is fitted into mortise already cut. See C, Fig. 5.

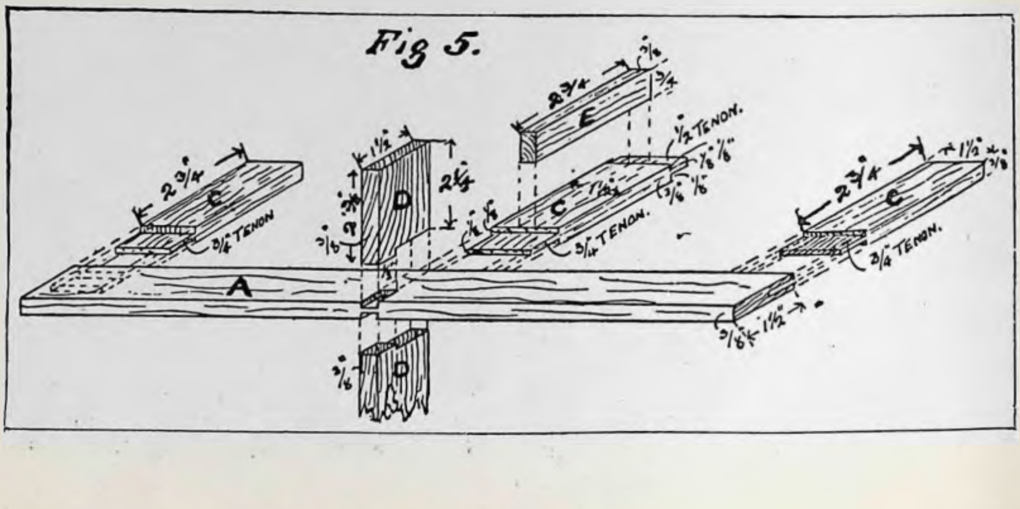
Cut two pieces 4½ in. by 1¾ in. by ½ in.; plane both faces, edges and shoot both ends square, finished size being 4 in. by 1½ in. by ⅜ in.; cut tenon ¾ in. one end, same as before, and a tenon the other end only ½ in. long. See centre pieces, Fig. 5.

These pieces can now be glued together, the piece with tenon either end being in the centre. When glued this frame must be laid flat, with a board on top of same, to save twisting, and put in a safe place until required for fitting to remainder.

Now cut 3 pieces 2½ in. by 1¾ in. by ½ in., plane both faces, edges and shoot both ends square, finished size being 2⅜ in. by 1½ in. by ⅜ in., keeping face edge to the front. Remove a piece from one corner of each 1 in. by ⅛ in., leaving a piece projecting, one end of the three pieces ½ in. by ⅛ in. by ⅜ in., the other end being square. Cut one piece same as before, but with a corner removed from each end, which is the division for the middle drawers, as is let in to both the top and bottom rails.

Next cut four pieces, finished size being 2¾ in. by ⅜ in. by ¾ in., as in E, Fig. 5. Taking the other 18 in. long strip, the finished size being 16⅜ in. by 1½ in. by ⅜ in., and has to be cut

Fig 5.



the same as the first, only has two mortises instead of one in the centre. As there are two divisions to be fitted to same, so we mark off from one end, 5⅝ in., ⅜ in., 5⅛ in., ⅜ in., and 5⅝ in. In cutting the three mortises it will be noticed by Fig. 1 that there is one on one side in the centre, to correspond with the rail above, and two below; all three are cut exactly the same as before, including the 1½ in. by ⅛ in. mortises at each end and centre.

Next cut a strip 18 in. by 1 in. by ½ in., plane both faces, edges and shoot both ends square, finished size being 16⅜ in. by ¾ in. by ⅜ in., on the face side and in the centre. Cut a groove ⅜ in. deep by ⅜ in. wide across same

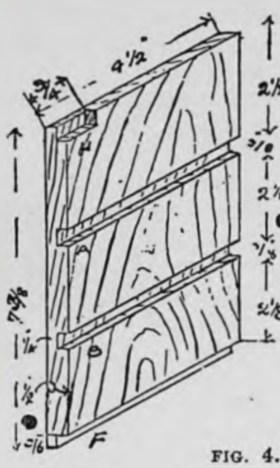
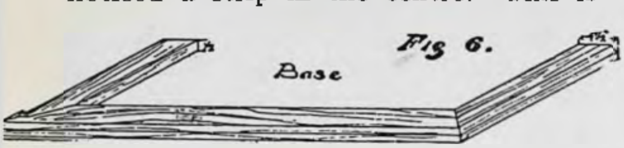


FIG. 4.

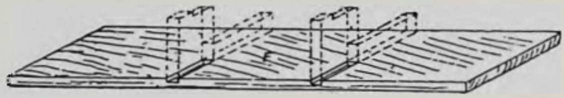
to take the square end of the piece, D, Fig. 5. This strip is fitted at H, Fig. 1.

In the back view, Fig. 2, will be noticed a strip in the centre. This is



7⅞ in. long by 2 in. wide, and ⅜ in. thick, and has two mortises cut to take the ½ in. tenons of the centre runners. To find the position of these mark off from the top 2⅝ in., ⅛ in., 2⅜ in., and ⅛ in. These mortises are 1½ in. long by ⅛ in. wide, and go right through the piece. Cut a board 16⅜ in. by 4¼ in. by ⅜ in., finished size and from one end mark off 5⅝ in., ⅜ in., 5⅛ in., ⅜ in., 5⅝ in. This gives us the position of the two grooves, which are 1½ in. by ⅜ in. by ⅛ in., and are cut as before. See Fig. 7.

The next thing is the base, Fig. 6. This is made up of three pieces of wood, one of which is 1½ in. wide by ½ in. thick by 1 ft. 4⅞ in. long, finished size,



and two pieces 5 in. by 1½ in. by ⅜ in. finished size. These three pieces have the edges bevelled the same as the top, and are mitred at the corners.

Little need be said as to fitting, as the drawings show clearly the way in which the pieces are put together. Glue alone should be used, and only a brad where necessary, and then only use the finest. The pieces, E, are glued to C. The strip, H, fits in the two pockets, H,H.

A piece, 1 in. wide by ½ in. thick, should be glued, and screwed to underneath side of top ¼ in. from back edges, and cut to fit between sides. To this the top edge of back boards are fixed, and is shown by dotted lines, Fig. 2. The top is secured by screws and glue to the two sides, the back edge being flush, the bottom or base pieces being secured in the same way. The tenons which project beyond the centre strip in back should be cut off flush. The edges of this strip should also be bevelled. Any ¼ in. or $^3/_{16}$ in. pieces of wood will be suitable for the back. Seven wood knobs will be required for the drawers.—*Hobbies.*

The Aeronautical Society of Great Britain has recently acquired a plot of experimental ground, which measures about one-half a mile square. Although the greater part of it is level, a certain section contains several steep mounds, about 50 ft. in height, which are well adapted for experiments in gliding flight and the testing of new models. Ultimately, a well-equipped laboratory is to be erected, containing a whirling table and other experimental plant. The society is by no means a new one, having been in existence over fifty years.

INTERIOR ELECTRIC LIGHT WIRING—Part V

GEORGE J. KIRCHGASSER, E.E.

FLEXIBLE CONDUIT AND ARMORED CABLE

Flexible conduit, as was shown in Fig. 39, Part IV, consists of galvanized steel strips wound in such a manner and locked so as to give protection to the wires and also to be flexible. Greenfield, Sterling and Flexsteel are the three makes of flexible metal conduit appearing on the approved list of the Underwriters National Electrical Association. The Sprague Electric Company, which manufactures Greenfield conduit, has two kinds, one made of a single strip of galvanized steel spirally wound and gasketed, and one of two separate strips with a gasket between. This latter type is somewhat more flexible than the single strip and is recommended for wiring existing buildings where this quality is at a premium. The makers advise the single strip type for wiring new buildings. Their appearance is practically the same.

Flexible conduit and armored conductor or cable are adapted for use where there are many bends, offsets, etc. In wiring buildings erected a number of years ago many difficulties are encountered, straight runs being usually blocked by some protruding beam or other timber. But with flexible conduit or cable fishing around and over these projections is sometimes possible. Less flooring and partitions need be ripped up and a fireproof, mechanically secure job is also assured. The flexible conduit and armored cable adjust themselves easily to the contour of the surface wired, and no time or apparatus is necessary for the bending of these conduits. For exposed wiring as, for instance, on the ceiling the rigid conduit looks better as it can be better supported by pipe straps. The flexible type would loop slightly between each support.

As with rigid conduit, the flexible conduit, with all switch, outlet and junction boxes is installed as a complete system before the wires are fished into place. We found rigid conduit commercially in 10 ft. lengths, while flexible conduit comes in coils averaging 50 to 100 ft. in lengths. This feature makes it suitable for long runs, as for feeders, risers, etc.

As seen from Fig. 50 the armored conductor or cable is practically of the same appearance as flexible conduit. The wires are already inserted in the armor so that the job of fishing in the conduit and the wires is done in one operation. The armor consists of concave and convex steel strips (galvanized) wound around the conductors with a gasket between the strips. A filler is used between the second braid of the double braid rubber covered wire, which is used, and the armor.

Both flexible conduit and armored cable must be run continuously from outlet to outlet, or other terminal, and the metal securely held by the fittings, as it is just as important to ground these systems as a rigid conduit system, as mentioned in Part IV. The same methods of grounding can be employed. It is important to provide proper terminal fittings so that the insulation of the wires will not be damaged by sharp edges of the conduit or armor. All junction, switch and outlet boxes must be located so as to be accessible at any time. With a two-wire lighting circuit on an alternating current system the both wires must be run in the same conduit to prevent induction trouble as has also been explained in relation to rigid conduit in a previous installment. It would not be practicable to use two single armored conductors, but twin would be satisfactory.

Many fittings for use with flexible conduit and armored cable have come into use, as couplings, box connectors, special boxes, etc. Where entering a box one method of securing the metal is shown in Fig. 51. The box connector is all in one and is the only fitting necessary. Outlet boxes as used for rigid conduit can be used, the knockouts, shown by the dotted circles, being removed wherever a conduit entrance is to be made. Fig. 52 is a cross-sectional view of a galvanized stamped steel connector on which a nut and screw arrangement is used to clamp the metal of the conduit or cable. The

FIG. 50

TWIN ARMORED CONDUCTOR

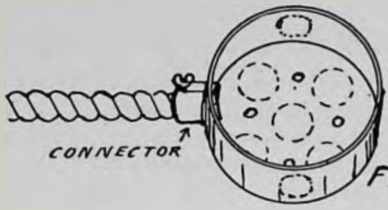


FIG. 51.

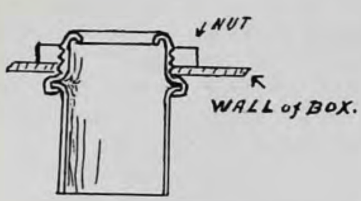


FIG. 52 BOX CONNECTOR.

CONDUIT STRAP

FIG. 53.

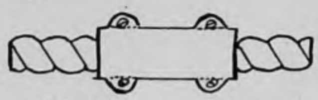


FIG. 54. COUPLING.

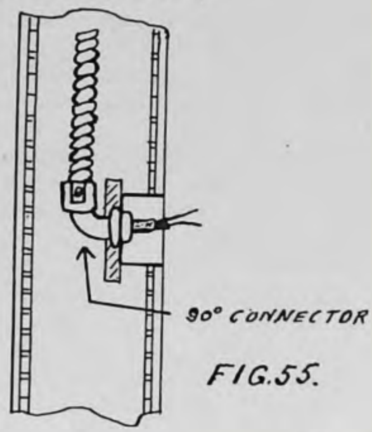


FIG. 55.

nut is used to secure the connector to the box where passing through the hole so that the metallic circuit will be complete and the effectual grounding possible.

Pipe or conduit straps are used to support the conduit or cable to the surface wires, and are simply strips stamped out of sheet iron, tinned. One is represented in Fig. 53.

The names Armored Conductors and Armored Cable are used indiscriminately. Cable really refers to more than one wire while we have on the market, although not used to a great extent, a single conductor, armored. Dropping the word cable and using the terms Armored Conductor or Conductors would be more correct. However, as most of the product found in practice is twin, as seen in the figure, not much difficulty is liable to arise through the use of the word cable. Three conductors are also employed to some extent. The smaller sizes of wire, Nos. 14, 12, and 10 are solid conductors; but above this, as Nos. 8, 6, etc., the solid wire would be too stiff, so that stranded wire is used for the large sizes.

For use in damp or wet places, as packing houses, breweries, where exposed to the weather, in fireproof buildings during construction or to be concealed later, a lead-covered armored cable is used. The lead sheath, which is about 1/32 of an in. thick, is between the outer braid of the wires and the steel armor. This is to proof the cable against moisture. Care must be exerted in stripping the armor from the cable (the ordinary or the lead-covered) when cutting into lengths so that the insulation of the wires is not injured. Hack saws can be used to cut the armor, although there are patent devices which do the work neatly and in quick time.

Fig. 55 is a 90° angle box connector for use with armored cable or flexible conduit. Feeding to a side outlet in a narrow partition the space prohibits a large enough bend to come into the box from the back and entering with a regular box connector. A forced bend of too small a radius will burst out the metal strips. With the connector as shown the conduit or cable can be run straight down and without any trouble enter the box.

There are also in use outlet and junction boxes with which no box connectors are needed to secure the metal of the conduit or cable. The cable or conduit can be run directly into the boxes which have inner clamps, connecting and bushing devices. The advantage is that time is saved and the number of fittings reduced. These outlet boxes as well as any type must be installed so as to come flush with the finished surface of the wall or ceiling as the case may be, and must be supported independently.

In many residences and small mercantile buildings even up to a few years ago, an electrical wiring equipment was not considered as necessary. But now since the increased use of electricity, a building is not considered complete without electrical wiring. The older and existing buildings now want electricity also, and it is in this field that the armored cable is especially well adapted. It is taking the place of much of the fished non-metallic flexible tubing method. An armored cable is easier to pull into place than two wires each separately enclosed in the flexible non-metallic tubing or loom. There is also less chance of injury to the wires when a tight pull is necessary. The armored cable is also considered as giving the same mechanical protection as rigid conduit. With flexible conduit the wires must be fished in after the conduit system has been first completely installed. Armored cable and flexible conduit are used together to a great extent, the conduit being used for the heavier mains and feeders, while the armored cable is used for the branch circuits.

We have now covered all the styles of wiring for interior work that are in use at the present time. There are uses for all of them, but the tendency is for an increased use of the conduit systems which are the best of which we have knowledge. There are, however, conditions or circumstances which make one of the other systems applicable, and if proper care is taken in the installation and afterward in the upkeep no trouble should ensue. The insulation of wires, while good, should not be depended upon to such an extent that wires will be allowed to come in contact with foreign objects or with each other on open wiring systems. In most all buildings no one system is in use but a mixture of many. The basement may be rigid conduit, first floor, concealed knob and tube, and in other portions we may find open wiring and some moulding. For the modern fireproof building only conduit is used.

Size of Wrench to Use on Pipe

A 10 in. wrench is plenty large enough for ½ in. and ¾ in. pipe and fittings. Your fitter simply proves himself wrong when he bursts so many fittings by using too large a wrench. With average fittings and good threads a 10 in. wrench will put home any ½ in. or ¾ in. fitting or pipe tight enough to hold, if you know when the proper point is reached. It does not cut any ice whether or not the threads are up to the shoulder; if the threads in the ell or tee and the threads on the pipe make the correct angle, and allow a strict iron to iron connection, a joint will be tight, no matter whether the fitting screws up two threads or six, and if it is tight made up at two threads and you use a larger wrench, forcing it up to six threads, you will burst the fitting nine times out of ten. The only way I know to tell when the proper point to stop has been reached, is the judgment acquired by the muscular sense of how hard the wrench pulls, backed by an examination of the threads of both ell and pipe before I try to catch the fitting. This sense of fitness comes only with practice. The manufacturer of the Stillson wrenches say: "We recommend a 6 in. Stillson wrench for use on ⅛ in. wire to ½ in. pipe; 8 in. on ⅛ in. wire to ¾ in. pipe, 10 in. to 1 in. pipe, 14 in. to 1½ in. pipe, 18 in. to 2 in. pipe, 24 in. to 2½ in. pipe, 36 in. to 3½ in. pipe, and 48 in. to 5 in. pipe.—*Domestic Engineering.*

The United States has 1,155,480 miles of telegraph lines, an amount about equal to the combined lines of France, Germany and Great Britain. The number of messages transmitted in the United States, however, is but 65,500,000, as against 94,000,000 in Great Britain. In France and Germany the number of messages is 58,000,000 and 52,500,000, respectively. The average cost of messages in this country is 42c, in Great Britain 16c, in Germany 15c, and in France 12c.

FORGING FOR AMATEURS—Part XV

F. W. PUTNAM, B.S.

In the last article I discussed at length the forging hammer, giving a bit of its history and the many uses to which it was put. We are now ready to start in with the discussion of the actual forging of a hammer. Fig. 165 – X shows three styles of small hammers which may be used for riveting or chipping work. You will notice that complete dimensions are given for these and the proportions as indicated will be found to be in good up-to-date practice.

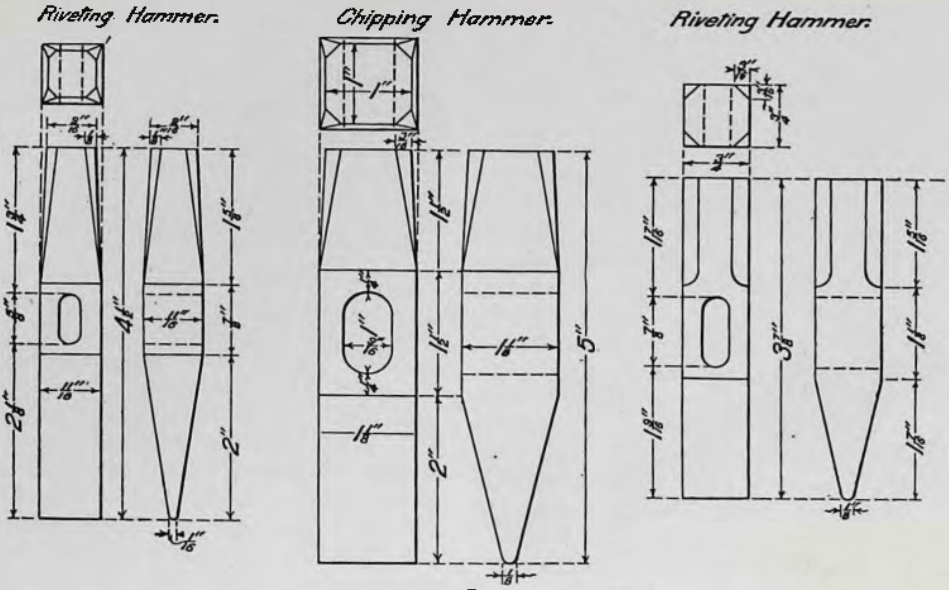


Fig. 165 – X

As a general rule when a hammer is to be forged by hand, the eye is made first. We take a bar of steel of the proper size and convenient length for handling and forge the hammer on one end of this bar, naturally shaping just as much of the hammer as possible before cutting it from the bar.

Let us for the present omit the discussion as to the kinds of steel that should be used for making the different hammers and confine ourselves directly to the forging itself. The hole for the eye is punched in the usual way at the proper distance from the end of the bar, making use of an ordinary punch with a long wood handle. I have given, previous to this, complete directions for the punching of holes so that the reader may look back to the proper article for this special work.

The nose of the punch is made a little smaller but of the same shape as the eye is to finish. Exceeding care must be taken to make this hole perfectly true and straight and at the centre of the bar. If a crooked hole has been punched, it is very difficult and even sometimes impossible to straighten out a crooked hole. After the eye has been punched, the sides of the stock are left naturally somewhat bulging. A pin known as a drift pin, and shown in Fig. 166, is driven into the eye, and kept there while the bulge is hammered out. In this way the true shape of the eye is kept while the stock is being hammered.

This drift pin, is, of course, made of tool steel, and, as the figure indicates, tapers from near the centre toward each end, one being somewhat smaller than the other. At the centre of the pin, the cross section should be the same shape and size as the eye is to be in the hammer. The bar is heated to an even red heat and a drift pin driven tightly into the hole, the bulge being forged down in exactly the same

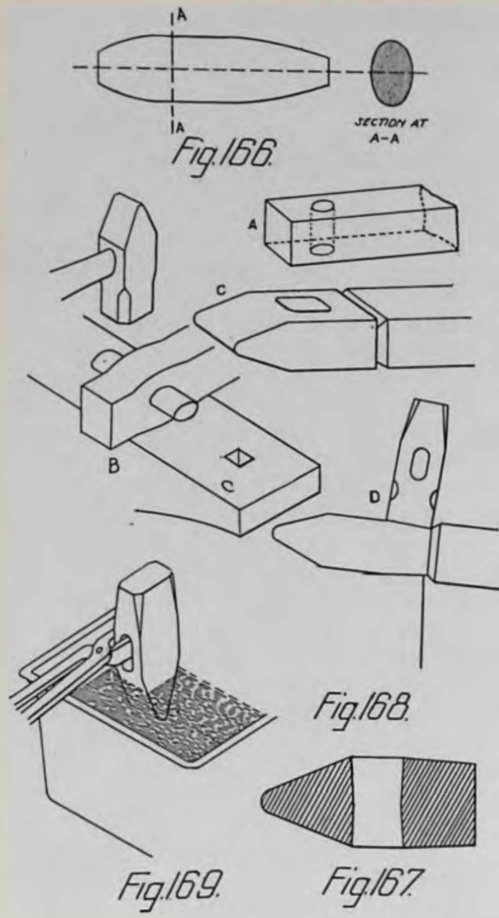


Fig. 166. Fig. 168. Fig. 169. Fig. 167.

way as is indicated at B, Fig. 168. Now this drift pin naturally receives heat from the hammer bar and soon has to be driven out and cooled. Be very particular never to heat the bar while this drift pin is in the hole, and always use this pin whenever there is the slightest danger of knocking the eye out of true or shape. At this point I will simply say that the steel which is used for hammers and like tools is invariably of a lower temperature, by which I mean contains less carbon than that used for lathe tools.

If you have ever examined the eye of a new hammer before a handle has been attached, you will have noticed that it is not of uniform size throughout, being larger at the ends and tapering quite a bit toward the centre, as is shown in Fig. 167. This figure shows a section of a hammer cut through the centre of the eye. The object of this double-tapered hole is to permit the hammer handle to be driven in tightly upon one end and then wedged against the sides of the eye by means of wedges which are driven in the end of the handle. This method of fastening holes by hammering firmly in place leaves no chance for the head to work up or down.

RIVETING HAMMER

A hammer which can be used as a cross pean, or a regular blacksmith's or riveting hammer, is shown at C, in Fig. 168. This figure illustrates very clearly, I think, the various steps in the process of forging such hammers. The eye is first forged as is shown at A. The pean end is next drawn out and shaped and a cut started at the exact point where the end of the hammer is to come, as shown at C, the drift pin being, of course, used as shown at B, in forging the metal around the eye.

After this part of the work has been completed, the other end of the hammer is then forged into shape, using a set hammer for getting the proper shape and angle to the side faces as shown at D. This hammer may be very nearly finished before it is cut off from the bar. When this is done, a hot chisel should be used in order to leave the end of the hammer as nearly square and even as possible. The end of the hammer must then be squared up and all the faces trued up after which the hammer is tempered. In tempering the hammer the whole of it must be heated in a slow fire in order to bring it to an even hardening heat. The hammer is held with a pair of tongs which should grasp the side of the hammer, one jaw being usually inserted through the eye. Both ends of this hammer should be tempered, one end being hardened at a time. The small end is usually hardened first by cooling as is shown in Fig. 169. Immediately after this end has been cooled, the hammer is turned over and the large end dipped in the water and hardened. While the large end is cooling, the small one is quickly polished and the proper temper color watched for. A dark brown scale is the color to be looked for at the end of the hammer, upon which appearance, the hammer is again reversed, bringing the large end above and the pean end in the water. The first end is then quickly polished and tempered in exactly the same way as the small end. If we can harden the large end properly before the temper color appears on the small end, we can take the hammer completely out of the water and polish the large end also, watching for the color on both ends at the same time. Just as soon as one end shows the proper color, it must immediately be dipped in water, following with the other end as soon as the proper color appears there. Be very careful never to cool the eye while it is still red hot. There are certain classes of work requiring hammering whose faces must be made very hard, and in these cases the color given above would not be satisfactory, but for ordinary use the temper now just described will be found perfectly satisfactory.

BALL PEAN HAMMER

In D, Fig. 170, is shown a ball pean hammer much used by blacksmiths

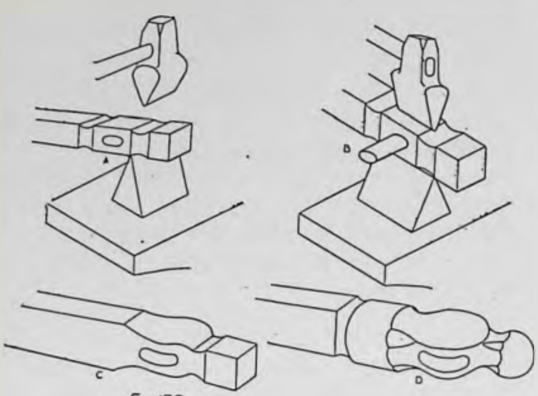


Fig 170

and machinists alike. The forging of this hammer also is started by punching the eye. The hammer is roughed out by the use of two fullers as is shown in A, Fig. 170. Care should be taken to select the size of stock used such that it will easily round up to form the large end of the hammer. After the metal has been roughed out as is shown at A, the metal around the eye is to be spread out sideways, using again two fullers as is shown at B, Fig. 170, the long axes of the fullers and the hammer now being parallel instead of at right angles as before. After this metal has been spread out by the fullers, a set hammer is used for finishing. This should leave the forging of the shape shown at C, Fig. 170.

The next step is to start the rounding and shaping of the bar and is forged as closely as possible to the finished shape. After this has been done, a cut is made with a hot chisel in the bar where the face of the hammer is to come, after which the large end is rounded up, leaving the hammer of the shape shown in D. The parts next to the eye are called the necks of the hammer and these are next smoothed and finished with fullers of the proper size. Some hammers are made with these necks octagonal in section, the more common shape, and others perfectly round. The hammer is next to be smoothed up as much as possible and finally cut from the bar and the face forged smooth and true. Both ends must finally be ground to exact shape before the tempering is done. The method of tempering is exactly the same as just described for tempering the riveting hammer. It is easily possible, since the invention of the steam hammer, to make very easily a ball pean hammer, with very little hand work, only when the steam hammer is used, round bars of steel are substituted for use in place of the fullers.

SLEDGES

Our next topic is sledges, which are made and tempered in about the same way as riveting hammers. They are used almost entirely for heavy work and so are usually forged and finished under the steam hammer. This being the case, I shall wait to take up the forging of sledges until I have described the use of steam hammers in one of the following articles.

HOT CHISEL

Fig. 171 shows the processes through which the stock has to go in the forging of a hot chisel. The eye is, of course, punched out first, after which the blade is started by the making of two fuller cuts as shown. The end is next drawn down as indicated by the dotted lines. When this is being done, the steel should be kept at a fairly high heat, so that the metal will not spread after it is drawn down to a comparatively fine edge. The other end, or head, is shaped

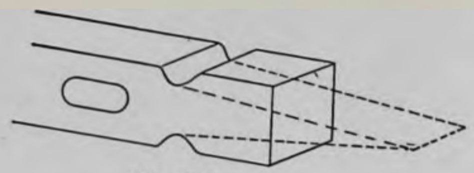


Fig. 171.

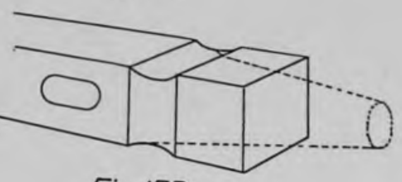


Fig. 172.

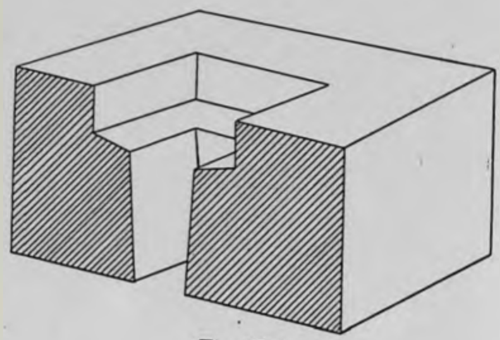


Fig. 173.

into the chisel and cut from the bar in precisely the same way that the riveting hammer was made. The cutting edge of this chisel should be tempered about the same as that of the cold chisel which I will now take up.

BLACKSMITHS' COLD CHISEL

This tool is forged in about the same way as a cross pean hammer. The end must be drawn out much longer and thinner, the thin edge being made parallel with the eye instead of at right angles to it. The only part of this chisel that is tempered is the cutting edge. The temper must be drawn to show a bluish scale which is just tinged a trifle with purple. Never harden the head of this chisel, because this would then probably cause the end to chip off when in use and flying chips from a blacksmith's hammer are liable to do serious damage should they enter the eye or other sensitive part, and thus cause a serious accident. The faces of the anvil and hammer dies are flat and parallel and so it is not possible to easily finish smoothly between swages. A special tool which is especially tapered, frequently is used for aiding the drawing out of the blade of a cold chisel.

HARDIES

Hardies, illustrations of which appeared in one of the earlier numbers, should be started by first drawing down the steel. This steel should be drawn down to the right size to fit the hardy hole in the anvil. After this end has been smoothed up, the piece is at once cut from the bar. This is then heated and the steel placed in the hardie hole in anvil and the piece driven down into the hole and against the face of the anvil in order to form a good square shoulder between the steel and the head of the hardie. After the shoulder has been formed, the blade is worked down by using two fullers in the same way that the cold chisel blade was drawn down. The cutting edge must, of course, be tempered and is given about the same temper as a cold chisel.

SWAGES

Swages may be made in a block similar to one used for the flatter. The swage is first upset in the block, the crease being formed the next thing. This crease is usually made with a fuller or else a bar of round stock the proper size.

FULLERS

Fullers are made in exactly the same way as swages. These tools just described together with the blacksmith's punches, set hammers and flatters are very usually upset and forged under the steam hammer, using the die or swage blocks, and I will therefore take these up in more detail later.

BLACKSMITHS' PUNCHES

The method of forging a blacksmith's punch is clearly shown in Fig. 172. After the eye has been forged, the remainder of the work is started in the same manner as in the case of the hot chisel, except that the fuller cuts are made on four sides instead of two, after which the end is drawn out to the shape shown by the dotted lines. This tool is tempered the same as the cold chisel.

SET HAMMERS AND FLATTERS

The set hammer is so simple in its forging that no directions should be necessary for the shaping of it. Only the face of it is to be tempered, a dark brown or purple color being used for this.

Flatters are usually made by upsetting the end of a small bar, the upset part being used to form the wide face. Another method is to use a bar large enough to form the face, the head or finger being afterwards drawn down. Here the eye is not punched until after the face has been made. The face should be tempered to a fairly deep blue. When many of these flatters are to be made, a swage block, shown in Fig. 173, is used. This figure shows only half of the block, the remaining half being cut away in order to show the shape of hole, the size of the finished flatter.

If such a block is used, the stock is first cut to the proper length and placed in the hole and upset.

Our next article will take up a set of miscellaneous exercises which are based partly on the work which has just been described. At this point I wish to give a concise set of directions which I believe will be of great value to the amateur especially in the hardening and annealing of steel.

RULE 1. *How to Anneal Tool Steel Containing Hard and Soft Spots.*—It frequently happens that the die maker will cut from a bar a piece of stock and afterwards find that he cannot plane it, owing to hard spots in the steel. These can be removed by first removing the scale and then heating in a slow fire to the lowest possible degree at which the steel will harden. Care must of course be taken that the piece is heated evenly all over. Quench in a bath of brine or fresh water, whichever is at hand, withdrawing it from the bath before it becomes thoroughly cold, or better still when the vibration, which can be easily felt by the operator, is apparently about to leave the stock. It will be found that a drop of water placed upon the piece will show a temperature of 212° Fahrenheit. Then you must reheat the part as before to a dark red heat. It is not at all necessary to place in a bath of charcoal or lime, but it may be put in any convenient dry place until cold. When this has become cold, it will be found that the hard spots have completely disappeared and the steel is exactly like soft machinery steel.

RULE 2. *A Method of Quick Annealing.*—Heat as in Rule 1. Withdraw quickly from the fire and plunge the piece in hot soap-suds or soda water.

RULE 3. *A Cold Water Anneal.*—Heat as in Rule 1. Quickly withdraw same from the fire and allow the piece to cool in the air to a slow heat, or until a blood-red color can be seen in the dark. Next plunge the piece into fresh water and withdraw same quickly, leaving intervals of a few seconds between plunges. Repeat the operation until the stock is thoroughly cold.

RULE 4. *How to Anneal a Hardened Piece.*—Never heat a hardened piece of steel as hot to anneal it as is necessary to harden it and never allow it to soak or lay in the fire after the desired heat has been reached, but immediately withdraw it and cover it with ashes or charcoal in order to prevent scale. Never place a hardened milling cutter tap or any other tool suddenly in a hot fire, but rather allow them to heat slowly, since sudden and intense heat has been frequently known to crack tools placed in the fire in this manner.

RULE 5. *How to Anneal High Speed Steel.*—Good results may be obtained by packing the stock in a cast iron box, covering it with cast iron chips or sifted coal ashes. Heat it in a furnace to a bright lemon color and allow same to stay at that temperature for a good eight hours. Then allow it to cool with the furnace gradually, but in no case should the air be permitted to come in contact with it until the stock is cold.

RULE 6. A very important feature referring to the hardening and tempering of carbon tool steels is the different heating appliances used. For heating a piece of steel and hardening, it is very essential that a uniform temperature exists in the steel in order to obtain uniform results, and it becomes advisable therefore that appliances should be made suitable for this work. Modern forging practice suggests that the tempering temperature of many shall be fitted out with the very best appliances in order to obtain the uniform results out of tool steels. It is just as essential in the economical condition of business to have this department as well as any other receive the attention and expenditure of a few hundred dollars towards benefiting this equipment and be in line with the advanced conditions, as is always aimed for in the main part of the factory.

In the first place, this department must have excellent light, so that no one is deceived in the color which shows the temperature of the steel. The open fire or forge is very fast becoming now a thing of the past, especially in shops where fine tools are made and gas furnaces, mufflers and lead baths have taken its place. It is usually considered that the lead bath for the heating of small tools, at least, is much more inexpensive than any other fire. It can be easily erected, at a nominal cost, requires very little fuel and best of all heats evenly. Of course, care must be taken to avoid heating the lead too hot. Charcoal which has been broken to the size of chestnuts and not crushed to coal dust is placed on the surface of the lead to prevent its oxidizing and sticking to the material. Pure lead should be used, under no condition allowing any Babbitt or other like metal to get to it, as even an ounce of Babbitt will render utterly useless a hundred pounds of lead for heating steel.

RULE 7. *How to Harden Blanking Dies.*—Use the lead bath if possible. Turn the die at frequent intervals with a shovel until it has reached the same temperature as the lead. Do not allow it to soak, but withdraw it immediately from the fire after the desired heat is reached and dip into water. Keep up a gentle motion backwards and forwards so as to allow the water to pass through the holes which have been cut in the die. Do not wait for the vibrations to cease, but at once withdraw the piece from the water when you think the cutting edges have been hardened sufficiently and immerse same quickly in a tank of oil. Do not allow the die to cool entirely in the oil, but continue drying it, letting fall a few drops of water on the face.

If the water boils but does not leave the piece directly, the die is safe and can be taken out. Wipe it off with a piece of rag and then draw to suit its requirements.

This method of hardening a blanking die will certainly prevent leaking between holes, will prevent the die from shrinking to a very great extent and also prevents warping. Care must be taken in the selection of tongs used while hardening these dies, for the heavier they are, the less liable the operator is to feel the vibration which is conveyed to him through the tongs while the die is in the water. This is a very essential point in this work and one which will of course require considerable practice before one can expect to become adept. Sectional dies for trimming forgings are usually hardened in the same manner as is a blanking die and with good results. The stopping up or plugging of screw holes in a blanking die is never necessary when hardened as directed in this rule, and I believe it is not practical to even put iron screws into the holes, because the contraction of the iron and steel while cooling is not equal.

RULE 8. How to harden thin blanking dies, for cutting light stock, which are hardened and afterwards riveted or screwed on a heavier backing of machinery steel or iron. Harden by heating to the desired temperature. Withdraw from the fire and rub cyanide of potassium all over the face or back of the piece, after which the die is to be replaced in the fire and reheated as before. Plunge into a bath of warm oil and then withdraw, until the piece has reached the same temperature as the oil. The die will be hard and does not require drawing, owing to its great toughness. Rub all over with a stiff wire brush or file card to clean the die, and we shall find that the piece has not warped out of shape and the pattern if pushed up through the back of the die will come flush with the cutting edge. This method obviates the necessity of drawing the temper to a degree such that the edge may be filed to fit the pattern.

I believe that the advantage of this rule will be immediately appreciated by a great number of mechanics who may have at some time an occasion to give it a trial. Reamers, finger gauges, back gauges, and numerous other small pieces which are more or less liable to warp when dipped in water, may be treated satisfactorily in this manner.

DESIGN AND CONSTRUCTION OF A WIRELESS TELEGRAPH STATION
1,000 Mile Receiving Station

EDWARD H. GUILFORD

There are today numerous experimenters who desire to own a thoroughly up-to-date and efficient wireless station, but who do not have the means to purchase the necessary equipment ready to install. The author will endeavor to describe in a series of articles the complete construction of such a station, at the same time setting forth the functions of the various instruments. The station, if constructed according to design, should be capable of receiving a 5 kw. station, transmitting at a distance of 500 miles, and to maintain communication over a distance of 50 miles.

I shall begin with instruments of the receiving station, the construction of the tuning coil coming first.

At the present time the tuning coil is used in the modern station merely to "listen in" on, but not to receive messages, as interfering stations cannot be tuned out by it. To tune out all interference either a "doughnut" transformer or an oscillation transformer must be used.

The tuning coil is a helix of copper wire wound with its turns very close together upon some form, such as a cardboard or wooden cylinder. The wire may be either bare or insulated, but if bare wire is used each turn must be insulated from the neighboring turn on the cylinder. Two movable contacts are used to vary the number of turns of wire used. Perhaps I can make the use of the tuning coil clearer by a short explanation. The length of a Hertzian wave is computed approximately by the following formula (I say approximately because, to determine the exact length, there are other things to be considered, such as the frequency of vibration):

$$\text{Wave Length} = 2 \times 3.1416 \times 86000 \times \sqrt{L \times C}$$

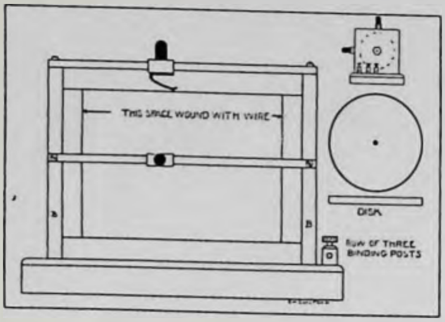
where L is the amount of inductance in the tuning coil, and C is the amount of capacity in the circuit. Now it will be seen that L and C are the only quantities that can be varied in this equation, consequently, by making either L or C larger or smaller, a long or short wave may be received. Since no two stations send out exactly the same length of wave, some means must be had of adjusting the inductance or capacity of the receiving instruments so that the square root of their product will equal the square root of the product of the inductance and capacity of the sending instruments. Hence the sliders on the tuning coil are used to adjust the inductance, while the capacity is varied by means of adjustable condensers which I will describe later.

I have designed a tuning coil which will receive waves as long as 2,500 meters which will be more than sufficient, since the usual wave length is from 400 to 800 meters.

The form upon which the wire is wound is made of cardboard of double thickness and cut to such a size that when bent into a cylinder it measures 8 in. in length and 6 in. in diameter with an overlap of 1 in. The cylinder is formed by wrapping the cardboard around two wooden disks 6 in. in diameter and ¼ in. thick. (See drawing of tuning coil.) The overlap is then glued together and string is wrapped around the cylinder to hold it in position while drying. The square ends of the tuning coil should be made of mahogany or some similar wood which will finish nicely, although any non-conducting material will do. When the cardboard cylinder is dry the wooden disks should be glued in the ends of it, after boring a ⅛ in. hole in the centre of each disk. The cylinder should now be wound with the copper wire. If bare wire is used it can best be done on a screw-cutting lathe, for by means of the screw-cutting attachment each turn of wire can be accurately spaced from its neighbor. If covered wire is used a little frame can be made to hold the cylinder while it is revolved and the wire wound on by hand. In either case while winding keep the cylinder coated with shellac so that the wire will be firmly held in place. About 150 to 200 ft. of wire will be required, the exact length depending upon the distance between each turn of wire. No. 22 B. & S. gauge is about the best size.

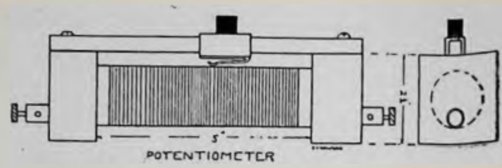
The slider rods (there are two of them) are made from square brass rod 8½ in. long and ¼ in. square. (See drawing of tuning coil.) They are fastened to the ends of the tuning coil by means of a screw through either end. The movable contacts or sliders are made from short pieces of square brass tubing which will easily fit on the slider rods. The contacts are made from spring brass and are soldered to the sliders. It is important that the contacts should touch but one wire at a time, so a small dent should be punched in the end of each spring contact in such a manner that it will project down upon the wire.

The tuning coil may now be assembled.



Bore a hole in the centre of each square wooden end and then by thrusting a ⅛ in. rod through a square end, the cylinder, and the other square end the whole may be held together by screwing a nut on each end of the rod. The slider rods can then be screwed on the square ends, one on top of the coil and one on the side. The coil may now be set on a base similar to the one in the illustration. The three binding posts are connected one to each slider and one to one end of the wire on the coil.

The potentiometer is a resistance used to vary the E.M.F. going through the phones and the detector. It is constructed in the same manner as the tuningc oil, with the following differences: only one slider is necessary, and german silver resistance wire is used in place of the copper wire. The cylinder upon which the wire is wound is of wood, 1½ in. in diameter and 5 in. long. A binding post is connected to each end



of the wire wound on the coil, and a third binding post is connected to the slider. About 50 to 75 ft. of wire will

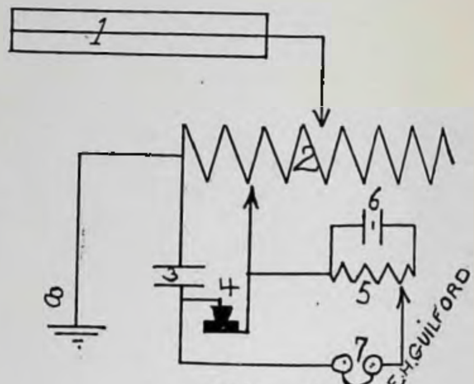
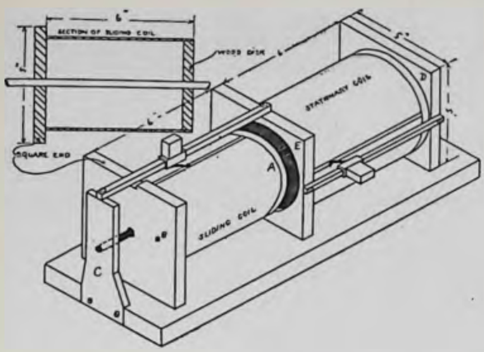


Fig. A

be required. No. 28 single cotton-covered wire is the best.

The zincite-bornite detector used is the most sensitive known. Its action will be readily understood by referring to wiring diagram A and normally a small current is flowing from the battery through the detector and the telephones. When a signal composed of a series of waves passes from the aerial to the ground through the tuning coil it induces another train of oscillations in the circuit composed of the tuning coil, the condenser, and the detector. Now the detector has the peculiar property of becoming a better conductor when the oscillations pass through it, and so, each time a series of waves pass through it, more current also passes through it, and the signal is thus heard in the telephones. In the recent issues of this magazine there have been several articles on the construction of detectors, so there is no need of going into that detail. Let it be sufficient to say that either article describes an up-to-date form of the detector, and either form will do.

For the interference preventer I recommend the "doughnut" transformer described in the November issue of this magazine, but for the sake



of variety I will describe another type of oscillation transformer which is used by a great many operators to shut out interfering stations. The drawing shows the type of instrument to which I refer. It consists of two separate cylinders of wire so constructed that one will just slide inside of the other without friction. The inside diameter of the stationary coil is 4 in., and the outside diameter of the movable coil is 3½ in. Both cylinders are 4 in. long. The coils are made in the same manner as the tuning coil. No. 22 copper wire is used, either bare or single cotton-covered. The smaller coil slides back and forth upon the rod through its centre. This rod runs from the block C to the block D. The transformer is connected up as follows: Four binding posts are fastened on the base of the instrument, one being wired to each variable contact, one to the end of the wire (wound on the movable coil) at A, and one to the wire on the stationary coil at the end, E of the coil. The wire which connects the end, A, to the binding post should be brought through the inside of the cylinder to the hole, B, and then connected by means of a flexible wire to the binding post.

The action of this transformer is almost the same as the tuning coil. Oscillations passing through the primary coil from the aerial to the ground induce oscillations in the secondary circuit composed of the secondary coil, the condenser and the detector. By varying the coupling, that is, the distance between the secondary and primary coils, very sharp tuning may be obtained.

Probably the most difficult to make of all the receiving instruments is the variable condenser. The condenser consists of a number of fixed metal plates built up in such a way that each plate is separated by a layer of insulating material. A second set of metal plates fastened on an axle are so arranged that they may be rotated and swung into the air spaces between the stationary plates, without however, touching any of the stationary plates. The maximum effect is obtained when the rotary plates are entirely inside the stationary plates. The electrostatic capacity of a condenser depends upon the area of the metal plates, and the kind and thickness of material between them. Thus by varying the area of the plates exposed to one another and allowing the other quantities to remain the same, the capacity of the instrument is changed. It will be seen that the above action is that which takes place when the movable plates are rotated. The rotary plates are *always* insulated from the stationary plates.

The stock required for both movable and stationary plates is sheet brass about 1/32 in. thick. It will be found that brass of this thickness may be easily cut with the tin shears, while if thinner brass is used it is difficult to keep from bending out of shape. For the condenser sixteen movable and seventeen stationary plates will be required. The stationary plates are easily made as they are of rectangular shape like Fig. 3. The neatest way of cutting them is by means of a power metal saw, but they may be cut by hand. When seventeen stationary plates (Fig. 3) have been cut a wooden form should be made (Fig. 2) in which to hold the plates while the holes, A, B, C (Fig. 3) are drilled. These holes are ⅛ in. in diameter. Two plates like Fig. 4 should now be made to serve

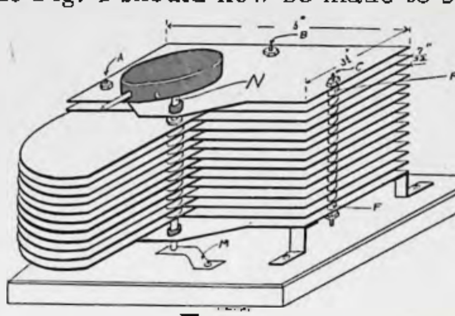


FIG. 1

as bearings for the axle upon which the rotary plates are fastened. This axle is shown in Fig. 7 and in Fig. 1. The holes, A, B, C (Fig. 4), should correspond in size and position to the holes, A, B, C, of Fig. 3. The hole, D (Fig. 4) is ⅜ in. in diameter. A number of spacers (Fig. 5) should now be

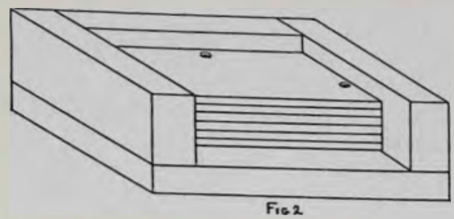


Fig 2

made, by cutting off lengths of brass pipe which has thick walls. It is important that these spacers be all of exactly the same length. The method of assembling the stationary plates is as follows: Take three brass rods, A, B, C (Fig. 1), ⅛ in. in diameter and 4 in. long, the ends of which have been threaded, and on one of each end place a nut. Then thrust the rods up through the holes of a plate similar to Fig. 4. Now set the rods and plate upon the table and place the remaining stationary plates upon the rods, taking care that each plate is separated by a set of spacers. The remaining plate similar to Fig. 4 is now put on and nuts are then temporarily screwed on the rods. The sixteen rotary plates (Fig. 6) are cut from the same size of stock as the stationary plates. To drill the hole, D (Fig. 6), the plates should be put in a form built like Fig. 2, but smaller. The diameter of the hole D is ¼ in. The axle (Fig. 7) is made of brass, ¼ in. in diameter. The ends, A and B are turned to ⅛ in. diameter. Fifteen spacers similar to Fig. 5 are made. They should be 3/32 in. long and of such a diameter that they will fit over the largest diameter of the rod, Fig. 7. To assemble the rotary plates, start by screwing two nuts on the end next to A, of the axle, Fig. 7. Then, after fixing the rod in an upright position place the remaining semicircular plates upon the axle, separating them by spacers. The nuts, N, should then be screwed on the rod so that the plates are fastened firmly together. The plates must be trued up until the straight edges are

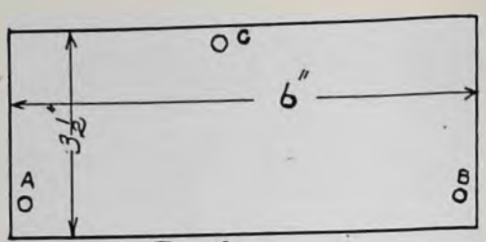


Fig. 3

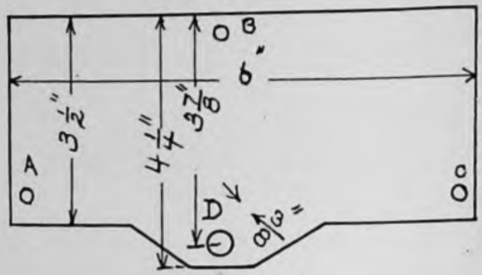


Fig. 4

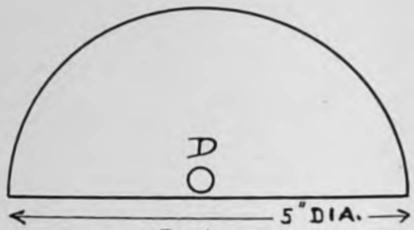


Fig. 6

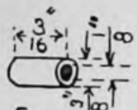


Fig. 5

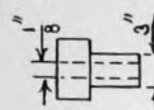


Fig. 8

all parallel. The insulators, Figs. 8 and 9, are turned from hard rubber or fibre. They are intended to fit in the holes, D, of the plate, Fig. 4.

Place the insulators in their position, as shown in Fig. 9, and then set the completed rotary section in the bearing plates. By adjusting the distances, F, Fig. 1, the bearing plates may be so arranged that the rotary plates will turn in between the stationary plates without touching them. Two binding posts might be set on the base of the completed instrument, one being connected to the spring contact at M, Fig. 1, and the other to any of the stationary plates. The handle by which the rotary plates are turned is made of hard rubber, 2 in. in diameter and ½ in. thick. To fasten it to the shaft or axle, bore a 3/16 in. hole half way through the centre

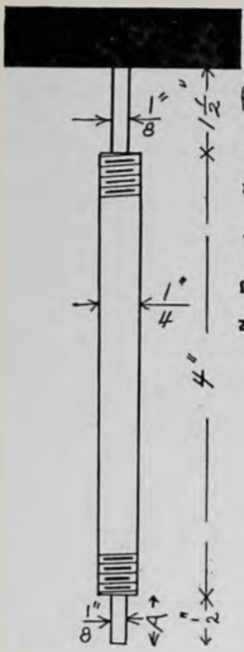


FIG. 7

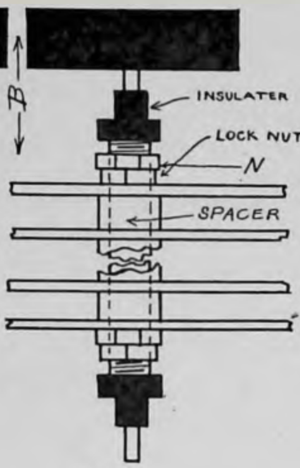
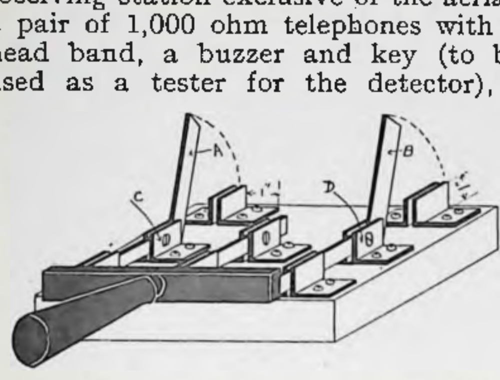


FIG. 9

of the handle and after hammering the end of the shaft square imbed it in the hole by pouring in hot sealing wax.

The aerial switch is used to change the aerial and ground wires from the receiving instruments to the transmitting instruments. The stock used is ⅛ in. brass about 1 in. wide. The two blades, A, B, to which the aerial and ground are attached, are cut in the shape of a broad V. The third blade is used to break the primary circuit of the transmitting instruments so that no spark will occur when the operator is receiving. A distance of at least 2 in. should separate each blade. The handle and base are made of hard rubber.

To complete the equipment of the receiving station exclusive of the aerial, a pair of 1,000 ohm telephones with a head band, a buzzer and key (to be used as a tester for the detector), a triple knife double throw switch, an old dry cell, and a double knife single throw switch must be provided.



The second article of this series will describe the construction of a complete transmitting station, the third article telling of the arrangement of the operating room, the construction of the 100 ft. mast and aerial, and the wiring and setting up of the instruments, while the fourth and last article will be devoted to the care and adjustment of the various instruments and the operation of a wireless telegraph station.

Red wax varnish is useful for painting parts of woodwork, wires of galvanometers and magnets. Small pellets of sealing-wax are shaken up with warm methylated spirits and dissolved. The viscid liquid is applied with a small camel's hair brush in two or more coats, according to the thickness required.

A liquid japan for leather is made as follows: Take four pounds of molasses, half a pound of lamp black, half a pound of sweet oil, and an equal quantity of gum arabic, also half a pint of isinglass. Mix well in 16 pounds of water; apply heat, and when cool add one pint of alcohol.

To blacken light woods, make a preparation of an ounce of borax, dissolved in a quart of water, with two ounces of shellac. The liquid is then to be boiled until a perfect solution is obtained, then stir in two teaspoonfuls of glycerine, and complete by adding a sufficiency of soluble aniline black to completely darken the liquid, which will now be ready for use.

Kinetic energy is the power stored in a moving object which keeps it in motion. By way of illustration, conceive a railway train rushing along a straight, level stretch of track, the train being driven to its power limit. If the source of power, say the steam pressure, is now suddenly removed by closing the throttle, the train will continue to run or "coast," for a long distance, due to its kinetic energy, gradually reducing in speed until the energy is exhausted and the train stops.

HOW TO MAKE A SHOCKING COIL

Most amateurs in electricity like to make a shocking coil at some time or another, chiefly at an early stage of their training. The reason for this is, no doubt, the fact of their being able to feel the force of the electric current. The principal point in making a shocking coil is the winding of the primary and secondary coils round the centre core, and amateurs must first thoroughly grasp the method of winding.

Starting with the base of the instrument, this should be of hard wood, preferably mahogany, planed smooth and finished to 5 in. wide, 12 in. long and ½ in. thick. For ornamental purposes a moulding should be worked all round the top edge.

The core should be made of soft iron wires of No. B. W. G. (neatly made up in the form of a bundle), each wire being cut 4½ in. long. These wires should be inserted in a thin brass tube about ½ in. shorter in length than the wire, and ½ in. in diameter, as in Fig. 1.

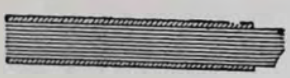


Fig. 1.

Fig. 2.

The best way to do this is to buy a coil of the wire and cut off a number of 4½ in. lengths. Fill the tube with these lengths, finally pushing one or two right in the centre so as to make the core very tight.

Next take some soft fine wire and bind the projecting end of the wires tightly, at the same time pulling the core carefully out and binding until all the wires are covered with the outer binding, as in Fig. 2. This bound core must now be placed in a fire till it is red hot, and then left there till the fire gradually dies out, after which the bundle can be removed. This process softens the core and renders it better fitted for the purpose for which it will be used. The binding wire must then be unwound a little at each end (about ½ in.), and the ends dipped in fluid solder. When this has set, all the wire must be unwound, leaving the soft iron core ready for use. It may possibly be found that the ends require a little filing in order to make the tube fit tightly.

The tube in which the core ultimately works (see A, Figs. 3 and 4) is an ordinary cardboard one, such as is sold at stationers'. The core must fit this tube tightly, and project about ¼ in. at one end.

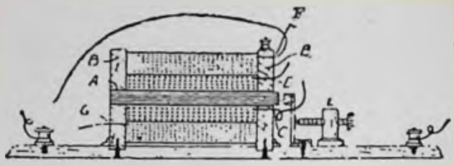


Fig 3.

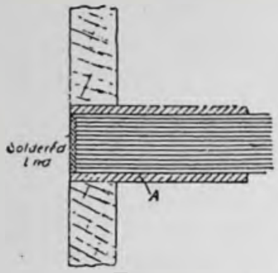


Fig. 4

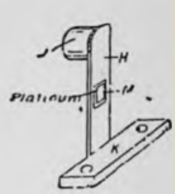


Fig. 6.

The bobbin heads, B, should be of hard wood, ½ or ⅜ in. thick, and about 2½ in. square. They can be fixed to the base in any convenient manner, the form shown in Fig. 3 being perhaps the strongest. Each head must have a central hole to fit the tube, leaving the free end of the core protruding as shown. The top of the head at this part must have two terminals, X and Y (see plan, Fig. 5), to ultimately hold the ends of the primary windings.

The "primary" winding can now be attempted. This is the term given to the first winding next to the core, and the wire used for this is much thicker than the outer or "secondary" winding. This wire is sold by the pound, and about five or six ounces of No. 20 B. W. G. cotton-covered wire will be required so as to make four layers. It is best to soak the wire in melted paraffin wax before use. Another way is to apply the wax thoroughly to each layer whilst it is being wound. In starting to wind the wire, a hole should be bored at C (Fig. 3), for the commencing end, and another at D, for the finished end of the primary wire. It is easier to do the winding before fixing one of the bobbin heads, as several inches can be left at the start and finish for passing through the previously prepared holes in the loose bobbin head.

The wire must be wound evenly and closely, beginning at the free end, then returning to this free end after the second layer has been wound. Do not forget the waxing at each layer, and take care to prevent the last turns in any one layer from sinking down into the space against the bobbin heads. When the primary is wound, cover it with three layers of paraffined paper. The free ends of the wire must now be bared of insulation for about ½ in., and connected to the terminals X and Y (Fig. 5). The secondary coil is made

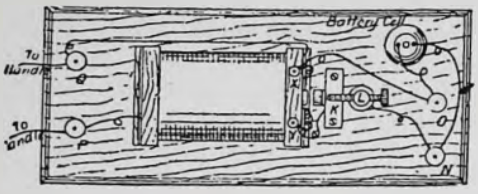


FIG. 5.

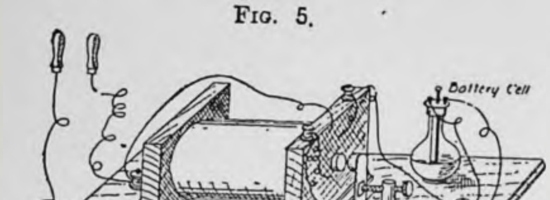


FIG. 7.

of much finer wire, viz., No. 34, about ½ lb. being required, and it should be *silk-covered*. This secondary wiring is wound over the primary coil exactly in the same way as the primary, evenly and closely, and about 6 and 18 in. being brought out at the ends (F and G, Fig. 3). For a neat finish to the coil, thin green velvet or silk should be covered over the outside of the wire. The wiring takes some time to do neatly, and simple devices (called coil winders) which facilitate the process can be bought.

We now come to the contact breaker, shown to a larger scale in Fig. 6. This device consists of an upright plate of thin, springy brass, to the top end of which is fixed (by brass rivets) a soft iron cylindrical piece, J. The lower end is similarly fixed to a stout piece of brass, K, which is secured by brass screws to the baseboard. The hammer piece, J, should be fixed so as to normally lie ¼ in. away from the end of the core. L, Fig. 3, represents an ordinary screw pillar such as is often used in electric bell work. A platinum foil piece, M (see Fig. 6), is soldered to the brass plate, H, just where the screw meets it, and a speck of platinum is soldered on the end of the screw. If platinum foil cannot be obtained, then No. 18 B. W. G. platinum can be soldered on and burred over to form a rivet head for the screw to make contact. All the current has to pass through these contacts, so that great care should be taken to make them perfect.

Four terminals (N, O, P, Q) are required on the baseboard (see Fig. 5), two (N and O) for connections to a battery, and two (P, Q) for the ends of the secondary coil. One of the battery terminals, O, is connected to the brass terminal, X, on top of one of the bobbin heads; the other, N, is connected to the foot of contact pillar, L, while another short piece of wire runs from the foot of the plate, K, to the terminal, Y. The apparatus is now complete with the exception of a couple of handles connected to P and Q, by means of flexible wires, as shown in Fig. 7 and a battery. With respect to the strength of battery necessary for such a coil, it may be mentioned that with one bichromate or dry cell, a not very powerful shock can be felt. By adding fresh cells, the strength of the shocks will be very marked. If dry cells are used, do not use them for long at one time, whilst if bichromate cells are employed take care to lift the metals from the solution when the coil is not in use.

Shocking coils belong to the family of induction coils, which can be roughly divided into two classes: those for shocking or medical purposes, and those for supplying sparks. Shocking coils do not require such care as sparking coils, the latter calling for greater precautions for insulation.

The cores of all shocking coils are made of iron (chiefly wires), and the method of mounting is precisely the same. The primary coils must always be soaked in melted wax as previously explained, solely because the insulation is rather poor. If cotton-covered wire is used for the secondary wire, it must also be covered with wax, but this is not necessary when silk-covered wire is employed.

The paraffin wax should be hard, clear and pale, and, if expense is not objected to, pure beeswax will answer, taking care not to burn the wax when melting it. A good plan is to melt it in boiling water, glue-pot fashion. No provision is made in the foregoing coil for regulating the shock other than by the battery, and if such is required, then the coil should be modified. Regulation can be effected by sliding the secondary coil over the primary, or by having a brass tube covering the core between the paper or cardboard

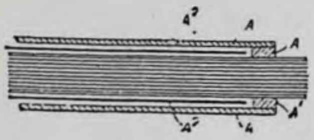


Fig. 8.

tube. Fig. 8 shows the latter arrangement. Here it will be seen that the cardboard tube, A, is much larger, and provided with an inside collar, A1. A brass tube, A2, fits over the wires, with a brass handle for withdrawing. This brass regulation tube slides over the core and checks the current, the greatest effect of the current being felt when the core is fully uncovered—that is, when the tube is fully drawn out. It is thus advisable to employ the original brass tube. By adopting such a regulating device, the apparatus becomes a sort of medical coil.

In the coil illustrated here it is not necessary to employ the terminals X and Y at all; the wires may be run direct to contact the breaker and battery terminal. The use of the terminals, however, prevents any drag on the coil itself.

In our drawings the wires are shown loosely, but in the actual apparatus they should be carefully hidden out of sight on the underside of the baseboard.—*Home Handicrafts.*

Pronunciation of Numerals over the Telephone

For a long time telephone companies have instructed their operators to use the word "O" instead of the numeral, "naught." This is intended to do away with errors. For instance, "Five-double-O-eight" comes more certainly over the telephone than "five thousand and eight" or "fifty-naught-eight." Following this, an effort is being made to identify the digit "three" by trilling the r's. Wherever "three" occurs in a telephone number, the operators in some of the large exchanges now trill the word so that it becomes "thr-r-r-ree." The purpose of this is far from being any affectation, but a laborious effort to identify this numeral at least so that it may not be confused with others. If some method could be devised similarly to differentiate "five" and "nine," telephone traffic managers would rejoice. With the same long vowel sound and with an indistinct aspirate in the case of "five," these numbers are often confused, and errors result in making connections.—*Electrical World.*

Aerial torpedoes controlled by wireless electricity are in course of development in Germany. Great speed has been obtained by these flying torpedoes, which are driven by electric motors. It is expected that further development will produce a type of aerial torpedo, which can be sent on long rapid flights and brought back to the starting point, when desired, by the utilization of electrical waves.

The town of Vallecas, in Spain, is almost entirely built of meerschaum. Vallecas has on its outskirts great quarries of a meerschaum, too coarse for pipemaking, and a meerschaum-built town is the result—an ivory-white town that shines in the Spanish sun. Think of the possibilities for color in the chimneys!

A BOX WITH SECRET OPENING

The box illustrated in Figs. 1 and 2 is made to resemble a book in shape, and is opened by drawing out a panel in one of its covers. When closed, it is not easy for a person who does not understand its construction to discover how to open it. It requires to be very neatly made, and the wood must be well seasoned, so that it will not warp or shrink and spoil the fit of the loose panel. For the same reason, the smaller it is made, the better, for the panel must not become loose enough to slip out of itself, nor must it be too tight to be drawn easily. The dimensions given on the illustrations, represent a convenient size, but there is no reason why they should be strictly adhered to. The choice of wood for the purpose may depend on what is available, but hardwood should be used in preference to soft, and among the common hardwoods, mahogany is the least liable to shrink or warp.

The simplest method of construction is to glue the sides and back on to a block which has had its central part cut out to form the interior space. This block, with the back glued on it, is shown in Fig. 3. In one side of this, a thin piece of solid wood is glued to form one cover of the book and on the other strips are glued to enclose the loose panel. These strips, which are 3 in number, leaving one end open, are shown on the upper face of the views in Figs. 1 and 2. As there is a likelihood of the panel becoming a bad fit through shrinkage, it is best to get it out first, plane it nearly to thickness, and leave it to shrink as much as possible before it is fitted. The block to which the outer parts are glued, may then be squared up to dimensions, and the hole, which is to be cut through it, marked out on both faces. This may easily be done, gauging lines from the edges and striking small rod in the corners with dividers. A centre bit hole is then bored through at each corner of the marked out portion, and the straight parts sawn within the lines. It is then pared through to the lines with gauge and chisel, and tool marks removed by glasspapering. Next a piece for the back is prepared and glued on. This must be large enough to overlap about ⅛ in. all round, as in

FIG. 3.

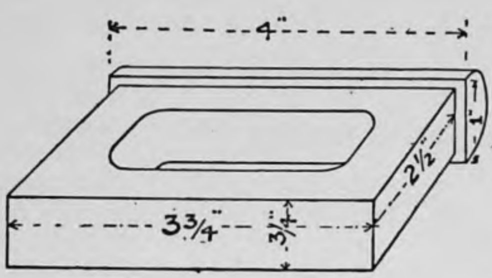
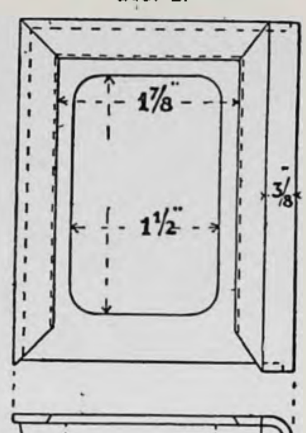


FIG. 2.



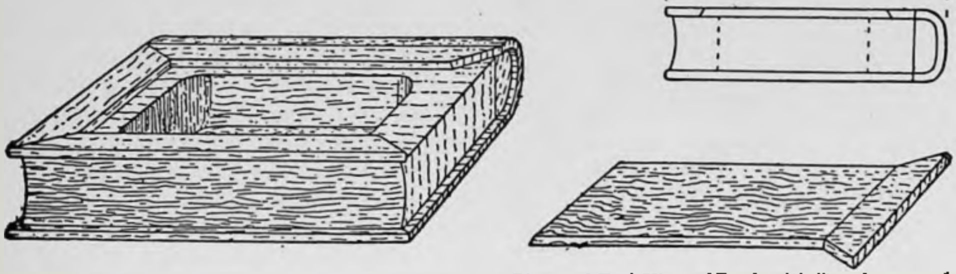


Fig. 1: View of Book with Panel drawn out. Fig. 2: Plan and End View of Book with Panel removed.
Fig. 3: Block with hole cut through it and back glued on.

Fig. 3, and it is best not to finish it to shape as shown, but allow sufficient for trimming down after the sides or covers are on. Next a single thin piece of wood about ⅛ in. thick, the full length of a cover and of a width to extend from the glued on back to about ⅛ in. beyond the front edge of the block, will be glued on one face of the block, thus covering and forming a bottom to the hole which has been cut through. On the other face of the block, 3 strips with mitred corners form a portion of the other cover, and the remainder of it is supplied by the panel, which slides in. The edges of strips and panel must be veed, so that the panel can only come out by sliding lengthwise. The panel is a single piece of wood, as shown separately in Fig. 1. A line is scribed across its face, where the mitred portion commences, and the cover on the other side of the book is scribed to give the appearance of a similar panel. The covers, however, are not exactly similar in appearance, because on the side where the strips are glued, the grain runs across at one end. This is rather an advantage than otherwise, because it shows the person familiar with it which way it opens, but even when noticed by another, does not solve the puzzle.

The work is finished by gauging the front to a curve, and rounding the back. Each end of the latter is carved out, as shown in Figs. 1 and 2. —*Hobbies*.

MAKING BLUE PRINTS

One of the important adjuncts to mechanical drawing is that of "blue printing." To obtain a blue print, you must have what is known as a tracing of the drawing. To get the drawing transparent, tracing paper or tracing cloth is used. This tracing paper is placed over the original drawing, and the tracing is made. There are two surfaces on tracing cloth, namely, the smooth or glazed side and the dull side. The dull side is the side which you place against the original drawing.

After the tracing is ready, the blue print is made. Blue print paper can be obtained in any mechanical drawing supply store, but if you wish to make it yourself, it is made as follows: dissolve 1 oz. of ammonia citrate of iron in 6 oz. of water, and in a separate bottle dissolve the same quantity of potassium ferricyanide in 6 oz. of water. Keep these solutions separate and in a dark place, or the solutions will be of no use. To prepare, mix the same amount of each solution and with a sponge or soft cloth spread it evenly over the surface. Let the paper remain in a horizontal position until the chemical has set on the surface, then hang the paper up to dry. When drying see that no light strikes the paper, or it will lose some of its value.

To make a blue print from the tracing, place the tracing with ink side out against the glass surface of the printing frame, then take the blue print paper and place the sensitized side down on the tracing. On the top of the paper place a felt cushion, which generally accompanies a good printing frame. and then put in place the hinged back of the printing frame. After this is done, expose to the sunlight. To make good blue prints, being guided only by the exposed edge of the sensitized paper, take a small test piece of the same paper and a piece of tracing cloth with a few lines drawn on it and expose that to the sunlight the same time that you expose the large print.

By having a dish of water at your side, you may tear off at different times pieces of the test blue print and wash it in the water. If the test piece shows up in a deep blue color and clear white lines, then it is time to take the big print out. After the print is taken out, it should be washed in cold water for ten minutes and then should be hung up to dry. Corrections can be made on the print with an ordinary writing or ruling pen and a solution of washing soda, caustic potash, strong ammonia, or any other alkali.

To obtain sharp lines on a blue print, all lines on the tracing should be heavier than on ordinary drawing paper, and a sharp inking pen should be used.

By using the following solutions, prints having blue lines on a white ground or just the opposite of a blue print may be obtained: 3 oz. common salts, 8 oz. ferric chloride, 3¼ oz. tartaric acid, 26 oz. acacia, 100 oz. water. Dissolve the acacia in half the water and dissolve the other acids in the rest of the water, then mix the two together. The solution is applied with a brush to a well-rolled paper in a subdued light. The paper should be dried as quickly as possible on account of the acid eating into the pores. When the paper is dry it is ready for use. One or two minutes are sufficient in strong sunlight, and a considerable longer time in a dull light.

To develop the print, it must be washed, after leaving the frame, in a very weak solution of potassium ferricyanide. None of this solution should touch the back of the print. Developing takes but a minute or two. If the background of the print is of a blue color, the print was not exposed long enough, and if the background shows a pale blue color, then the print has been exposed too long.

When development is complete, the print is washed in clean water for two or three minutes, and then placed in the following solution for ten minutes: 3 oz. sulphuric acid, 3 oz. hydrochloric acid, and 100 oz. of water. In this solution, all the iron salts not turned into blue compound will disappear. After this is done, the print is washed in water and then allowed to dry.

One of the important uses of blue prints is its use in the shop of the mechanic or engineer. The best advice to be given to them is to take the blue print and mount it on a pasteboard back, but if it is required to keep the prints in first-class shape, mount them on sheet-iron or zinc backs, and then apply a coat of varnish over each side to make it water proof.

To make drawings from the prints, the blue prints may be inked over with waterproof ink, and when thoroughly dry, washed with a solution of oxalate of potash; treated thus, the ink lines will remain and the blue ground will fade, leaving the background white and appear like an original drawing.

Erasing on tracing cloth, in case of mistakes or errors, should be done with an ink eraser or a sharp, round erasing knife. The surface of the tracing cloth must be made smooth in those places where erasing has been done. This is done by rubbing the cloth with soapstone or powdered pumice stone or talcum applied with the fingers.—*The Practical Engineer.*

Electricity Prevents Fires in Railroad Wrecks

An unusual number of railroad accidents have occurred in various parts of the country during the last few weeks, and accounts of these disasters in the newspapers have been read with sympathetic attention. However, it is to be remarked that further horror of fire has not been characteristic of recent wrecks, and this is at least partly due to the doing away with open-flame illuminants by the use of electricity. The use of electric heaters also prevents scalding from broken steam pipes in case of accident. Referring to a railroad wreck which occurred at Western Springs, Ill., on Dec. 18, a Chicago daily makes this significant comment: "The cars were heated and lighted by electricity, so that there was no danger from fire."—*Electrical World.*

Electro-plating aluminum by the Wegner process is done by first pickling the article in a bath of copper acetate dissolved in vinegar, iron, oxide, sulphur and alumina chloride. After removal from this, the surfaces are scratched over with a soft wire brush and mixed in clean water. A durable coat of nickel-copper, gold, or other metal can then be deposited in the usual way.

The patent rights covering the manufacture of aluminum have expired, and now the industry is an open one to any one who wants to embark in it. At the present time the output of the Aluminum Company of America is entirely sufficient to take care of the demand, and, having hydro-electric power and ample supplies of the raw material, it can increase its production should it be demanded.

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 in at one time. No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for 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.

1216. **Condenser.** G. K. T., Maplewood, N.J., asks: (1) How many sheets of tinfoil, and of what dimensions should a condenser be to have a capacity of .001 microfarad, for a wireless receiving set, and what would the proportions be for one of twice that capacity? (2) How is the maximum rate of discharge of a storage battery found? Take for instance one rated at 40 ampere-hours. Ans.—(1) The sample of paper you sent seems well adapted for the purpose of serving as dielectric, but for all such uses it should be treated in a vacuum with melted paraffin, and sheets be used in pairs; that is, use two thicknesses. Two such will be about .002 in. in thickness, and for such a small capacity of condenser, you will need only a couple of sheets of tinfoil. A good illustration of an actual condenser is at hand; it consists of 92 sheets of double thickness paper, .002 in. thick, and 5 in. by 7 in. area. The tinfoil sheets are 4 in. by 6 in. The capacity is 1.47 microfarads, and the dielectric resistance is 160 megohms. Other capacities would follow in direct proportion. For wireless telegraphy it is customary to use plate air condensers, with considerable separation, so the area must be increased in direct proportion. (2) The faster the rate the less the total ampere-hours. The rating applies to the 8-hour discharge, meaning 5 amperes for 8 hours. For one hour, the maximum rate would be reduced to one-half the proportional rate, or only 20 amperes.

1217. **Motor Speed Reduction.** M. F., Montevideo, Uruguay, asks: (1) What book will give him directions for making resistances for reducing the speed of a 3-phase 50-cycle, 220-volt, 1,350 revolution induction motor? It has a short-circuited armature, and was made by the Societé Alsacienne. (2) What sort of resistance or other device can he make for operating a 110-volt fan motor on a 220-volt circuit? (3) What sort of a dynamo should be used for galvano-plastic work, and in charging small storage cells? Ans.—(1) For permanently reducing the speed, it will be necessary to rewind the motor for a larger number of poles. At present it has four, and the next number would be six. The machine may not, however, have an appropriate number of slots to make this change. The motor would require no changes. You can make occasional reduction of speed, but very uneconomically, by putting choking coils in the three mains, thereby impressing a lower e.m.f. on the stator windings. Hobart's book on Electric Motors is a good one, treating of the design of such machines, as is also Hawkins and Wallis, this latter in two volumes. (2) Get a reactive coil from some discarded multiple alternating current arc lamp, and put it in series with the fan motor. If one is not enough, put in two. (3) Use a plain shunt wound machine; say of 25 volts. Watson's designs of small machines would fit such purposes.

1218. **Calculation of Magnetic Flux.** B. K. F., Tacoma, Wash., asks for the formula for predetermining the flux in a straight iron core, such as is used in an induction coil, operating with a make and break contact. Ans.—This can be done only in cases in which the iron core forms a closed or nearly closed magnetic path, and the current is steady, or follows some simple law, such as that of the sine.

1219. **Small Steam Boilers.** W.V., Schenectady, N.Y., asks: (1) how to make a 1 h.p. boiler without tubes, suitable for use with gasolene for fuel? (2) How to make a flash boiler? Ans.—(1) An excellent, and almost explosion-proof, boiler for amateur purposes can be made from an assemblage of mercury flasks. These vessels are made of wrought iron, and from wholesale dealers in chemicals they should be obtained at not more than 75 cents each. Connect a number of them together with piping, at both top and bottom. We warn you, however, not to use gasolene in an open flame for fuel. Let the steam automobile people do it, if they wish, but an amateur might as well use gunpowder. (2) We cannot find directions for making a flash boiler. They have been used for various purposes, from torpedo boats to automobiles, and for stationary engines, but their chief defects appear to be rapid deterioration of the tubes or plates when kept at red heat, and to the fouling within the tubes from impurities that enter with the water.

1220. **Telephone Bells.** W. S. M., Spangle, Wash., asks: (1) Can direct current be used to ring ordinary telephone bells, such as are used on bridging sets? (2) What kind and size of dynamo would be proper for charging 18 storage cells, capacity being 18 ampere-hours? (3) How much light does a 16 c.p. incandescent electric lamp give in comparison with a No. 2 kerosene burner? Ans.—(1) No. Alternating currents will alone operate these "polarized" ringers. (2) Use a plain shunt wound machine for 50 volts, and having a capacity of at least 3 amperes. Watson's 1/4 h.p. size would answer. (3) The electric would give about twice as much light, but a "B & H" or "Rochester" burner will give more than the electric.

1221. **Renewing Dry Cells.** A. R. McC., Lincoln, Cal., asks if this can be done? Ans. —See description of method in the February, 1909, magazine, page 346.

1222. **Magneto Direct Current Generator.** L. F. F., So. Orange, N.J., asks if he can make one from a 3-bar telephone generator? Ans. —Yes, see description in March, 1907, magazine, p. 258.

1223. **Electric Stove.** C. D. C., Williams, Ariz., asks if the one described in the May, 1909, magazine is adapted equally well for alternating and direct currents, and will it make a humming noise when used? Ans.— The resistance in the coils is purely a matter of ohms, and therefore the device is adapted for either sort of current. There being no sheet iron plates to vibrate, there will be no noise resulting from its use.

1224. **Switchboard Wiring.** R. B. L., Greenfield, O., asks: (1) if when connecting a compound wound generator it is not better to lead from positive brush directly to series field coils, then to switchboard, than to go to board from brush and take in the series coils after passing through line? (2) Should the single-pole circuit-breaker be placed in the positive or the negative lead? (3) Is there any feasible way for power to be taken from a 250-volt direct current source for operating the ignition circuit of a gasolene engine? Ans.—(1) The former way is preferable. As ordinarily made, the connection boards on generators are arranged for this order, and to adopt the other would bring terminals close together that have the full difference of potential between them. (2) In all but grounded railway circuits it is customary to have a breaker, the same as a fuse, in each main. (3) About the best way will be to have two or three storage cells permanently connected in series with some one incandescent lamp that is in use most of the time. They will thus be charging without any special attention; the diminution of light from the lamp will not be noticeable. Connect the ignition apparatus to the cells in the usual way.

1225. **Toy Induction Motor.** M. K., Chetek, Wis., is making a motor much like the one described in the May, 1908, magazine, and asks how it should be wound for 133 cycles, and if it is necessary to cut off certain extensions he has left to serve as feet? Ans.— At 133 cycles the synchronous speed will be 3,900 revolutions per minute. This is ordinarily too high, but perhaps in so small a machine you can endure it. For that frequency you ought to have six or eight poles, thereby bringing the speed down to 2,660 or 1,950 revolutions. You will have to experiment somewhat to get the proper size of wire for the stator, but for the motor use as coarse wire as possible, in order to minimize the self-induction. A few turns of coarse wire will be better than a large number of turns of fine wire. The projections for feet will do no harm.

1226. **Engine Parts.** V. V. K., Camden, Pa., asks: (1) Where can finished parts of 1/2 h.p. gasolene engines be obtained? (2) Is Watson's design of 1/4 h.p. dynamo of the enclosed type? Ans.—(1) Address some of our advertisers. (2) No.

1227. **Relay.** E. W., Carson City, Nev., asks: what is a good design for a relay magnet or tapper to use in connection with a coherer for wireless telegraphy? He has made one in apparently good manner, but even with three dry cells, only the feeblest amount of magnetism can be felt at the poles. Ans.— It would seem that you have used too small a quantity of wire. The spools for cores of this size should be about 1 in. in diameter. A good way to make such for use with subdivided core is to bore 3/8 in. holes through pieces of wood, in lengthwise direction, mount them on arbors and turn them down thin for the winding space, leaving walls at the ends not over 1/8 in. thick. After winding these spools you can bend the iron wires in U shape and thrust in as many as the space will hold. File the protruding ends off flat. To make sure you have the direction of the current right in the two spools, do not hesitate to exchange the terminals of one of the coils.

1228. **Tools.** C. M. B., Franklinton, La., asks: (1) Is it possible to finish rough castings in a place where there is no machine shop? He has been told that tools are very expensive, and are not to be found elsewhere than in a railroad repair shop. (2) What is a list of the most important tools for amateur work, where can they be obtained, and what will they cost? Ans.—(1) No, for even with a good equipment of suitable tools, it is difficult enough to do good work. We do not regard a railroad repair shop as being well fitted for small or accurate work. It is all pretty heavy repairing, and, except for some parts of the locomotives, pretty rough. (2) You need a screw-cutting lathe, an upright "sensitive" drill, and a whole lot of small tools like drills, taps, reamers, measuring devices, etc. The Seneca Falls Mfg. Co., Seneca Falls, N.Y., makes a high grade lathe. The Garvin Machine Co., New York City, deal in drills and almost all other sorts of tools. The Sebastian Lathe Co., Cincinnati, O., are makers of such machinery. Sears, Roebuck Co., Chicago, also are dealers. You could not get a good equipment short of $300. Unless you have had a chance to take lessons on the use of such machinery, you could not expect to do satisfactory work.

1229. **Dynamo Winding.** F. B., Serena, Ills., is making a small dynamo of the following dimensions, and wishes to learn what sizes of wire will be best. Armature core, 2 1/8 in. in diameter, 2 5/16 in. in length, with 20 slots, each 1/8 in. by 7/16 in. A 10 segment commutator is used. Field magnet is of Edison type, cores being 3 1/2 in. long, and 1 1/2 in. in diameter. Air gap is 1/32 in. Present armature winding has eight wires per slot. Ans.—We regret that the samples of wire you sent have been lost, and we cannot be sure of the sizes you used. Probably that on armature was No. 18. For field you might have had No. 21. If the field was of cast iron, and armature was driven at 3,000 revolutions per minute, you could then not have obtained more than 4 volts. Probably that is lower than you desire. If the field does not build up its magnetism with the two spools connected in series, try them in parallel. Be sure to connect them in either case in a manner to let the current pass in opposite directions. By use of oiled muslin for slot insulation, you could use No. 21 wire, 3 wide and 10 deep, and thus get an armature adapted for 12 to 15 volts, but for only 4 or 5 amperes. Field should then consist of No. 24 wire. Field cores, if of cast iron, should have been about 2 in. in diameter.

1230. **Bullet Mould.** C. M. S., Griswold, Ia., wishes to make one, say from brass, but wishes to know how to make a start. Ans.—Cast iron will be cheaper than brass, and even better, for in use, the lead may stick to the brass, while it will not at all to cast iron. Make a wooden pattern in halves, with projections on one end through which an iron rod or wire nail can be put, and thus give a hinge joint. On the other ends should be provision for screwing in two round rods on which wooden handles can be slipped. The mouth for pouring in the lead will lie half in each casting. You ought to be able to find some book in a public library that will give you some good ideas on foundry methods. We have published some articles on that subject.

1231. **Small Dynamo.** R. R. M., Atchison, Kan., has one that gives 20 volts and 3 amperes. Armature is 3 in. in diameter and 3 in. in length, with 12 half-inch diameter round slots, each containing sixty-five No. 20 wires. Speed is 2,000 revolutions per minute. Field has two coils wound with No. 25 wire, 16 layers deep. He asks if he rewinds armature with one hundred and sixty No. 26 wires per slot, what will be the output, and how can he determine the polarity? Ans.—From that size of armature you ought to be able to get two or three times the output you mention. The speed can be higher, but it would appear as if the field magnet was too weak. You did not give sufficient data for us to judge. Other things being the same, you will get a voltage proportional to the number of turns of wire on the armature, or about two and a half of the present figure. With a proper field magnet, you should get 150 volts on open circuit, and 110 for a working potential. Allowable current, 1½ amperes. You should use a 24 segment commutator. Polarity can be found by thrusting the terminals into a vessel of water and observing from which the evolution of gas is greatest. The positive is the other. Look up in some book on physics the procedure for decomposing water with the electric current.

1232. **Low Voltage Motor.** Q. D., Rockdale, Tex., asks for directions for making a motor of 2½ h.p., for use with a relatively low voltage, as for an automobile equipment. Ans.—Hobart's book on Electric Motors is about the most explicit of any on the market, but it does not describe any as small as you desire, nor of the particular sort. If yours is actually for an automobile, it should be a series wound one, designed for light weight and high efficiency. We can give you the general dimensions and data for such a one for $5. Frame should consist of steel casting or wrought iron forging, have laminated pole pieces, series drum wound toothed armature.

1233. **Armature Winding.** C. W. M., Trenton, N.J., asks: Why if formed coils are placed on a drum armature, upside down, the direction of rotation is affected? Ans.—As you state, it is true that the current may still enter by the same brush, but if you follow the path of the current, it will in the two cases aim for a different pole. This will be sufficient to reverse the direction of rotation. You can make the matter clear if you will draw two ring winding diagrams, one with spirals put on right handed, and one left. Draw a N and S pole for each. Then, assuming a certain brush as the positive, and putting on the arrows to follow the direction of the currents, you will see that they pass under opposite poles, and give the reversed rotation. A drum armature obeys all the laws for the ring winding, but it is not so easy of representation.

1234. **Battery Motor on Lighting Current.** A. B., Washington, D.C., asks how he can get as much as 5 or 6 amperes for operating a low voltage motor, for running a toy railway? Ans.—Instead of trying to take enough current through a single large lamp, remove a fuse plug in the cabinet, and substitute for it an attachment plug with a sufficiently long flexible cord to reach to your apparatus. Then by turning on or off the regular lamps on that circuit, you will get some control of the current. If you fail to get enough, use 32 c.p. lamps. The motor will steal some voltage, and the lamps will burn a little dimmer than usual, but this may not be of consequence.

1235. **Choke Coil.** J. M. L., Bay City, Mich., asks some questions as to the construction and method of using the choke coil described in the October, 1908, magazine. Ans. —To wind the two wires in parallel, twist or solder them together at the start, and wind them side by side, and solder the final ends together. Thus at both start and finish there will be a double wire soldered to a binding post, or other suitable terminal. Thus terminals, and not loops, as you suppose, are met with. Of these terminals, one attaches to supply, other to lamp. Other line wire goes directly to lamp. Paraffin oil is the kind to use for filling the tank. The article referred to is of English origin, and the wire given is in Birmingham gauge, corresponding to No. 10 B. & S. A choking coil takes the place of a rheostat, but of course is operative on alternating currents only. An adjustable coil would be desirable to fit various conditions.

1236. **Fan Motor.** H. G. S., Jamaica,

N.Y., has a motor, marked 16,000 alternations, 104 volts. It has 8 poles, each wound with 52 turns of No. 28 B. & S. gauge wire, all being connected in series. Polar faces 1 in. x ¾ in. Armature has a definite winding and only two brushes, but there is also a "squirrel-cage" winding on the same core. The question is how to rewind for 110 volts and 60 cycles. Ans.—This is one of the very best of the alternating fan motors put upon the market. Its high cost, however, militated against its popularity. It is the "Lundell" design, and made by the Interior Conduit and Insulation Co., now better known as the Sprague Electric Co., but owned by the General Electric Co. It is essentially an induction motor, but provision made for good starting torque and economical running conditions by the addition of a series armature winding. For your purposes you will not have to change the squirrel-cage part, but the direct current portion will require rewinding, for the present will not answer for four poles. For this latter it will be well to read the chapter on Armature Windings, in the November, 1908, magazine. For the series winding to fit four poles, and with the 32 segment commutator you have, it will be necessary to solder two segments together, thus giving the effect of 31, and although you put 32 coils on the core, one will have its ends left out of account, its presence being merely to fill the space and give mechanical balance. Two brushes will be used, and these one quarter of a circumference apart. The same size of wire and number of turns may be used as at present. For the field, you will need to make new coils that will embrace the present poles in pairs, thus giving the effect of four poles, with a gap space in the centre of each. You will need to use one size smaller wire, and to get on all the turns possible. The change will be a bothersome one to make, and can be recommended only as a lesson in engineering. It will be cheaper to buy a new motor.

1237. **Wireless Telephone.** L. A. W., Portland, Me., asks: (1) What is needed in making a small wireless telephone? (2) Please send diagram for connecting same. (3) What is the best way to make a coherer, filings used and distance it will work a 75 ohm relay? Ans.—(1) and (2) Too long to answer here. We expect to have a series of articles on this subject. See also article in our number for July, 1908. (3) We refer you to *How to Make Wireless Outfits*, by Newton Harrison, which we can furnish for 25 cents.

1238. **Wireless Telephone.** W. H., Baltimore, Md., asks: (1) How can I make a wireless telephone? (2) What do I need for sending? (3) What for receiving? Can silicon be used in the receiving side? (4) What will be my receiving distance. Ans.—See answers to above questions.

1239. **Helix — Amperage.** A. H., East Orange, N.J., asks: (1) I have a sending helix, composed of No. 7 copper wire, wound on a mandril 9 in. in diameter. Would I be able to make a transformer tuner of it by winding a secondary outside of it, and if so, how many turns of what size wire should be used, and how much space should be left between that and the primary? Diagram enclosed. (2) What is the maximum amperage that could be safely obtained from a 60 A.H. storage battery without harming it? How should the sliders be arranged? Ans.—(1) Yes, 4 or 5 turns of copper or brass strip 1 in. wide. Use the helix as a secondary, 2 or 3 in. (2) 60 amperes. The aerial slider should include more inductance than the other slider.

1240. **Wireless Telegraphy.** G. W. W., Topeka, Kan., asks: (1) Should the wire from aerial to instruments be rubber or covered, or have weather proof insulation? (2) Would there be any loss of current if wood-base switches were used on secondary circuit of transmitter, or (3) wood-base switches and instruments in the receiver? (4) Is the condenser made of 12 sheets of tin foil 3 in. x 4 in. between 13 sheets of paraffined paper 5 in. x 6 in. suitable for any kind of detector? If not, please describe one that is. Ans.—(1) It makes no difference so long as the aerial leading-in wire is thoroughly insulated from all surrounding objects. (2) Yes. (3) No. (4) Use a condenser just twice as large.

1241. **Wireless Coil.** J. H., Pittsburg, Pa., asks: I wish to make a wireless coil to send 4 miles. Dimension core 8 in. long, ⅞ in. in diameter, secondary 3 lbs. No. 30 S.C.C. or 2½ lbs. No. 32 S.C.C. primary, 2 layers No. 16 D.C.C. (1) What size wire is the best for the secondary? How many sections should I have? (2) What size spark should I get and will it send the above named distance? Ans.—(1) No. 30 or No. 32 is all right for above coil. Make sections ¼ in. thick. (2) You should get a short vicious spark which is just what you need. It should transmit 4 miles.

1242. **Loop Aerial — Iron Pipe Mast.** H. L. H., Hoopeston, Ill., asks: I want to do long distance work with a loop aerial composed of No. 14 B. & S. copper wire, loose coupling tuning coil, variable condenser, silicon detector and 500 ohm receiver; aerial to be 60 ft. high. (1) How long should the aerial be? (2) Would 1¼ in. (outside diameter) iron pipe, supported by guy wires every 20 ft., be all right if the guys were insulated at the pipe, and at the ground? (3) Could the perikon detector with potentiometer be used to as good an advantage as the silicon detector, on the above apparatus? (4) Would the Electro Transformer Coil ½ k.w. with a helix 12 in. in diameter and 14 in. high be able to send to Chicago? 110 A.C. to be used on the above coil. Ans.—(1) Your aerial should be at least 50 to 75 ft. long. (2) No. An iron pipe mast is very difficult to construct because of its tendency to buckle. Make your mast of three 22 ft. sections of spruce about 3 in. in diameter or 3 in. square. The top section can be tapered to 2 in. Brace every 10 or 15 ft. with No. 12 or No. 14 galvanized iron guy wires. Break iron wire every 30 ft. with insulators. (3) The perikon detector with potentiometer is the most sensitive known. (4) The manufacturers can best answer this.

BOOK REVIEWS

Handy Man's Workshop and Laboratory. Compiled and edited by A. Russell Bond. 370 illustrations. New York, Munn and Co., 1910. Price, $2.00.

This is a volume devoted to useful suggestions and ideas for the amateur and professional mechanic who likes to do odd jobs. It is full of practical suggestions for doing emergency jobs with the means which happen to be at hand, and for doing all sorts of things cheaply. It contains working directions and drawings for making all sorts of things from batteries and springs to wireless telegraphs and flying machines. Every man who uses tools should have the book.

Electricity Explained. By J Calvin S. Tompkins. New York, Cochrane Publishing Co., 1909. Price, $1.00.

This little book of 64 pages contains a lot of useful information about electrical principles put into very simple language, and will probably make clear a good many points, which may have puzzled the student, if attentively read. It leads through a description of the various kinds of currents to wireless telegraphy and telephony.

The *Mechanical World* Electrical Pocket Book for 1910. Emmott and Co., Ltd., Manchester, England. Price, 25 cents.

A companion to a similar mechanical handbook, this little pocket volume contains more than 200 pages of valuable electrical information and tables, designed for the man who has to take charge of electrical machinery, and a diary for 1910. It is marvellous value for the money.

Who Makes What, a book of reference for buyers. Daniel T. Mallett, 253 Broadway, New York. Price $1.00.

This is a most useful list of manufacturers, their products, foreign merchants, hardware jobbers and importers. It contains a very complete list of manufacturers of hardware of all kinds and a list arranged alphabetically of the products manufactured by them. There is hardly a tool or object of metal, wood or other material handled by hardware dealers which is not referred to with the name of the manufacturer. It is an indispensable book of reference for the desk of almost everyone of our readers.

Vehicles of the Air. A Popular Exposition of Modern Aeronautics with Working Drawings. By Victor Lougheed. Chicago, The Reilly and Britton Co., 1909. Price, $2.50 net.

This is a bulky volume of nearly 700 pages, counting the full-page illustrations, of which there are a hundred or so, all of the highest grade of excellence. Into these 700 pages the author seems to have compressed practically all that man knows of flight, and this treasury of information is absolutely indispensable to all who would know about the conquest of the air. The experimenter will find here a complete record of all that has been attempted or accomplished, from the dark ages down to the middle of last November, and a careful perusal of these pages will keep him from repeating the mistakes of earlier inventors. Every type of balloon, dirigible, glider and aeroplane is described, and pictures, in most cases with scale drawings. Every detail of construction, equipment or operation of every description of aerial craft is set forth clearly and fully. The book may justly be described as an encyclopedia of flying. We commend it without reserve.

Maver's Wireless Telegraphy and Telephony: A Handbook of. By William Maver, Jr. Fourth Edition, 366 pages, 258 illustrations. New York, Maver Publishing Co., 1910. Price, $3.00.

The first edition of this well-known handbook was published in 1901 as an appendix to the author's standard book on telegraphy. The rapid advance and increase of the art rendered separate publication necessary, and new editions have been called for every year or two. The present one, greatly enlarged, fully revised, and brought down to date, is an excellent practical working guide. Theory is by no means neglected, but practical instruction has been the author's chief aim. The various commercial systems are fully described, as well as the various forms of sending and receiving instruments. A long chapter is devoted to the needs of the amateur. The book closes with an excellent section on the present status of wireless telephony, which it is fair to assume will shortly attain to the dignity of a book by itself.

How to Build a Biplane Glider. A Practical Handbook on its Construction and Use. By Alfred Powell Morgan. New York, Spon and Chamberlain, 1909. Price, 25 cts.

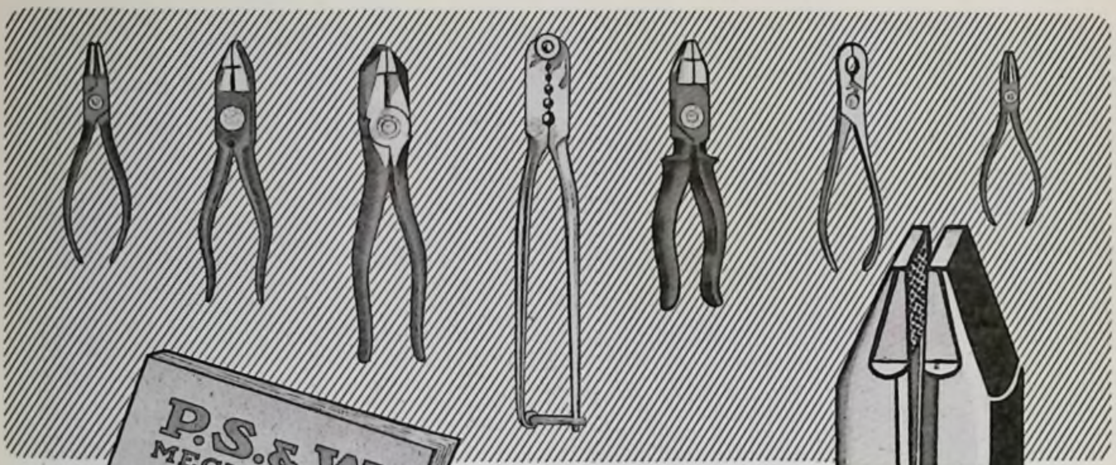
Our readers may remember Mr. Morgan as the author of some articles on wireless telegraphy, in which he is a proficient experimenter, and will not be disappointed in expecting a good book in this new field of experimentation. Mr. Morgan's description of the construction and operation of a Chanute glider is clear and easily followed. As the use of such a glider is the first step in the management of an aeroplane, there is much demand for such a book. Essentially Morgan's machine differs very little from that described in our pages last month, in an article copied from *Suburban Life*.

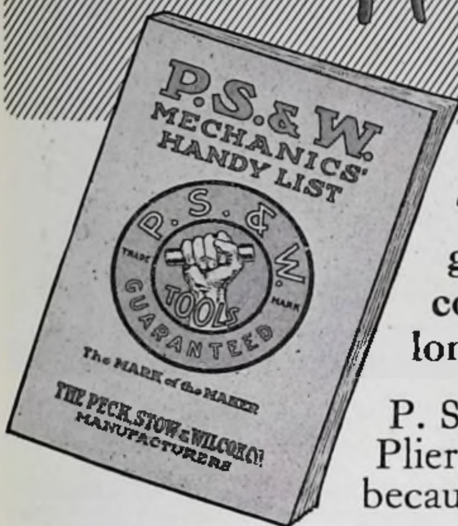
The Model Vaudeville Theatre: How to Construct and Operate it. By Norman H. Schneider. New York, Spon and Chamberlain, 1909. Price, 25 cents.

This interesting little book describes the construction and use of a small theatre and numerous devices to be employed with it. Various novel effects are described, and the book affords means for many pleasant evening entertainments for ingenious youngsters.

Credit Where Credit is Due

By an unfortunate oversight in proofreading last month, we neglected to state the source of the article entitled "How to Make a Gliding Machine." This originally appeared in *Suburban Life*, and to the courtesy of the publishers of this beautiful magazine we are indebted for the loan of the illustrations, and permission to reprint the article.





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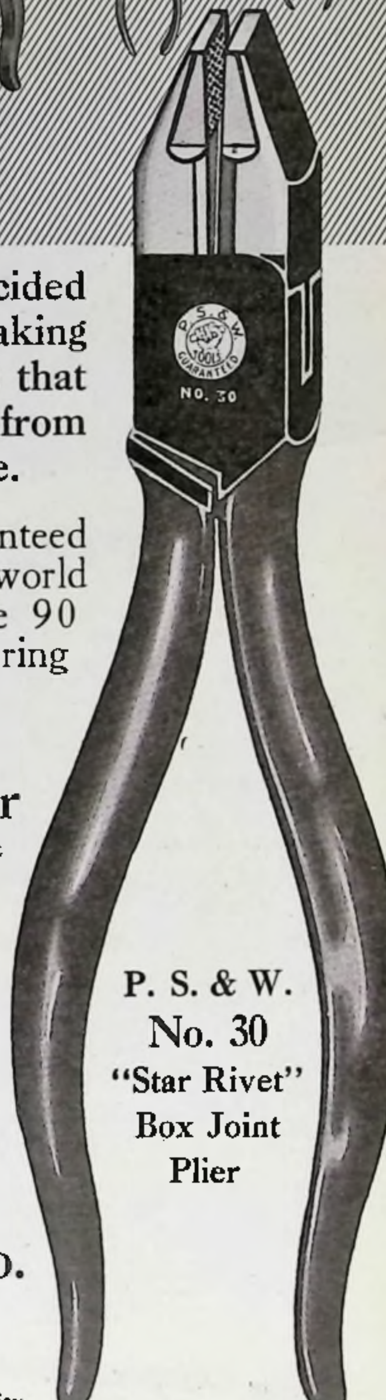

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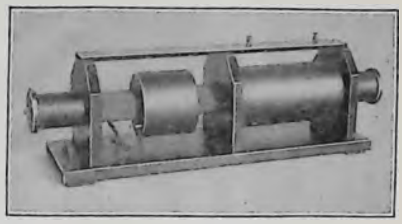

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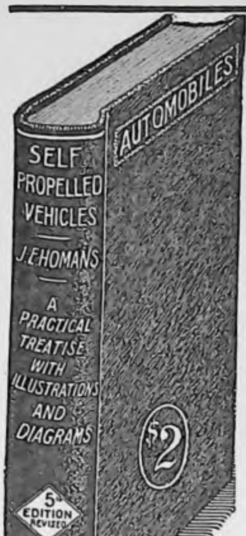

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