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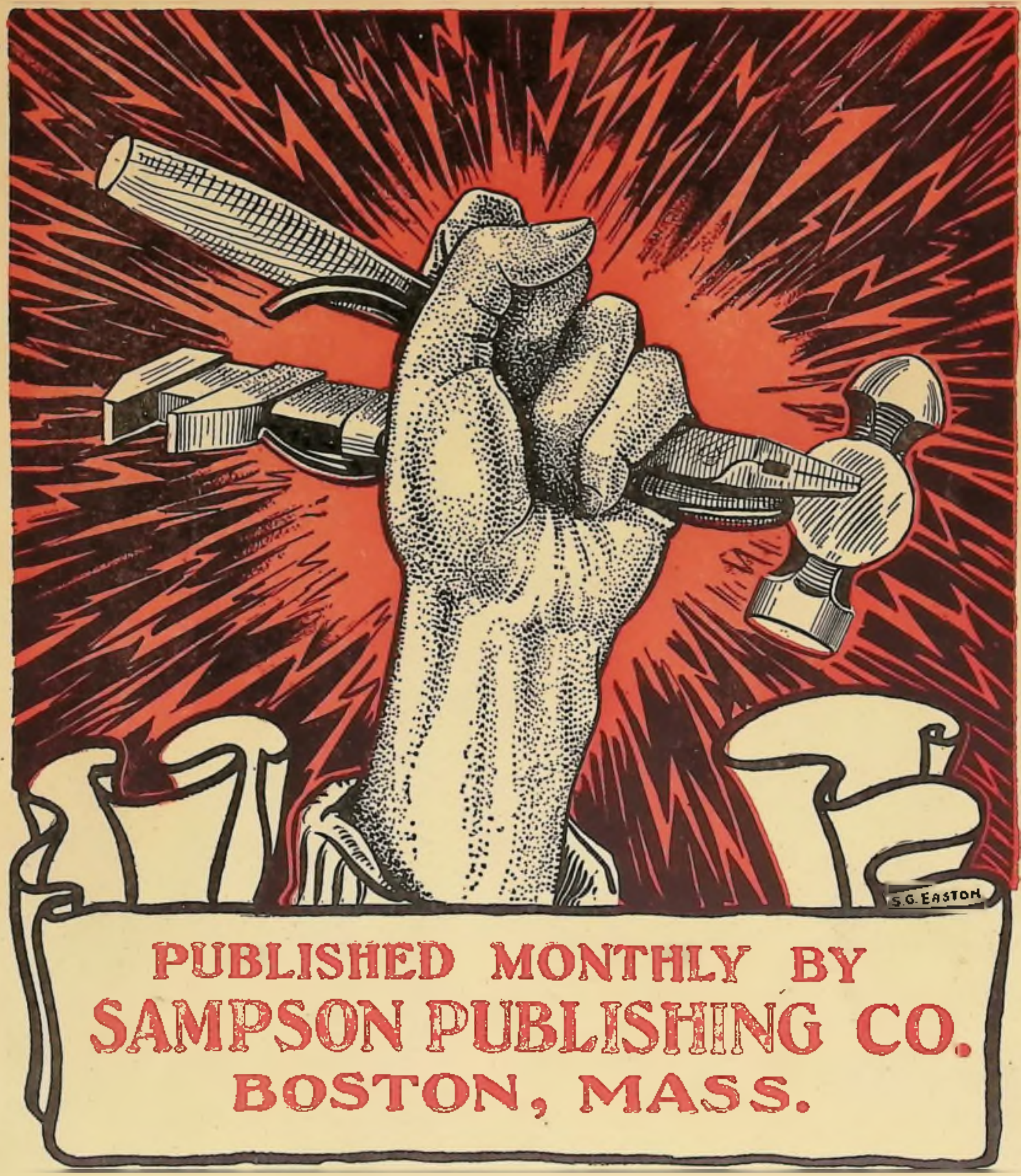

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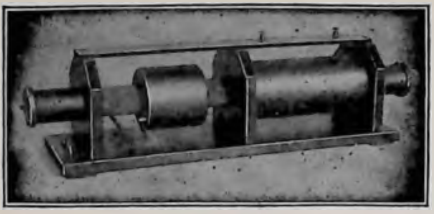

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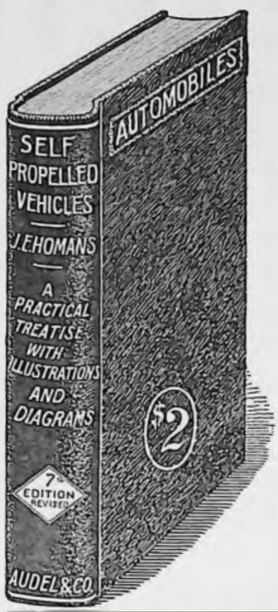

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ELECTRICIAN & MECHANIC

VOLUME XXII JUNE, 1911 NUMBER 6

MODERN STEAM LOCOMOTIVES

A. LESCARBOURA

In the past few months the public has become generally interested in the electric locomotives, owing to their adaption on many railroads for suburban traffic. There has been a great deal said in magazines regarding these locomotives. However, even the fact that the electric locomotive has come to stay should not detract the public attention from the wonderful progress and improvements made on the steam predecessors of these new electric giants of the rail.

Every year has witnessed the growing size and manifold improvements in the steam locomotives, until today the climax has been reached, where larger locomotives cannot be built, until the road-bed and rails have been strengthened to withstand the tremendous strains The present locomotives, which render the 18-hour trains possible to Chicago, are only the creation of the last few years, and are giants as compared with their forerunners of the latter '90's. Below, the writer has endeavored to give a few facts regarding some of the largest steam locomotives of the various types in service at this date. They are all built by the American Locomotive Company.

In Fig. 1 we have a monstrous Mallet compound locomotive illustrated. This is the No. 1604 of the Delaware & Hudson R.R. which was built with the purpose of having a strong locomotive for hauling trains over the steep grades on that road. On looking at the driving wheels, the reader will note that there are two independent sets of these, each set having an independent driving-rod,

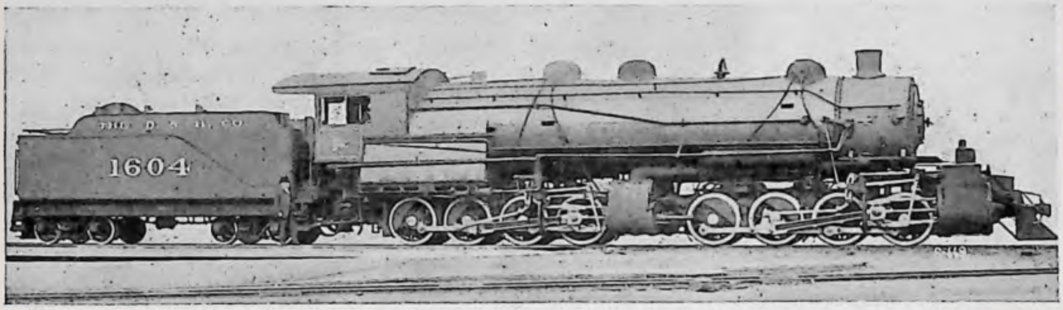


FIG. 1

piston-rod, cylinders, etc. In other words there are two separate locomotives having the same boiler, cab, control, etc., in common. This type of locomotive is known as the Mallet compound, and is rapidly becoming the favorite for powerful traction requirements. The advantages lie largely in the greater number of wheels that may be used, without using driving-rods of exaggerated proportions. Then, in cases where a driving-rod should become broken, the locomotive still has three sets of active drivers to rely on in reaching its destination. By comparing the size

FIG. 2

of the man standing alongside the steps leading to the cab, the reader may appreciate the size of this freight hauler. The most important dimensions are: driving wheel diameter, 51 in.; engine and tender wheel base, 75 ft. 7 in.; weight of engine, 445,000 lbs.; weight of tender, 166,800 lbs.; boiler pressure, 220 lbs.; maximum tractive power, 106,000 lbs.; water tank capacity 9,000 gals.; soft coal capacity of tender, 14 tons.

Fig. 2 is another example of the Mallet type of freight locomotives, which are becoming universal on the better railroads in this country. This locomotive is of a certain type commonly called "camel back," as suggested by the cab being midway on the boiler. The fireman, contrary to the usual type of locomotives, is not situated in the same cab as the engineer, but in the rear cab where the firebox door is located. A bridge connects the two cabs and is protected with hand rails, so that the engine crew may walk from one to the other while the train is in motion. This type of locomotive is largely used by some railroads for both passenger and merchandise traffic, but the more important roads do not advocate this system. This particular locomotive is used by the Erie Railroad for switching and grade work. While not as large as the D. & H. locomotive just described, it is nevertheless considered a very large machine. The dimensions are: driving wheel diameter, 51 in.: engine and tender wheel base, 70 ft. 5 in.; weight of engine, 410,000 lbs.; weight of tender, 167,700 lbs.; boiler pressure, 215 lbs.; maximum tractive effort, 94,800 lbs.; water tank capacity, 8,500 gals.; soft coal capacity of tender, 16 tons.

The Fig. 3 is an example of the Consolidation type of locomotive used on the Chicago & Alton R.R. This is a much smaller freight locomotive than the two preceding ones, and is nearer to the size of the freight locomotives usually seen on the railroads. It also has compound cylinders, as the other locomotives have which are illustrated in this article. This is one of the new improvements which has come into practice only in the last few years, though there are still many engineers who are strictly against the compound locomotives. One of the striking details in this locomotive are the trailer wheels used under

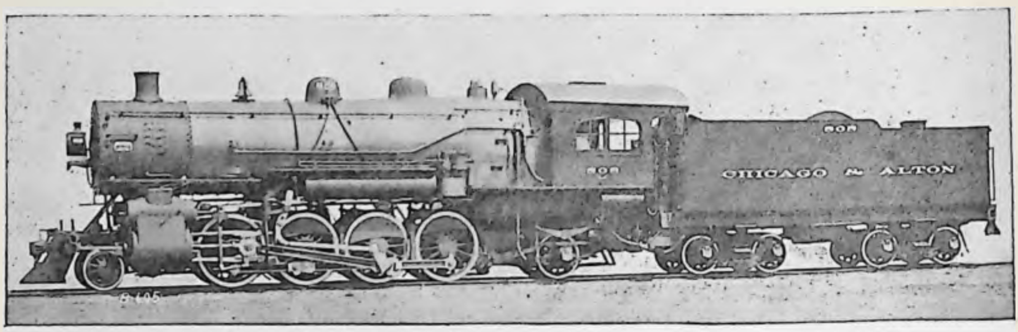


FIG. 3

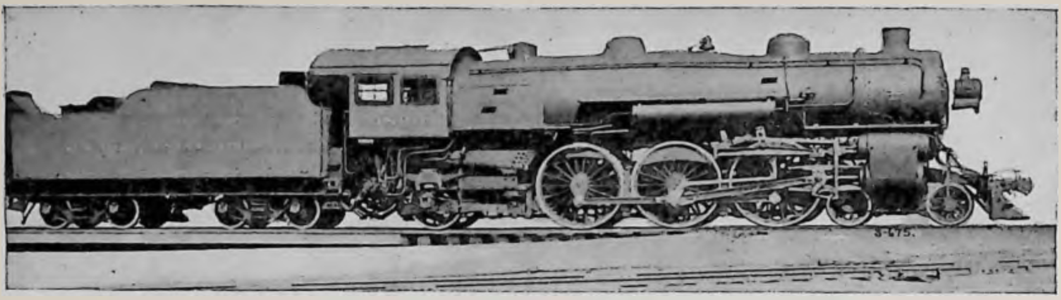


FIG. 4

the cab. These wheels until recently were only used on passenger locomotives exclusively, but many of the present freight locomotives are being built with these trailer wheels. The data on this locomotive is: driving wheel diameter, 62 in.; engine and tender wheel base, 67 ft.; weight of engine, 269,000 lbs.; weight of tender, 168,700 lbs.; boiler pressure, 160 lbs.; maximum tractive power, 48,300 lbs.; water tank capacity, 8,500 gals.; soft coal capacity of tender, 14 tons.

Coming to passenger locomotives, we do not find as many varied types as in the freight haulers. The design of all the present passenger locomotives is universally the Pacific type machine illustrated in Fig. 4. This is the No. 4890 of the New York Central Lines (L.S. & M.S. Division), and is the type that hauls all the fast trains. The old practice of having the drivers at the rear of the locomotive and as near as possible under the cab, has long been dropped, and the present practice is to have the drivers under the center of the boiler and the trailer wheels to take up the rear weight. It will be noticed that the passenger locomotives of today bear little resemblance to those of a few years ago. The cumbersome headlight and funnel have changed, and the steam-dome, sand box and other accessories on the top of the boiler have become smaller each succeeding year. The Walschaert valve gear has supplanted the old cumbersome link valve gear which held sway for over half a century. The dimensions of this steam giant are: driving wheel diameter, 79 in.; engine and tender wheel base, 67 ft. 11 in.; weight of engine, 266,500 lbs.; weight of tender, 164,500 lbs.; boiler pressure, 200 lbs.; maximum tractive power, 29,200 lbs.; water tank capacity, 8,000 gals.; soft coal capacity of tender, 14 tons.

The writer trusts that the few preceding paragraphs will impress the reader with the remarkable progress which has been wrought on the "steam horse," and not to be led into believing that the steam locomotive is already doomed by the electric substitute. Many years have still to elapse before such a state is reached, for better means of transmitting electric power with a smaller percentage of loss have yet to be perfected.

Origin of "O.K."

How many of the countless thousands of persons who daily use the popular abbreviation, "O.K." ever give a thought to its origin? Yet a very interesting story is told of its birth, and at one time "O.K." was the slogan of a Presidential campaign. There are, in fact, several explanations of its meaning, and quite a few legends are told to explain it.

It is plausibly held that in early colonial days the best rum and tobacco imported, came from Aux Cayes, in Santo Domingo. Hence, the best of anything came to be known locally as Aux Cayes, or O.K. The term did not, however, pass into general use until the Presidential campaign of 1828, when the supposed illiteracy of Andrew Jackson, the Democratic candidate, was the stock in trade of his Whig opponents. Seba Smith, the humorist, writing under the name of Major Jack Downing, started the story that Jackson indorsed his paper O.K. under the impression that they formed the initials of "Oll Korrect."

WIRELESS TELEGRAPH WORKING IN RELATION TO INTERFERENCES AND PERTURBATIONS*

J. E. TAYLOR

Summary.—After referring briefly to the position and arrangement of a radio-telegraph station as regards freedom from extraneous noises, the author discusses local inductive disturbances, interference between stations, atmospheric perturbations and variations in the transmitting efficiency of the atmosphere. Suggestions are made as to the method of minimizing such interferences.

The working efficiency of a radio-telegraph installation is very greatly influenced by its freedom or otherwise from interferences and perturbations of all kinds, says *The Electrician.* The situation of a radio-telegraphic coast station should be chosen primarily with the object of commanding traffic from ships over as wide an area of sea as possible, consistent with despatch and economy in disposing of the traffic handled. The character of the receiving apparatus used also demands consideration in the choice of site, since receivers of the auditive type have now, because of their undoubted superiority for the purposes of coast station work, almost entirely replaced those of the recording type. The receiving range of a station using auditive receivers is practically limited only by the inability of the operator to interpret signals of less than a certain strength in the telephone receiver. In these circumstances it will be readily perceived that almost absolute silence in the building in which the apparatus is housed is very necessary. A special and separate building in a quiet locality should be used for radio-telegraph coast station work, rather than appropriate portions of existing buildings, such as post offices, for the purpose.

Interferences and perturbations in radio-telegraph working may be broadly divided under five main heads: (1) direct interference by extraneous sounds and noises; (2) electrical interference by local induction influences; (3) electrical interference by waves from other stations; (4) atmospheric electrical perturbations; (5) perturbances of wave-propagation efficiency of the dielectric medium. The direct interference, under the first head, is, of course, avoidable and need not be further dwelt upon.

LOCAL INDUCTIVE DISTURBANCES

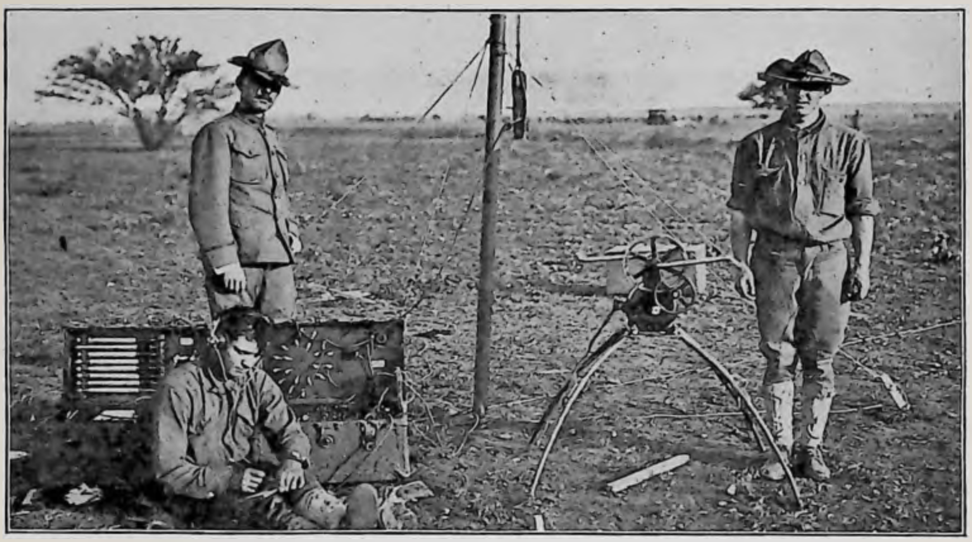
These interferences are also avoidable, but special arrangements are necessary. Firstly, it is necessary to take precautions to ensure that there is no electrical disturbance of the radio-telegraph receiver by the operation of the land circuits. Such disturbance may, in the case of Morse apparatus on the land circuit, arise from sparking at relay and key contacts, electrostatic or electromagnetic induction from circuit leads, or from battery leakage direct or via the earthing elements. There may also be direct induction from the external line to the aerial wires of the radio-telegraph plant, due either by the operation of the land circuit itself or to inductive disturbance re-transmitted from other circuits on the line of route. In the case of a telephone connection the latter will be the principal source of trouble to be guarded against, though the calling apparatus may also produce disturbance similar to that of the Morse telegraph. To obviate these troubles the following precautions are adopted:

(*a*) Telegraph or telephone circuits are led into the station by a short length of underground cable, so that the exposed land line is at least 30 yds. or 40 yds. distant from any part of the aerial wire system of the radio-telegraph plant.

(*b*) The land-line apparatus and wiring are located in the operating room as remote from the radio-telegraph apparatus as possible, consistent with convenience in having both sets of apparatus manipulated by one officer.

(*c*) Twin wiring is adopted for the connections of the apparatus and batteries (if any), and the wiring methods used in telephone exchanges to avoid induction are followed in radio-telegraph stations as far as possible.

* Abstract of a paper read before the Institution of Electrical Engineers.



U.S. Signal Corps Wireless Pack Set in Operation

This shows the transmitting and receiving instruments, the hand generator, and the base of the sectional mast. The officer in the picture is Major Squiers of the Signal Corps, whose recent researches in multiplex telephony have been occupying much space in the technical journals.

U.S. Signal Corps Wagon Set

This is the generator and gasoline engine used where the higher powered outfits are required. The generator is of the alternating current type, and is directly coupled to the engine. Suitable field rheostats and switches are provided for perfect current control and constant voltage.

(*d*) The necessity for having the land circuit apparatus under the surveillance of the wireless operator renders it desirable to provide a visual and noiseless call in the shape of a small telephone exchange glow lamp.

(*e*) The land-circuit earth connection should be made separately to an earth-plate distinct, and separated by at least a few yards, from the main high-frequency earthing system of the wireless telegraph plant. If the earth-plate is buried at a moderate depth below the surface of the ground, immunity from interference on this score will usually be assured. An alternative plan is to "double back" the land telegraph wire and find earth at a convenient distant point.

(*f*) Interference from sparking at relay and key contact points will not usually occur if the scheme of twin wiring has been effectively carried out. If, in spite of these precautions, interference is still appreciable, it may be minimized by shunting the contacts by a condenser of about 1 mfd. capacity with a non-inductive resistance coil of about 500 ohms in series with the latter.

There is also the reverse action to consider,—viz., the powerful electrostatic induction of the wireless transmitting plant on the land line and Morse apparatus. In the case of wireless telegraph transmitters with coupled or closed circuit excitation, troubles of this kind are not very apt to occur; doubtless, because of the building up of the aerial oscillations by resonance and their extremely transient duration. On the other hand, if "plain aerial" transmission, or any form of transmission involving pre-charging of the aerial system prior to disruptive discharge across the spark-gap, be used, strong inductive disturbances are liable to be created on neighboring circuits.

So far as inductive disturbances, due to coupled wireless transmitters, are concerned, the precautions observed above in regard to elimination of induction on the wireless receiver are equally effective in neutralizing induction of the land circuit. Methods of transmission involving pre-charged aerials are banned in the British Postal Telegraph Service except as purely temporary expedients, by reason of their emission of waves of a character very prone to produce interference with other wireless stations. As regards the reaction of the high-frequency oscillations on the low-frequency transmitting plant, in postal telegraph practice the wiring of the low-frequency apparatus is effected throughout with lead-screened cable. This is found effective in preventing sparking due to electrostatic induction whilst further aiding in reducing the effects of "back surges."

Commutator ripples are specially prone to occur in a penetrating and obtrusive form where power plant is installed for charging accumulators, and are greatly accentuated during the process of cell charging. In such cases it is desirable to exclude the charging circuit completely from the operating room. Where trouble is experienced from commutator humming or sparking during the ordinary running of the plant (apart from the charging of accumulators), it is desirable to adjust the brushes whilst listening on the telephone receiver.

MUTUAL INTERFERENCE BETWEEN STATIONS

This is a peculiarly involved problem in view of the number of variable factors concerned. In the first place, the whole question of tuning and selectivity is involved. The theoretical investigation of the possibilities of selective signalling from contiguous stations by the use of wave-lengths differing sufficiently from one another presents no insurmountable difficulties, but its practical realization is quite another matter. It is too frequently overlooked that the resonance curve obtained is really a mean of a number of curves of greater and less amplitude. In certain tracts of sea around the British Islands, where congested radio-telegraph conditions arise, it is sometimes necessary, under present working arrangements, to rely largely on "shouting down" interfering stations. Although, under the International Radio-Telegraph Convention, the range of wave-lengths allotted for ship to shore working is strictly limited and defined, it is fairly certain that no radical improvement in working conditions can at present be expected from any system of allotting distinctive wave-lengths for individual coast stations.

U. S. Signal Corps Wagon Set
Instruments for transmitting and receiving shown in front, while generator set is in the rear. Receiving messages regarding the battle at Agua Prieta, Mexico

Many of the manipulative difficulties at present experienced in radio-telegraph working would, however, be largely reduced if less disturbing and more speedy types of transmitters were adopted at certain Continental stations. Much benefit would likewise accrue from the adoption of a standard method of easily and readily regulating the strength of antenna current to suit the particular communication on hand, such as by a regulating coupling between the closed circuit and the aerial circuit in coupled transmitters.

The problem of selectivity in radio-telegraph working involves much more than mere tuning, and it will be well to consider the interference-producing elements under the following six heads:

(*a*) *Electrostatic Interference.*—This is an effect which decreases very rapidly with increase of distance of separation. It is generally more pronounced in transmitters of the open-circuit type, in which the aerial system is charged up to a high potential prior to discharge across the spark-gap. These may be conveniently designated "precharged aerial" methods in contradistinction to coupled transmitters. One well-known system in which the precharged aerial method is usually adopted, viz., the Lodge Muirhead, will at once be brought to mind. Excellent as are the results which have been obtained with this system, both from the point of view of range of communication and syntonization of stations when using the special devices adopted or invented by the promoters, practice has shown that it is not advisable to attempt to work a Lodge-Muirhead and an ordinary coupled transmitter station using earth in too close proximity, or the result will be disastrous for the latter.

Emphasis must be placed on the disability of the station experiencing interference at close quarters to "tune out" to the necessary extent by dissonance, and it will only be possible to reduce the trouble by greatly reduced coupling of the receiver or other special appliances.

(*b*) *Plain Aerial Interference.*—Interference by pre-charged aerials on distant stations is also of a very pronounced character. This effect cannot, of course, be due to electrostatic induction, but is doubtless determined by the character of the waves emitted.

(*c*) *Heavily Coupled Transmitters.*—These give rise to interference both in respect of impurity of wave-train, due to forcing at the transmitter, and in respect of the well-known double wave emission. Very frequently, however, the former so overshadows the latter that no distinct trace of separate waves is perceptible at the receiver. In this category, it is feared, many of the continuous wave and even the quenched spark transmitters must be placed, unless they be connected in such a way as to reduce damping in the aerial system to a sufficiently small amount. This can, of course, only be achieved by sufficiently reducing the radiation coefficient of the aerial.

(*d*) *Lightly Coupled Transmitters.*—These have most certainly proved themselves to occupy a premier position as regards elimination of objectionable interference. Decrease of range of communication governs the degree to which reduction of transmitter coupling can be carried, but for communication between fixed stations on a fixed wavelength this can be compensated to a large extent by sharply tunable receiving appliances for picking up the waves. For ship and shore communication a very light coupling is impracticable, both by reason of the diminution of range and because if sharp tuning is necessary there will be difficulty in getting into touch. There is, however, no good reason why all installations for coast and ship communications work should not be provided with "stand-by" and "tune" adjustments, not only for the receivers, but for the transmitters. If such a scheme were universally adopted, the "stand by" sides of the apparatus being used only for calling and look-out purposes and the "tune" sides for actual transmission and reception of messages, a very great improvement might be looked for in the conditions of working to ships at sea so far as the British and Continental seaboards are concerned.

Even in coupled transmitters it will occasionally happen that the transmitted waves will be of a more obtrusive and interfering character than the degree of coupling would indicate. This is probably due to forcing and prolongation of the trains of oscillations in the closed exciting circuit, semi-continuous trains of oscillations being produced by an overplus of available energy from the transformer. When this is the case, the oscillations are of impure wave-form and give rise to impure wave emissions from the aerial system. Effects of this kind are much more pronounced where the capacity of the condenser in the closed circuit is relatively small and a large type of high-tension transformer is used. Unfortunately, this scheme of transmitting plant appears to have been rather largely adopted in Continental installations.

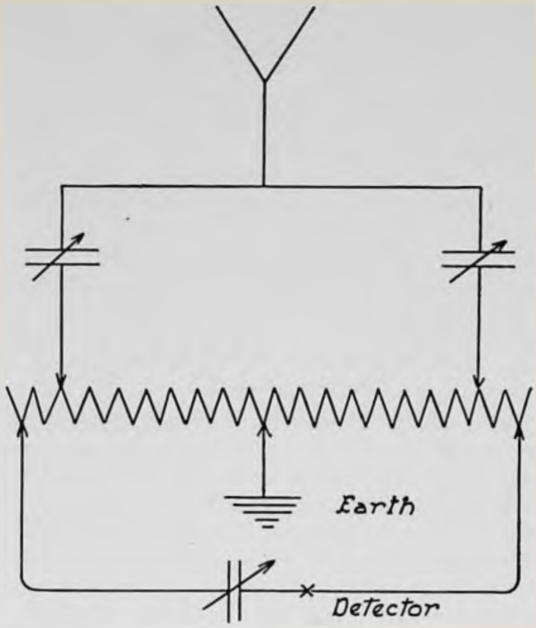
(*e*) *Interference from Continuous Wave System.*—With so-called "undamped" wave systems it becomes necessary, by reason of the small amplitude of vibration excited in the transmitting aerial, to rely to a much greater extent on the accumulative properties of the tuned receiver. It then becomes very necessary to provide closed receiving circuits of extremely small damping in order that the decreased amplitude of vibration may be compensated by making use of a much longer consecutive series of waves in the receiver. At first sight it might be supposed that a very high degree of immunity from disturbance would be secured as between such a system and a neighboring spark system with a small degree of dissonance in wave-length. Though full tests have not yet been made on this point in the post office service, yet there is good reason for suspecting that the degree of immunity in either direction is of a high order where the stations are not greatly separated from one another. This is not altogether surprising in view of the "forcing" action which governs the operation of the "undamped" wave transmitter, so-called. The term "undamped" is surely a misnomer, as any one oscillation considered separately must be very appreciably damped, and the damping necessarily tells on the purity of wave-form. "Continuous wave transmitter" is a better term in this respect, in spite of the fact that absolute continuity is not necessarily obtained.

(*f*) *Accidental Waves.*—Interference produced by emission of accidental waves may sometimes occur if conductors in the neighborhood of the aerial wire, such as the insulated sections of the stay wires or ropes to the mast, are allowed to spark to ground or to one another. This may happen by reason of the powerful electrostatic induction set up. When it occurs, the discharging conductors emit waves of a period determined by their own electrical constants.

(*g*) *Damping in Relation to Interference.*—The effect of damping *per se*, so far as transmitters are concerned, is doubtless bound up with the influence produced on the purity of wave-form, and consequently on the interfering qualities of the transmitter. A more potent factor accruing from damping, however, may be the deformation of waves due to increased "driving" or "pumping" of energy into the oscillator to maintain the oscillations. So far as the receiver is concerned, experience shows that a moderately damped receiver is not nearly so selective in its action as one very slightly damped.

In connection with the prevention of interference at the receiver, the well-known Marconi "multiple-tuner" is considered useful by the author. This instrument combines what are, at first sight, two methods of reducing interference. Primarily, the object is to make use of variable coupling while providing an intermediate circuit of very small damping. The end achieved by the use of the intermediate circuit, so far as interference reduction is concerned, is to enable the maximum benefit to be derived from the reduction of coupling. Without its use, since both the detector and aerial circuits possess considerable damping coefficients, it would not be feasible to reduce the coupling to so great an extent and still preserve signals of readable strength.

In contrast with coupling methods of reducing interference, various plans of divided circuits have been proposed or used in which the impulses conveyed by one branch are annulled by those conveyed by the other, except to the extent necessary for the interpretation of the signals required. In these methods the required signals are "tuned in" as against tuning out undesirable impulses. Fessenden's "differential" method and S. G. Brown's "bridge" method are examples of this class. The basis of the bridge scheme is shown in the diagram herewith. If the two branches of the divided circuit are absolutely symmetrical all received impulses will divide equally and no effect will be produced on the detector (which occupies a position corresponding to the galvanometer in a Wheatstone Bridge). A very slight disturbance of the balance by shifting the point of the earth-wire connection to right or left will determine signals on the detector from the branch



best tuned to the received impulses. If these impulses consist of a sufficiently long train of waves, discrimination is effected between these and any other impulses (even if of the same periodicity), if such other impulses are of a more rapidly damped character. A "valve receiver" interference preventer based on a similar principle has been patented by Marconi.

It is not abundantly clear that devices of this kind possess advantages over, or involve any further principle than, that of reduced coupling. Greater promise of satisfactory elimination of disturbances and perturbations is afforded, in the writer's view, by the adoption of non-earthed directive aerials, at any rate, so far as the shorter waves in practical use are concerned. For communication over short distances between fixed stations, simple balanced directive aerials disposed to radiate in the line of communication give promise of very satisfactory results. These take the form of a vertical triangle, the apparatus being connected in circuit at the midway point of the base line, no earth connection being used. The properties of such aerials have been very fully investigated by Bellini and Tosi and confirmed by post office investigations.

The use of transmitters of high sparking rates or intermittency producing a constant musical note in the receiver lend themselves to acoustical methods of reducing interference both by reason of the possibility of resonating acoustically to the spark frequency and by the comparative ease with which signals of high and constant periodicity can be magnified at the receiving station. This method appears to have been fully worked out by the Telefunken Company, but the plan has not yet been put to trial in the British telegraph service.

ATMOSPHERIC ELECTRICAL PERTURBATIONS

The phenomenon known in operating parlance as "X's," otherwise parasitic impulses or "atmospherics," presents a wide variety of characteristics depending upon the latitude in which they are observed, the season of the year, and the time of day. They manifest themselves in the auditive wireless receiver as a series of scraping, scratching or explosive noises of various intensities, and present distinct periodic characteristics in all latitudes, being stronger, more persistent and prevalent during the summer than the winter months, whilst they also present distinct periodic variation connected with the times of rising and setting of the sun. During thundery weather, especially in the early stages of a storm, they manifest themselves with great intensity and are frequently precursors of stormy weather. At periods of magnetic storms no exceptional characteristics are noted unless it be that they are then less marked than usual.

In winter months, in England, these disturbances are rarely strong enough to interfere seriously with traffic, whilst they are sometimes totally absent for days together. The writer arranged for a series of observations to be taken simultaneously at all the coast stations in England during the week commencing December 11, 1910. By a happy accident during the week chosen for the observations, atmospheric disturbances of a more than usually pronounced type for the winter months were experienced on two or three days. The results obtained show that these disturbances affected practically the whole of the British Islands, though they did not, apparently, possess the same characteristics of intensity at all places simultaneously.

With regard to means of reducing interference due to "atmospherics," no special devices are at present in use at the British coast stations, and it is problematical whether any entirely effective arrangement is possible, for the reason that a rough comprehensive kind of tuning adjustment is essential at these stations for their normal receiving arrangement or "stand-by" adjustment, in order that calls on a variety of wave-lengths from ships may not be missed. For actual reception of messages, however, the sharply tuned adjustment with variable coupling can be resorted to, and the intensity of disturbance thereby much diminished. Tuning alone does not appear to be by any means a complete solution of the problem, doubtless for the reason that most, if not all, of the disturbing impulses have no specific wave-length or frequency of their own. They appear to be due to sudden changes in the electrical state of the atmosphere.

Various devices have been proposed from time to time for eliminating or reducing these interferences, but, so far as the author is aware, the degree of success attained is not greater than is possible by the use of sufficiently light coupling combined with a "detuning" of the aerial carried out on the following lines: (1) Reduce the coupling of the receiver to a minimum for good strength of signals, having all circuits well tuned. (2) Throw the aerial circuit out of tune (preferably on the short-wave side) as much as possible consistent with preserving the signals well above the minimum readable strength. (3) Increase the damping of the aerial system (by suitable resistance inserted) to as great an extent as possible without reducing the signals below readable strength.

The comparative immunity of wireless stations from actual damage by direct lightning flashes is rather striking, in view of the exposed positions and nature of the constructions.

PERTURBANCES OF WAVE-PROPAGATION EFFICIENCY OF THE DIELECTRIC MEDIUM

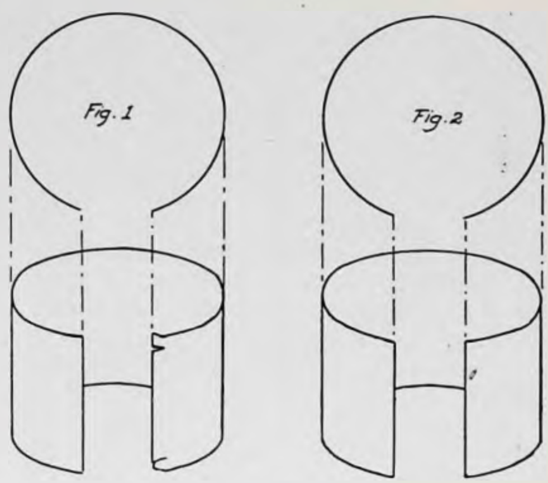
These exhibit almost the same characteristics of irregularity as atmospheric impulses. These variations of range are not found to synchronize definitely with the periods of atmospheric disturbances, though it may well be that more disturbances are observed when the range extends. The author has, however, observed these remarkable variations in range on nights when "atmospherics" have been conspicuously absent. Communications taking place at ranges of less than 100 or 200 miles appear to be rarely, if ever, influenced by this phenomenon in these latitudes, and it does not, therefore, greatly concern the working of coast stations. It appears probable that the phenomenon is closely connected with changes of an electrical nature occurring in the upper regions of the atmosphere, and the author ventures to suggest as a possible clue that the effective receiving range of a station is determined, not so much by the height of its aerial system as by the height from which it will experience inductive influence, or, in other words, the height to which the lines of electric strain emanating from the aerial under the influence of the atmospheric potential gradient will persist.

SOLDERING AND BRAZING

H. W. H. STILLWELL

To know how to solder and to know how to solder perfectly are two entirely different things. Almost anyone can close a hole in some old or worn receptacle, a tea kettle, wash boiler, tin pan, or any of the numerous and more or less abused articles to be found about the ordinary household. As I have said, anyone can close such a hole with solder, but will the job be a good one, a thing of beauty, and certainly not always a joy forever? It is not the purpose of this article to go too much into details, as it is thought that the reader will understand the uses of the ordinary tools, apparatus and other paraphernalia, which are commonly used in soldering. It is hoped, however, that it may correct some of the weak points in this much-abused art and offer some new and practical suggestions which are not understood by many; even good mechanics, who have not had any use for it, have not taken the trouble to add this very necessary and highly important chapter to their mechanical knowledge.

Soldering and brazing are very much alike in many ways, the results are about the same, that is uniting two surfaces or metallic edges, by some metal or alloy which must be more fusible, however, than the metal or metals to be united, and with this object the components and their relative amounts are varied to suit the character of the work. Technically speaking, soldering and brazing come under the same heading, although each has its particular uses, and would not be suited to all classes of work.



The old saying, "There's nothing new under the sun," seems to hold just as good now as it ever did, and even in the art of soldering it can be well applied. It is said by authorities that the art was employed in ancient Egypt, vases made of overlapping plates supposed to be soldered together have been found which date back to 1490 B.C. It is said that Alyattes, king of Lydia, possessed a vase and pedestal made from silver, iron and gold, the various parts being soldered together, and was probably constructed in 617 B.C. In these days the art is practiced by many, but thoroughly understood by comparatively few, and is it not strange that more attention should not have been given to it by the layman as well as the mechanic, to perfect one's self in an art that is as antiquated as this?

The various solders are distinguished by names denoting the quality, composition, or the use for which intended, as hard, soft, button, pewterer's, plumbers', tin, copper, silver, spelter, gold, white, etc.

Solders which require a high temperature to fuse them, such as a red heat, are called hard solders, and are employed in joining brass, iron and the more refractory metals. Solders which melt at a comparatively low temperature are called soft solders. The common tin solder composed of 1 part tin and 2 parts lead is perhaps the best known example of this class. Spelter and silver solders are the most generally used among the hard solders, composed of silver, copper, brass and arsenic in varying proportions to suit the needs of the work upon which it is to be used. To give anything like a complete list of the varieties of solder and alloys used in soldering and brazing would require more space than is here available.

The mechanic is often called upon to repair some part of the shop equipment by soldering or brazing, and not having the necessary articles at hand, or that which is still more important—the *knowing how*, is often at sea, and contents himself with repairing the trouble with ordinary solders at hand, and let it go at that. Many an enterprising mechanic has found himself much embarrassed when asked, by the boss, to do a more or less simple job. He may have been a good man, although careless of some such little kink or bit of mechanical knowledge that could have been fitted into this little opening of his career; and who knows but that he might have risen in the estimation of his employers? The modern employer wants a man who is on the job, and if he is not, he not only falls in his estimation but loses caste as a mechanic, which is even worse.

There are numerous methods of applying heat in soldering and brazing, such as, naked or open fire of coals, hollow furnace or muffle, immersing in melted solder, pouring on melted solder, blowing stream of heated air, blow-pipe flame, alcohol flame, heated iron not tinned, heated copper tool tinned, etc. These methods are employed in different classes of work.

TO BRAZE IRON AND BRASS

An excellent brazing spelter for small articles of brass consists of 5 parts copper, 3 parts zinc and 2 parts silver, can be made as follows: Melt the copper first, then add the silver and lastly the zinc; directly the zinc is immersed, stir the molten alloy so that its composition will be uniform throughout, and then cast in small ingots. These ingots may be rolled down to form a sheet about .049 or No. 18 B.W.G. in thickness. From this narrow strips may be cut as desired.

If the seams of the article or articles to be brazed are not to stand much working after being joined, they may be joined edge to edge (Fig. 2). When seams are joined in this way it is advisable to file very small nicks about ⅜ in. or ½ in. apart along the edges so that the solder flowing through the nicks will render the joint sound (see Fig. 2). If the seam is to be worked or hammered after brazing, a small lap is quite necessary to ensure adequate strength, to make a neat lap it is necessary to thin the edges of the metal along the ends which are to form the seam about ⅛ in. from the edge, so that when they are joined, the combined thickness will be the same as a single thickness of the metal in other parts. To overcome the difficulty in holding edges in place, a small cramp should be cut at the top and bottom of the seam (Fig. 1), fit the opposite edge in these cramps and secure in place with binding wire. After preparing the article to be treated, powder some borax, add enough water to form a thick paste, this forms the flux. Place a little of this along the parts to be soldered, gently heat the article by some convenient means, such as a Bunsen burner, gas torch, or foot bellows and blow-pipe. The heat must be applied gradually to ensure equal expansion and not disarrange the seam; increase the temperature until the metal, at the seam, is a dull red, then take a strip of the solder, dip end in borax flux, rub along the seam until a little melts off. It is best to hold solder strip with pliers, or fingers may suffer. The solder must be kept in a molten state and with a piece of wire flattened at one end, rub the solder along the seam until every part is joined. If it is desired to repair small articles of iron, they may be handled much in the same manner as the above with the exception of the alloy which may be made from equal parts of copper and zinc, omitting the silver. If the iron is to be hammered or subjected to much working after being soldered, the alloy should be 2 parts copper and 1 part zinc; this will be found to be much more suitable. With the two last-named solders mix equal parts of borax paste and grains of solder. Sufficient of this mixture should be spread along the seam to solder when melted. If the solder does not flow freely, a receptacle containing dry borax should be kept close at hand, a little of which may be thrown upon the solder which will remedy the trouble.

TO BRAZE THIN TUBING AND MUSICAL INSTRUMENTS

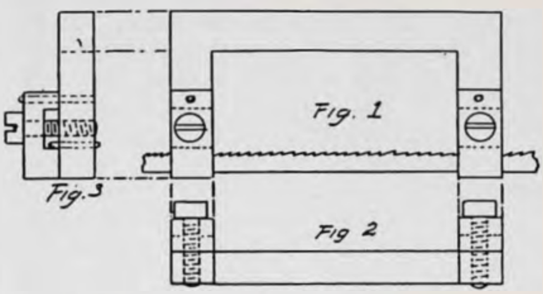
A very excellent alloy for brazing thin tubing and parts of musical instruments can be made, using 6 parts copper, 5 parts zinc, 3 parts silver. This may be cast in an ingot and rolled down to any desired thickness after which it may be cut into strips of suitable sizes.

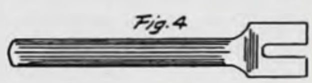
BRAZING STEEL

It is often desirable to braze small steel pieces. This may easily be done by using an alloy of 18 parts silver, 2 parts brass wire, 1 part copper wire. When this alloy becomes cold it may be beaten into a sheet or granulated while molten by pouring into water. A solder that will flow at a lower temperature than brass wire should be used for small articles. In brazing, the parts to be united must be carefully cleaned, coat with pulverized borax which has been previously heated; take small piece of solder, place on parts to be united and heat article until solder melts. Do not use any more of this alloy than is absolutely necessary to make a neat and strong joint.

TO BRAZE BAND SAWS

In the pattern, carpenter and woodworking shop, much inconvenience and annoyance is sometimes caused by the breaking of the band saws at times when most needed. Extra ones are not always on hand, therefore quick repairs must be made. The necessary tools for these operations are few and simple, and can be made by anyone with a little mechanical knowledge in a short time. Dimensions are not given in the accompanying drawings, for the reason that the tools must vary in size and strength to suit the thickness and the width of the band saws to be brazed. The clamp (Fig. 1) should be made as shown in the sketch, from stock heavy enough to stand the necessary strain. In Figs. 1, 2 and 3 the various views of the clamp are clearly given, and from these there should be little or no difficulty in constructing them. Fig. 4 illustrates the iron heating fork which is also a very important part of the equipment, and should have an iron handle long enough so that when the prongs or jaws are heated, the handle may be grasped with the hands when brazing. When all is





in readiness to proceed, file each end of saw for the length of two teeth and secure the ends in clamp as shown in sketch; care must be used to have saw straight in clamps. Twist a loop of iron wire around splice to hold in place; then wrap about a foot or more, according to the width of saw, of soft brass brazing wire about the splice. Apply a little of a saturated solution of borax, enough to moisten the splice. Heat the fork (Fig. 4) to a bright red heat, slip it over the splice so that the splice comes between the jaws. When the brass wire melts and runs into the splice, remove the fork and let the splice cool until of a dull red heat, then quench in oil. When cold the braze may be filed, and the teeth set and filed in the usual manner. There are several methods of brazing band saws, but the above is as good and better than a great many for all around use, and if the directions are carefully followed, the results will be very satisfactory.

HOW A MAGNETO MAKES ELECTRICITY

The Principles Involved and Method of Operation Explained and Illustrated. How Sparks are Produced Mechanically for Ignition Purposes.—Part III

P. S. TICE

The photographs of the magneto fields in the first part of this paper show the armature as having been moved through 90 degrees—from the maximum to minimum inclusion of lines of force. During this travel, the lines of force are distorted from their normally straight paths because of their tendency to travel the path of least resistance; namely, through the most permeable medium, the soft iron armature. However, when the segmental armature pole pieces are set directly across the pole pieces of the magneto field magnets (Fig. 11), they furnish the most direct paths for the lines of force, without including in their circuit the main body of the armature, upon which the wire conductor is wound. It is when the armature pole pieces begin to come into action to divert the lines of force from their paths through the armature body (Fig. 10), that the cutting of the lines by the armature winding becomes rapid enough to induce a current of sufficient value for ignition purposes, the really rapid cutting beginning shortly after the armature position shown in Fig. 10 (for these figs., see May *Electrician and Mechanic*). In Fig. 11, the cutting of the lines by the winding is presumably completed at the highest speed possible, and, therefore, the value of the induced electric pressure is a maximum at this point.

As the armature continues its rotation, in a clock-wise direction from the position in Fig. 11, the lines of force re-enter the armature core and pass through it in the opposite direction from that in which they passed with the armature in the position shown in Fig. 10. In re-entering the armature core and passing through it in increasing numbers, as the armature continues its rotation the winding is again cut by the lines of force and an electric pressure is induced within the winding. The second cutting of the winding, upon the entry

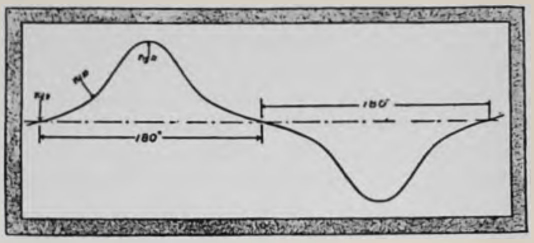


Fig. 12.—Electrical pressure fluctuations and changes in direction of flow in the armature winding through one complete revolution.

of the lines, induces an electric current which is the same in direction as that induced by the exit of the lines, but is an exact reversal of the pressure values due to the exit of the lines. The diagram (Fig. 12), shows this. Here, beginning at the horizontal, zero electric pressure line, the pressure within the armature winding has progressively increasing values as the armature is rotated from the position in Fig. 9. The curve in Fig. 12 represents the rise and fall of this pressure value with its reversals of direction. In this figure the armature positions of Figs. 9, 10 and 11, corresponding to the electrical pressure values of the curve, are indicated. Evidently, the current is at a maximum value in armature position Fig. 11, and is maintained at about this value for a short time by the sudden re-entry of the lines of force in the opposite direction. From the maximum position in Fig. 11, the current value falls off as the armature continues its rotation, until it again becomes a minimum when the armature core lies directly across the field poles.

From the foregoing, it appears that two current impulses of opposite direction, ranging in value from zero to maximum and back again, are induced per complete revolution of the armature. This reversal of the direction of current flow through the winding has caused the induced current to be termed an alternating current. All magnetos, no matter with what type of ignition system they may be employed, generate their electric current in the manner above indicated, although there are several distinct ways in which the induced current is made to cause the ignition spark and ignite the gas.

UTILIZING THE INDUCED CURRENT

The low tension system, or that directly employing the induced current in the ignition of the charge, will be taken up first and considered as type "*A*." Here, the sparking points within the cylinder are arranged so that one of them is movable with reference to the other. In fact, these points form a simple contact switch within the combustion chamber. One of these points or electrodes is supported in an insulation which prevents its electrical contact with the metal of the engine cylinder. One end of the armature winding of the magneto is connected to this insulated electrode through a conductor or bus-bar, and an intermediate spring plunger or spring, called a brush, which latter conveys the induced current from the moving winding. The other end of the armature winding is electrically connected with the body of the armature, and, therefore, with the main body of the magneto and with the engine. This latter connection is termed the ground, and the electric circuit for the induced current is completed by it, when the sparking points are in contact.

In this system, called the make and break, the magneto armature is positively driven from the engine by gears in such a manner that the points of maximum current induction in its winding coincide with the piston positions within the cylinder at which it is desired that the ignition spark occur. Also, the movable and the stationary electrodes are so mounted and operated that the points are separated sharply by the make and break mechanism at the instant at which the spark is to occur. At some time previous to the occurrence of the spark, the movable electrode is brought into contact with the stationary, insulated electrode, and the current induced in the circuit by the motion of the armature is, therefore, short circuited upon itself.

When the points are separated by the operating mechanism, at the instant at which the induced current in the armature circuit is at its maximum, the lines of force through the winding, due to the field of the magneto magnets, and to the field of the current through the winding, are about to be removed and replaced by lines acting in the opposite direction. The break in the circuit

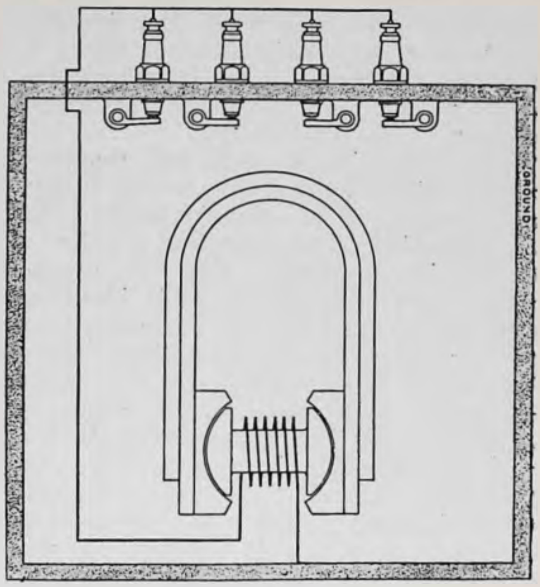


Fig. 13.—Wiring diagram of Type "A" (Make and Break) Systems.

It is here shown how the circuit is completed through the frame work or "ground," the insulated electrodes and the movable, "grounded" contact points. The points on the left are in contact and complete the circuit, which will be broken by their separation at the point of maximum induction in the armature winding.

causes a sudden electric pressure to be produced by self-induction. As explained in the above, when the lines, acting in one direction, are removed from the armature winding, the pressure thereby induced in the circuit acts in the same direction as does the pressure induced by the re-entry of the lines in the opposite direction. Thus, it appears that the spark produced at the electrodes in make and break systems, is due both to self-induction and to the pressure regularly induced by the motion of the armature winding within the magneto field.

WITH VIBRATOR COILS FOR JUMP SPARK IGNITION—Type *B*

In this case it is unnecessary that the the armature be driven positively and in a definite relationship with the engine crank shaft, since a timer is employed for the purpose of timing and advancing the spark. In order that there may be no interference with the action of the vibrator, the armature is driven at several times the engine speed, so that a great number of induced current impulses may be available, and the vibrator act at once upon the closure of the circuit by the timer. This is necessary, in order that the ignition sparks may be synchronous or timed to occur at the same points in the strokes of the several cylinders of multi-cylinder engines.

With the vibrator coil and magneto combination, the magneto serves simply as a generator of electric current for the actuation of the coil, and is called a low-tension magneto. The part played in the system by the coil is identical with the coil action when it is used with either storage or dry batteries. Upon the closure of the circuit by the timer, the current induced in the magneto armature winding flows through the vibrator contact points of the coil, and one of the coil windings, called the primary winding, since it is due to the flow of current through this winding that the necessary magnetic field is created in the coil. (See Fig. 7 in April issue.) Current continues to flow through the coil primary winding and build up the magnetic field about it (increase the number of lines of force through the coil) until the vibrator acts to break the circuit. This action of the vibrator is due to the magnetic field induced about the primary winding by the flow of current through it.

Just here, it should be explained that the coil primary is wound upon a core of soft iron for the purpose of increasing the number of lines of force induced by the magnetizing current. The purpose in so locating the coil primary winding is the same as that explained in the above in connection with the location of the winding of the magneto armature upon a soft iron core; namely, to cause the induction of the greatest possible number of lines of force with a given value by filling, as far as possible, the space traversed by the lines with the most permeable material known. The vibrator itself, or a portion of it, is always made of magnetic material, either iron or steel; and current continues to flow through it and the primary winding until the field due to the current flow is sufficiently strong to cause the attraction of the vibrator, or the magnetic portion of it, also called an armature, against the tension of the spring fitted to resist its motion. Evidently, the intensity of the field about the coil primary, at the instant at which the vibrator is attracted and the circuit broken, can be adjusted by adjusting the tension of the spring which resists the motion or attraction of the vibrator.

When the vibrator and its armature is attracted by the coil core, the circuit through the primary winding is broken, the force which induced the lines of force in the field of the primary is withdrawn, and the lines themselves, therefore, vanish. In so doing, the lines of force cut through the secondary winding and induce an electric pressure within it. Since the value of a pressure induced electro-magnetically depends upon the number of lines of force cut through by or cutting the conductor, as the case may be, it appears that, with a given magnetic field about the coil primary. and a given speed of exit of the lines from the field, upon the breaking of the primary circuit, the pressure induced in the secondary winding is directly proportional to the number of turns in the winding.

With a given initial energizing current flowing through the primary winding, the intensity of the field, or the number of lines of force created, is directly proportional to the number of turns of wire about the core; and, therefore, the relationship of the pressure induced in the secondary winding is to that initially flowing in the primary winding as the number of turns in the former is to the number of turns in the latter. Obviously, this being the case, the pressure in the primary can be "stepped up" so to speak, to any value desired, so long as all the turns of the secondary lie within the field created by the current in the primary. This fact is taken advantage of in the construction of jump spark coils for engine ignition, the relative number of turns in the two windings being so proportioned that the pressure induced in the secondary is sufficient to cause the current to jump a considerable air gap or break in the metallic continuity of its circuit. The temperature of the spark caused by the jumping or bridging of the gap is variously estimated at from 3,000 degrees to about 4,000 degrees Fahrenheit.

There are several other things to be considered in coil construction besides the relative number of turns in the windings. Chief among these is self-induction in the primary winding upon the occurrence of the break in its circuit. Self-induction and its causes have been mentioned in the foregoing, but it was there shown to be of positive advantage (in connection with make and break systems). In this case, however, self-induction is something to be avoided, since it creates a counter field about the primary. This retards the speed at which the lines of force vanish, and therefore reduces the pressure induced in the secondary winding. Self-induction is largely overcome by making the primary of a few turns as possible and connecting a device called a condenser across the vibrator points.

The condenser usually consists of many pieces of tinfoil and possesses, in its entirety, a very considerable surface area. The pieces or sheets of tinfoil are prevented from making electrical contact with each other by thin pieces of non-conducting or insulating material, and alternate sheets are electrically connected in a manner similar to that employed when connecting many battery cells in multiple. The large, opposed surfaces of the condenser become charged by the self-induced current in the primary winding, and, in so doing, absorb this pressure and prevent the retardation of the exit of the lines of force from the secondary winding. Also, through this absorbing action, the condenser prevents the formation of sparks at the vibrator points. These sparks, if permitted to occur, would correspond in origin to those at the sparking points in the make and break, low-tension system.

The charge entering the condenser, upon the occurrence of a break in the primary circuit, acts to increase the rapidity with which the magnetic field is induced about the windings upon again closing the circuit. That is, it acts as a reserve of pressure which is returned into the winding upon the closure of the circuit, and which very much facilitates the rebuilding of the magnetic field, and thus tends to increase the rapidity with which the coil can be made to produce ignition sparks.

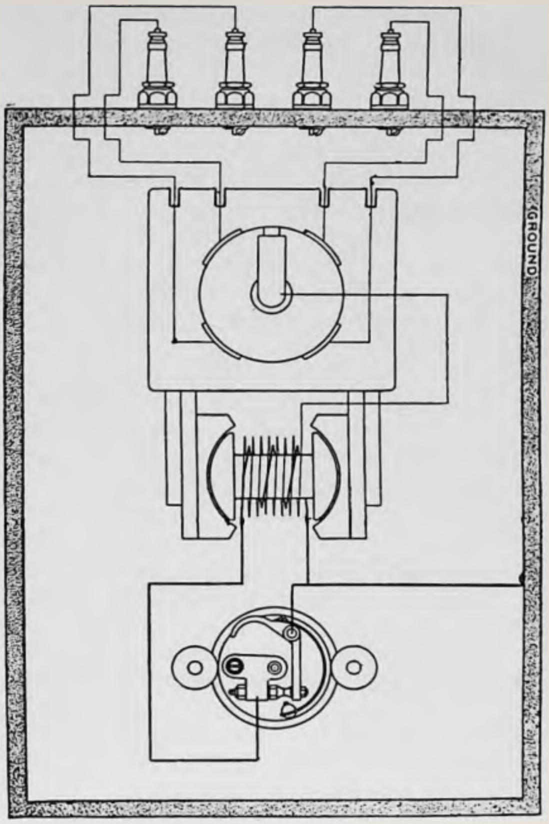


Fig. 14.—Wiring diagram of Type "C" systems (with external transformer).

The primary armature winding, that in which the electric pressure is induced, is here shown short circuited upon itself by the contact points of the circuit breaker. When the pressure has risen to a proper value, the circuit breaker points are separated by the double cam shown, and the induced electric current is caused suddenly to enter the primary winding of the coil, shown below the circuit breaker. The sudden influx of current into the coil or transformer primary winding induces a rapid growth of lines of magnetic force through the secondary winding, and these cause the induction in that winding of an electric pressure sufficiently high to bridge the gaps at the spark plugs, it being commutated to the plugs in proper order by the distributor and wiring shown in the upper part of the diagram.

WITH EXTERNAL NON-VIBRATOR COIL OR TRANSFORMER—Type "C"

The most popular forms of magneto ignition are of two types—in which a single, external, non-vibrator coil is used to transform the low-tension current induced in the magneto armature winding; or of the type in which the windings, for the "stepping-up" of the current pressure value, are incorporated directly into the magneto armature. The system with transformer external to the magneto armature will be discussed first:

The only real difference between the transformer employed in this system and the coil or coils discussed in the above lies in the fact that no vibrator is employed, the break in the primary circuit being caused by mechanical means rather than magnetically. The circuit breaker mechanism is incorporated into the magneto as an integral part of it, and is positively operated at definite rotative intervals, corresponding to the points of maximum current induction in the magneto armature winding. In Fig. 14 is shown a wiring diagram of this system with external coil or transformer.

Referring to Fig. 14, it will be noted that the primary winding of the transformer is so connected with the magneto armature winding that it completes the metallic circuit through the latter. That is, the transformer primary is in series with the armature winding. Also, it is seen that the circuit breaker points, separated at definite rotative intervals by the cam shown, are so connected into the armature and transformer primary circuit that a direct short circuit through the armature winding is caused when they are in contact. The breaker points are here said to be connected in parallel with the transformer primary.

As the induced electric pressure within the armature winding rises in value, due to the motion of the armature within the magnetic field, it flows through the circuit formed by the armature winding and the circuit breaker points until the instant at which it has attained its maximum value, when the contact points are separated by the cam and the direct short circuit broken. When this separation of the points occurs, the induced electric pressure is caused to enter the transformer primary with great suddenness, and create lines of force through the transformer windings with extreme rapidity. This entry by the current, and the consequent creation of lines of force, causes the lines to cut the secondary winding during the formation of the magnetic field about the transformer, and this cutting induces an electric pressure within the secondary, as per the above on electro-magnetic induction.

Of course, with this system, the armature of the magneto is positively driven from the engine by gears, so that the points of maximum pressure induction in the armature winding may coincide with the instants at which ignition sparks are desired within the engine cylinders. Since a single transformer with a single circuit breaker is employed, and all the current for the ignition sparks is generated therein, it is necessary that some means be fitted for the distribution and consecutive connection of the transformer secondary with the proper spark plugs in the engine cylinders. This distribution is accomplished by a distributor, also made an integral part of the magneto, and driven positively and in a definite relationship with the circuit breaker.

Again referring to Fig. 14, it is seen that the ends of the transformer secondary winding are connected, for the completion of its circuit through the spark plugs, one to the engine frame (grounded), and the other to the radial, revolving central arm of the distributor. The distributor arm receives its current from the secondary winding through an intermediate brush, and delivers the current to metal pieces, in electrical contact with the spark plug electrodes, through a second brush incorporated into its other end. These brushes are usually of carbon in the form of guided plungers backed by light helical springs for the maintenance of contact.

The distributor proper is so constructed that each of the metal pieces which connect with the spark plugs is separated and insulated from all the other pieces, and that the high-tension current induced in the secondary will be forced to follow the path selected for it, depending upon the position of the distributor arm. In Fig. 14, and also in the other wiring diagrams, heavy and light lines indicate the so-called primary and secondary circuits, respectively.

(To be continued)

To Drill Aluminum

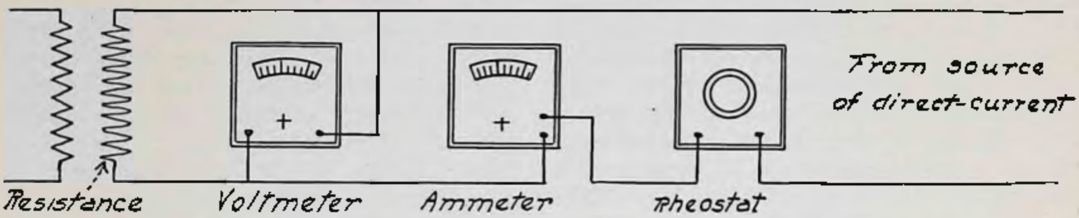
Use kerosene oil (coal oil) for drilling or turning aluminum.

MEASURING RESISTANCE WITH AMMETER AND VOLTMETER

LEONARD WORK

Amateur workers in electricity, in addition to their studies of electrical phenomena, should not neglect the mathematical end of the science, but should learn to make ordinary electrical measurements, at least, and the study of this important part will in general be found quite fascinating.

The basis of electrical calculations, it may be said is Ohm's law, named after its discoverer, Dr. Ohm, a German physicist. It is expressed by the formula $\frac{E}{R}=C$, where C is the current, E the electromotive force, and R the resistance. Other variations of the formula are $C \times R=E$ and $\frac{E}{C}=R$.



For measuring resistance there are various instruments and each is useful in a certain field, but the simplest and perhaps most used by electrical manufacturing companies for measuring comparatively low resistance such as of machine and transformer windings, etc., is the ordinary portable ammeter and voltmeter.

As an illustration of the use of these instruments for the purpose in question, consider the measurement of resistance of the windings of a transformer as it is actually done in the factory.

To obtain the resistance of any circuit it is only necessary to know the exact voltage required to force a definite current through it.

In the present case the terminals of one winding are connected to a source of direct current potential such as storage cells or a generator giving a steady voltage. Included in the circuit is an ammeter and a rheostat of convenient size for adjusting the current.

The maximum allowable current is indicated by the size of the wire on the transformer coil; however, a current much below the maximum capacity must be used in order that the temperature of the coil may not be raised by the measuring current and the resistance increased, as the resistance of copper wire varies with its temperature. Consequently, the use of a large current is very likely to give conflicting results, especially if the readings are not taken rapidly.

A voltmeter is connected directly across the resistance to be measured. Current is applied and raised until a good deflection on the ammeter is obtained when simultaneous readings are made of both instruments. At least three readings are taken, each with slightly different current strengths.

The results may appear like the following:

Volts	76	66.5	55
Amperes	4	3.5	2.8

The first two readings agree precisely and indicate a resistance of 19 ohms; the third apparently shows 19.6 ohms, but considering that the first two values agree, the latter is undoubtedly wrong, and probably due to a wrong observation of the instruments, this not being at all unusual. Sometimes four or five readings will all differ very slightly. In such a case the average is taken.

For very precise results correction has to be made for temperature. A thermometer, attached to the windings prior to the test, indicates the temperature at which the wire was measured. If above 25 degrees centigrade the measured ohms must be reduced by .0042 per cent. for each degree, or if below 25 degrees, the resistance must be likewise increased in order to bring the results to the accepted standard of temperature for measurements.

In testing departments it is customary to work out all calculations on an ordinary pocket slide rule: this wonderful little instrument being an almost indispensable adjunct of the test room. All amateur workers in electricity would do well to obtain a slide rule as it is so easily learned, and its use is so convenient that with it mathematical problems cease to be a drudge and become a pleasure.

NEW METHOD OF MAKING ORNAMENTAL ART PANELS

EDWIN L. POWELL

Burnt wood or hammered brass ornaments, although striking, cannot quite come up to the beauty of the placques which I will endeavor to describe below. The amount of work is not so great, but it must be carefully done.

Get any picture from a magazine or the like which you would like to transfer. Cut out of ¼ in. holly or white maple, a placque that will make a nice sized mount for your picture. Now, take the piece of wood and sandpaper it thoroughly, so that there are no rough places in it whatsoever. The smoother you get it, the better it will be. Give it a coat of white shellac. When thoroughly dry, give the wood a coat of white spar varnish, and then let it stand for one-half hour. Take your picture and lay it face down on the still wet varnish and rub it thoroughly until there are no air bubbles between the paper and the wood. This rubbing should be kept up for half an hour or more, for the longer you rub it the better your results. When you think it has been rubbed enough, lay the whole aside for three hours so as to let the varnish get about half way dry. After this take a damp sponge and rub the back of the paper until you get it so thin that you can see the picture clearly through the paper. Be careful not to let the sponge touch the varnished wood where the picture does not cover it entirely. Lay your panel away over night and let the varnish get completely dry.

When the varnish is dry, take your wet sponge again and rub all the paper off of the face of the wood. You will now find that the picture has been transferred to the wood. Next, take some very fine sandpaper (No. 00) and sand the surface of the panel, going lightly over the picture part so as not to scrape it off, until you have gotten it perfectly smooth. Give it a second coat of white spar varnish, which, when dry, must be rubbed down with powdered pumice stone and water until it takes on a dull gloss. Now give it a third coat of varnish. This last coat must be rubbed down twice: first, with pumice stone and linseed oil, and second, with rotten stone and oil. This operation finishes the panel and makes it look like glass.

The beauty of these placques lies in the fact that though the pictures are perfectly clear, they are also perfectly transparent, letting the grain of the wood show through them. Colors transfer as well as plain black ink. I advised the use of holly or white maple because the pictures do not show up as well on dark wood. Soft white wood such as bass and white pine will not work very well, because it is so porous that all the varnish sinks into it.

Magnet to Halt Runaway

An electric device to stop runaways on bridges has just been invented and patented by P. J. Minck, 55 Beaver St., Brooklyn. The contrivance consists of magnetic plates placed at intervals on the bridge roadways, graduated in degrees of strength of magnetic current.

At a signal from any point that a horse has become unmanageable, the bridge attendants turn a current into the plates and when the runaway and the wagon come in contact with the plates, the animal's speed is retarded, and before he reaches the last set of plates he is forced to stop. The horse's shoes and tires make separate points of contact and make it impossible to evade the magnetic current, it is claimed.—*The Generator*.

IMPROVEMENTS ON THE MICROSCOPE

An instrument of very great interest in making visible minute microscopic particles was exhibited at the Royal Society by Mr. J. W. Gordon and Mr. Fletcher Moulton. It was an improvement on their contrivance for increasing the powers of magnification of microscopes which was exhibited last year. The higher the magnifying power used by a telescope or a microscope, the smaller is the diameter of the transmitted pencil of light. But, to sum the matter up roughly, Messrs. Gordon and Fletcher Moulton place a screen of rough glass in the way of this emergent pencil of light, and by refracting the light rays, give them as it were a fresh start, and broaden the diameter of the pencil of light. There were several objections to this contrivance. One of them was that the grain of the glass screen showed in the microscope, and interfered with the image received by the eye. That was overcome by continually oscillating the glass screen so that its grain should not be perceptible. But that was awkward, too, because the contrivances for keeping the glass always oscillating interfered with the accuracy and disposition of the microscope. So a new idea has been imported; and it amounts to replacing the glass through which the pencil of light was refracted and broadened by a reflecting screen which serves the same purpose and neither gets in the way nor has to be oscillated. The "screen" is a very fine deposit of precipitated sulphate of barium placed on the vertex of the front lens of the objective combination. This objective, used with an ordinary eyepiece, institutes a high power ocular capable in combination with an ordinary high power microscope of magnifying up to eight or ten thousands diameters and supplying a good image. The inventors describe it as a "perfect" image, but it is not certain that any greater clearness of definition is attained.

Two other of the less prominent exhibits at Burlington House deserve special mention. The first consisted of the "Master Gauges" or measurement standards, which were exhibited by R. Kerr, and which are made by C. E. Johansson of Sweden. These little steel ingots are made with an almost incredible accuracy, and with a smoothness of surface which produces an unexpected physical effect. Their accuracy is such that they measure to the one-twenty-five-thousandth part of an inch. Their surfaces are so smooth that when two of these little blocks are placed face to face they stick—just like magnets; and so adhering will sustain a pull of twenty-two pounds to the square inch. Sir William Crookes examined these steel specimens with great interest, and suggested that the reason for the sticking was that the two smooth surfaces came so closely into contact on account of their smoothness that molecular action was set up. It was at any rate a most surprising phenomenon. The other exhibit was the new instrument of Professor Hewlett and Mr. J. E. Barnard for disintegrating bacteria so as to get at their intra-cellular poisons. This instrument has the advantage of being safe in use. The late Dr. Alan McFadyen possibly lost his life through inoculating himself with some typhoid micro-organisms while engaged in grinding them in the apparatus which was designed for that purpose, and which began operations by freezing the bacteria solid by means of liquid air.

Cast Steel

Some tests which were recently undertaken on hardened cast steel to determine the strength of the specimens when subjected to combined bending and torsion, showed that the maximum principal stress is the best criterion of strength for a brittle material when subjected to combined stress. As a rule, while the hardening did not affect the bending strength, there was an increase of 100 per cent. in the torque which was necessary to bring about failure.

To Restore Burnt Cast Steel

Heat the article to a red heat and dust it with a mixture of 8 parts of red chromate of potassium, 4 parts of saltpeter, 1/8 each of aloes and gum arabic and 1/4 of rosin.

A WORD ON THE WINDMILL QUESTION

E. A. FINCH

Since the introduction of the improved Edison storage battery, the question of charging storage batteries by windmill power has acquired new interest, for a period of calm weather lasting six weeks or so would not ruin the Edison battery, and overcharging is said not to be very injurious.

What we are now waiting for is, perhaps, a windmill specially designed for the purpose, with the dynamo mounted on the top gear, so as to eliminate two sets of bevel gears and the vertical shaft, with a considerable amount of friction. If I am not mistaken, it should be possible to pump oil to the top of the windmill for oiling purposes, and thus render it unnecessary to climb the tower except at long intervals. If the axis of the windwheel were inclined, like that of the old Dutch windmills, an effect similar to that given by a side rudder, without some of its disadvantages, would be obtained, and the windwheel would tend to turn out of the wind when the load on the dynamo became too great.

Possibly the gyroscopic effect would seriously interfere with the regulation, but it looks as if it might be possible to arrange the gearing in planetary form, so as to raise a weight and store the excess power for a few moments, until the windwheel could turn out of the wind, or the breeze slacken a bit.

Various forms of windmills have been invented in which the governing is done by centrifugal force. Some of these are without a tail.

The author has a battery charging plant which operates without speed-changing device, overload cut-out, voltmeter, or ammeter. The dynamo is belted direct to the windmill pulley, without even a jockey pulley to tighten the belt, as the reaction of the vertical shaft tends to turn the foot-gear around in the same direction, thus tightening the belt as the windmill speeds up. Charging is considered finished when bubbles commence to rise rather freely from both plates. The charging rate is limited by a series winding on the dynamo which acts in opposition to the shunt winding when current is passing into the battery.

The main trouble with this system is a tendency to speed up tremendously at times. In the author's case, this is counteracted by not using too large a pulley on the windmill, by adding a side rudder to the windmill and by keeping the reefing gear in good order, also by being careful not to turn the windmill too far into the wind.

A centrifugal governor at the foot of the windmill shaft operates a switch which cuts the battery out of the circuit when the speed of the windmill is low.

Sulphating of the battery is avoided to a large extent by the use of a dilute electrolyte containing a little sodium, that is, a little sodium carbonate was added to it.

The outfit has been used for pumping water, running the sewing machine, a small lathe, and the grindstone, also for many interesting experiments.

In ordinary winds, a straight shunt wound dynamo will work very well, but in high winds the belt will be thrown off or a fuse blown. Have not tried M. K.'s idea, but think there may be something in it. In order to test the idea, a series motor was put in the charging circuit, and belted to a pumping jack. An improvised winding reel replaced the pump rod, and a weight was raised by means of pulley blocks. The friction rendered it necessary to pull the weight down by hand, but when the upper pulley was suspended from the reefing gear, it pulled the windmill out of the wind very nicely. With a differential gear in place of the series motor, and due care paid to the avoidance of friction, it looks as if a first class outfit could be constructed, except that the differential gear would involve *some* friction.

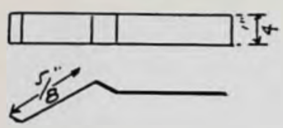
"Mr. Smith," spoke up the young lawyer, "I come here as a representative of your neighbor Tom Jones, with the commission to collect a debt due him."

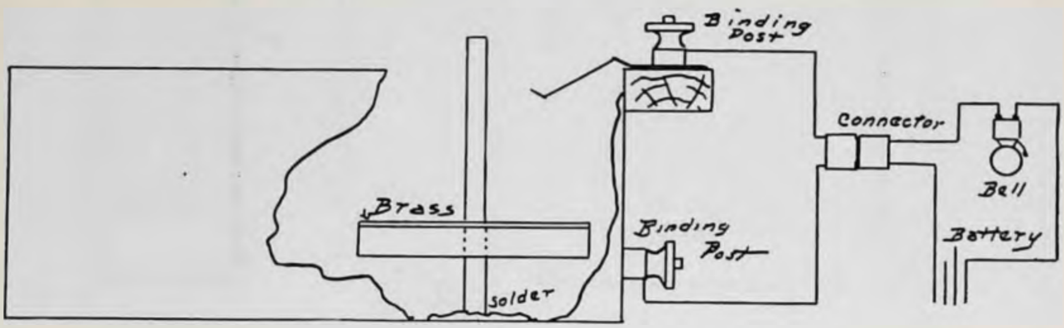
"I congratulate you," answered Mr. Smith, "on obtaining so permanent a job at such an early stage in your career."—*Success Magazine.*

FLOAT SWITCH

GEORGE UZMANN

Some time ago I was asked to devise a float switch for an ice-water drip-pan, which would ring a bell as a signal that the water had reached a certain height. The following are the directions and drawings to build this switch, using a pan having a depth of 5 in.





The float is constructed of cork or wood, having a diameter of 3 in. Over this is tacked a piece of $\frac{1}{32}$ in. sheet brass. Through their centers a sleeve having $\frac{1}{4}$ in. inside diameter is placed, using care that both sleeve and brass make good contact. The contact spring is made of a piece of spring brass, $\frac{1}{32}$ in. thick, bent into the form shown in the drawing. The spring is connected by a binding-post, to a block of wood $1\frac{1}{2}$ in. x 1 in. x $\frac{1}{2}$ in., which is then screwed to the side of the pan. A brass rod 6 in. x $\frac{1}{4}$ in. is soldered vertically to the bottom of the pan, so that the float can make perfect contact with the contact spring. In order to complete the circuit a binding-post is soldered to the side of the pan.

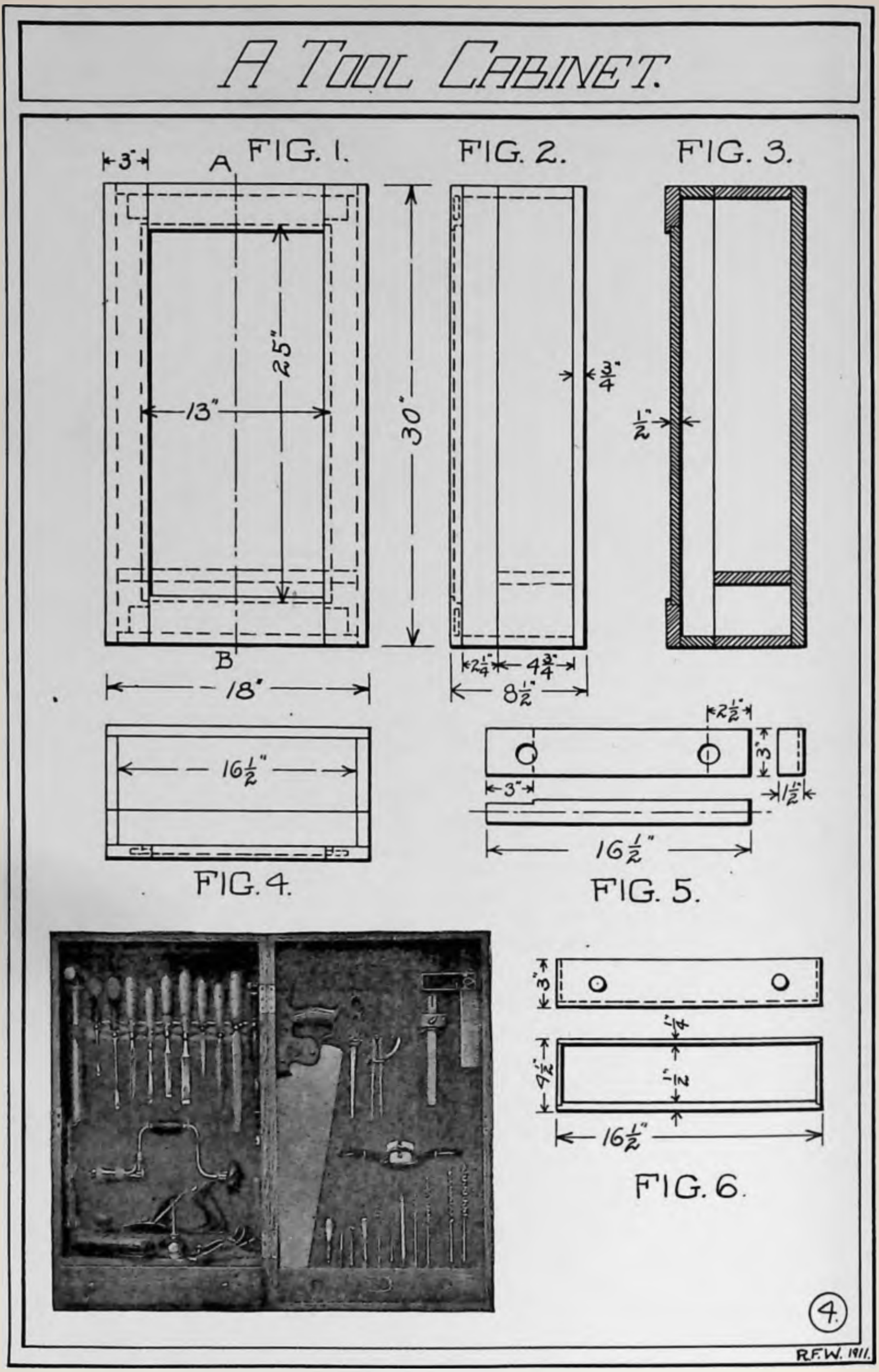
By using a plug connector, manufactured by various concerns, the circuit may be broken, without interfering with the wires at the binding-posts.

By following these directions closely a very useful implement may be constructed for the household.

Strangest Marine Experience on Record

One of the strangest experiences ever recorded in marine history is that of the crew of the British ship *Mermaid*, which was wrecked in Torres Strait in October, 1829. The crew was saved by the war vessel *Swiftsure*, but three days later the latter foundered in a gale, all hands being saved by the man-of-war *Governor Ready*, which also foundered soon afterward. The three crews were rescued by the *Comet*, a revenue cutter. Inside of a few days the three crews and the crew of the *Comet* were cast away again, the *Comet* sinking because of a leak. All hands were saved by the ship *Jupiter*. A week or two later the *Jupiter* capsized, and the five crews were again adrift, but were again rescued. This ended the bad luck, during which not a life was lost and all the rescues were made by vessels which accidentally sighted the sufferers.—*Nautical Gazette*.

It is estimated that the available water power in the province of Quebec amounts to 17,075,039 h.p., and in the province of Ontario to 3,129,166 h.p. The total available water power in Canada is estimated at about 25,000,000 h.p., the equivalent of about 550,000,000 tons of coal per annum.


A Tool Cabinet.
FIG. 1.
FIG. 2.
FIG. 3.
3"
A
25"
13"
30"
B
18"
3/4"
1/2"
2 1/4"
4 3/4"
8 1/2"
16 1/2"
FIG. 4.
2 1/2"
3"
3"
1 1/2"
16 1/2"
FIG. 5.
3"
1/4"
9 1/2"
1/2"
16 1/2"
FIG. 6.
4
R.F.W. 1911.

THE HOME CRAFTSMAN

RALPH F. WINDOES

A TOOL CABINET

The craftsman must supply himself with a suitable storage for his tools when they are not in use, and a cabinet has proven itself the most convenient. It has numerous advantages over the old-time tool chest, among them being its appearance. If well made, it does not look out of place in any room in the house; for when the door is closed, there is nothing about it to suggest its containing tools. Another advantage lies in the fact that all of the tools are in plain view of the owner, and he can immediately tell if anything is missing, and he then has a chance to look it up before it has strayed very far from where it belongs.

Chestnut is an excellent wood to use in the construction of the tool cabinet, as it is hard, rather light and easy to work. If the craftsman has the panel in the door cut out and glued up for him at the mill, he should have little trouble in assembling the rest of the pieces; but it would be excellent practice for him to do all of the work himself. The stock should be ordered as follows cut to exact dimension and sanded:

1 pc. ¾ in. x 18 in. x 30 in., chestnut
2 pcs. ¾ in. x 4¾ in. x 30 in., chestnut
2 pcs. ¾ in. x 3 in. x 30 in., chestnut
2 pcs. ¾ in. x 2¼ in. x 30 in., chestnut
2 pcs. ¾ in. x 3 in. x 15 in., chestnut
3 pcs. ¾ in. x 4¾ in. x 16½ in., chestnut
2 pcs. ¾ in. x 2¼ in. x 16½ in., chestnut
1 pc. 1½ in. x 3 in. x 16½ in., chestnut
1 pc. ½ in. x 13 in. x 25 in., chestnut
1 pc. ½ in. x 3 in. x 16½ in., chestnut
1 pc. ¼ in. x 2¾ in. x 16½ in., chestnut
1 pc. ¼ in. x 4½ in. x 16½ in., chestnut
2 pcs. ¼ in. x 2¾ in. x 4 in., chestnut

In addition to the hardware previously purchased, the following will be needed:

2 small knob drawer pulls
1 lock and key
2 ¾ in. hinges with screws
2 lbs. ¾ in. finishing nails
1 box straight screw hooks, 2 in.
1 box straight screw hooks, 1½ in.

In the drawing, Fig. 1 shows the front elevation, Fig. 2 the side elevation, Fig. 3 a section on line *A*, *B*, Fig. 4 the plan or top view, Fig. 5 a detail of the tool rack fastened on the inside of the door and Fig. 6 a detail of a drawer. In the first four figures the tool rack and the drawer are omitted from the drawing, but their position is easily recognized from the illustration of the inside of the cabinet. The hardware is also omitted from the drawing, its positions being so easily understood.

The first step in the construction is the building-up of the panel, if the craftsman has decided to build it himself. It will be noticed that the drawing shows a panel flush on the inside. This makes a smooth surface on which to hang tools. The first thing to do is to lay out and cut away the groove in the four ¾ in. pieces on the door, in which the panel sets. This should be ½ in. square. Next cut the mortises out of the side pieces, and fit corresponding tenons on the top and bottom members. Glue and clamp these four together and when set, fit the panel in place. This can be fastened by gluing and using a few small finishing nails, nailed from the inside, and held while drying with hand screws.

Next build up the sides and the back according to the drawing, and put in the shelf. The back can be screwed into place onto the sides, and the other pieces nailed and glued together, being sure that the nail heads are set and puttied.

The tool rack on the inside of the door is next constructed. Fig. 5 does not show the location of the holes that are bored along the center line to hold the small tools in place, this being left for the builder to do according to the number of tools he has to put there. The cut on the left end is made to receive the points of the saws. The two holes are bored part way through the piece so that the pulls on the drawer will enter them and allow the door to close tight.

Fig. 6 plainly shows the construction of the drawer, and it should be made and fitted into place without much trouble.

Attach the hardware and sandpaper the cabinet preparatory to finishing. The tools are arranged in place by the craftsman, and he may either use the straight screw hooks, or buy tool holders already to screw into place. Some of the very small tools are put away in the drawer, and all those that cannot be lodged in the cabinet, may find a resting place in the drawers of the bench.

Directions for finishing the cabinet will be found at the end of the next article.

A SCREW AND NAIL HOLDER

The screw and nail holder is easily constructed if chestnut is used. It is a companion piece to the tool cabinet and it offers an excellent stand to place the cabinet upon.

The stock is ordered as follows, planed and sanded:

1 pc. ½ in. x 16¼ in. x 35½ in., chestnut
3 pcs. ½ in. x 2 in. x 16¼ in., chestnut
6 pcs. ½ in. x 2 in. x 12 in., chestnut
6 pcs. ½ in. x 2 in. x 5 in., chestnut
3 pcs. ½ in. x 2 in. x 5¼ in., chestnut
1 pc. ⅞ in. x 14 in. x 20 in., chestnut
2 pcs. ⅞ in. x 13 in. x 40 in., chestnut
4 pcs. ⅞ in. x 12¼ in. x 16¼ in., chestnut

In addition to the previously supplied lists, purchase 1 box 1½ in. 10s blued steel screws.

Fig. 1 is the front elevation, Fig. 2 the side elevation, Fig. 3 the plan, and Fig. 4 a detail of the partition of the nail boxes. The top shelf, on which no partitions are placed is designed for the storage of boxes of screws, screw eyes, etc.

The first step in the construction is the forming of the sides. Nail them together, keeping the edges even, with about two nails so that the heads of the nails are above the surface of the wood, and may be easily withdrawn. Lay out and saw the legs into shape and pull the nails out. By so cutting them out together, much time is saved, and better work assured. Next screw the shelves into place, using three of the round head screws in each shelf. Put the top and back on, and hold them in place with finishing nails. Form the partitions as shown in Fig. 4, and nail them on the lower shelves. Sand the pieces, especially where the legs were cut out, and prepare to finish it together with the tool cabinet.

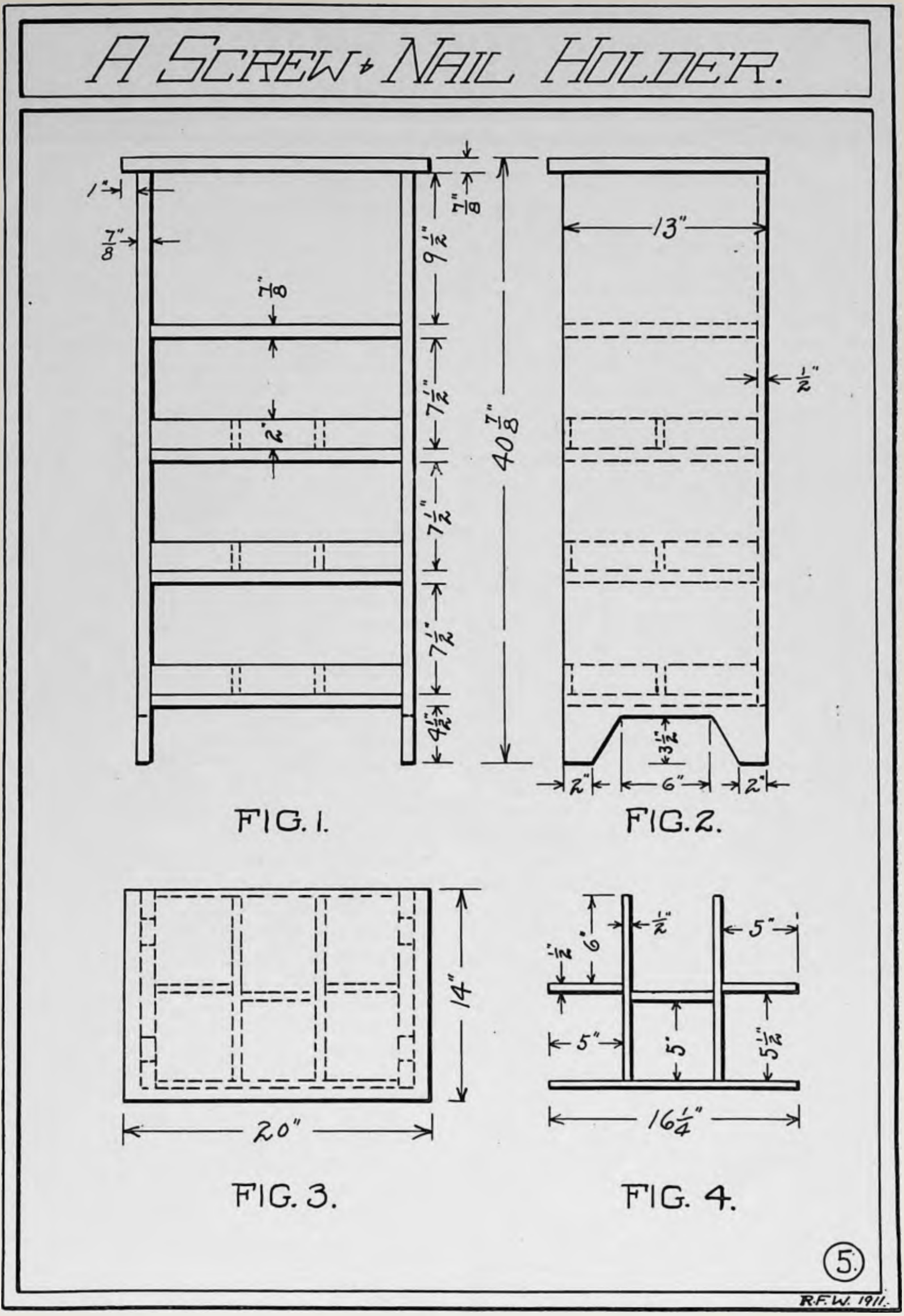
In an open-grained wood, like chestnut, a filler should be used in order to obtain a smooth surface on the piece. Fillers may be purchased or made by the craftsman. In these particular pieces a natural filler should be employed to harmonize with the work bench. If the craftsman desires to make his own filler he may do so in the following manner.

PASTE WOOD FILLER

Mix two parts of turpentine and one part of raw linseed oil and add a little japan dryer. Next stir in bolted gilder's whiting to form a paste. Apply this paste with a brush and let it stand for about 15 minutes, or until it turns gray. The length of time required depends on the amount of dryer used. Rub the surplus off with a piece of cloth, burlap will do, rubbing across the grain. The filling should stand about 24 hours and then given a slight sanding, after which a coat of shellac should be put on. Give this about 15 hours in which to dry and sand it slightly; enough to remove the raised grain. Then apply another coat of shellac and when dry, the articles are ready for use.

If a color to the wood is desired, dry colors may be added to the filler. Burnt umber will give it a golden oak effect, lamp black a weathered oak, etc.

(To be continued)


A SCREW & NAIL HOLDER.
1"
7/8"
7/8"
9 1/2"
7/8"
2"
7 1/2"
7 1/2"
7 1/2"
4 1/2"
40 7/8"
13"
1/2"
3 1/2"
2"
6"
2"
FIG. 1.
FIG. 2.
14"
20"
6"
1/2"
1/2"
5"
5"
5"
5 1/2"
16 1/4"
FIG. 3.
FIG. 4.
5
R.F.W. 1911.

FOR THE LABORATORY

EXPERIMENTAL HIGH-FREQUENCY APPARATUS

STANLEY CURTIS

Comparatively little data has been published on the construction and use of high-frequency apparatus which is particularly well adapted to the use of the physics teacher in the high school or the electrical student who desires to give public demonstrations of this most interesting group of electrical phenomena. The oil-insulated Tesla coil has a considerably higher efficiency than the air-insulated type, which this article will describe, but the Tesla in oil is entirely sealed up, thus, with such a coil, the teacher has no way of clearly showing his pupils just how the apparatus works.

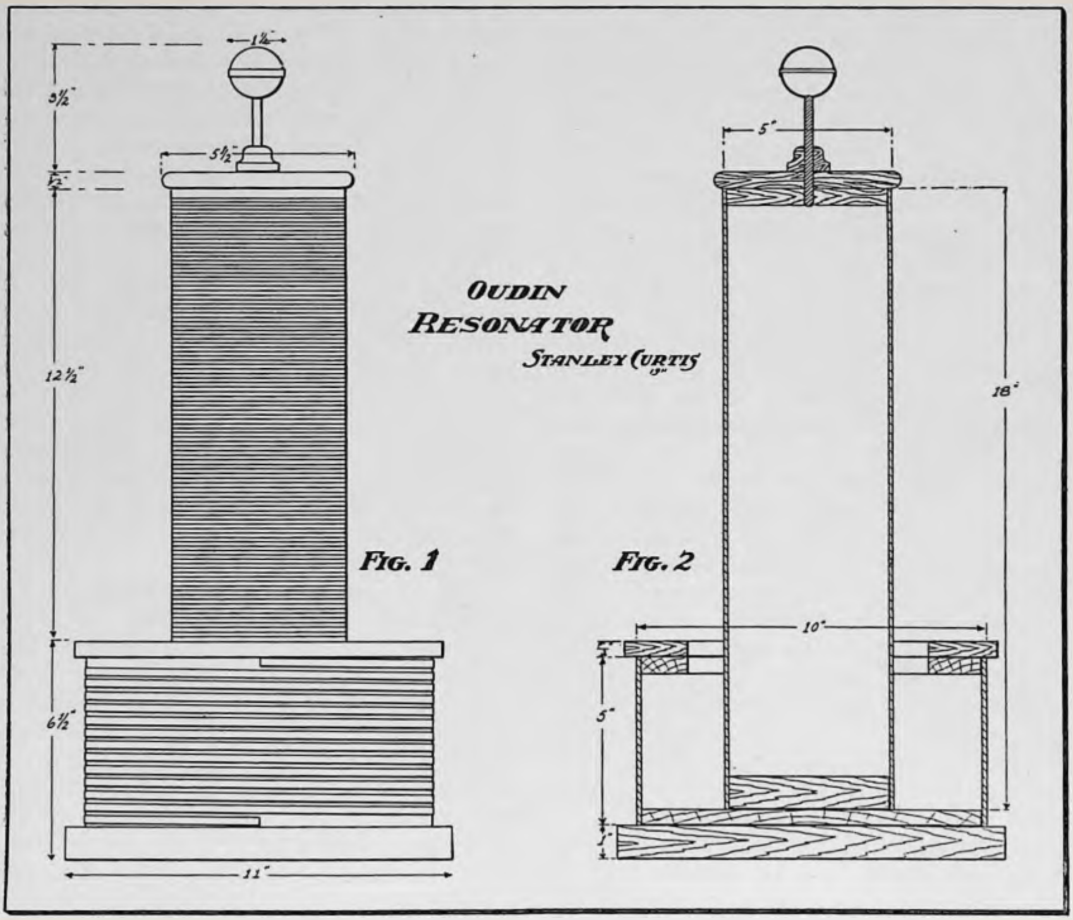
With the open type of coil, there is considerable brush leakage and the primary must be at a greater distance from the secondary in order to prevent the insulation (air) from breaking down. This leakage, however, forms one of the most beautiful features of high-frequency apparatus while it is operated in darkness. The entire coil glows with a soft purple light which increases near the ends or terminals.

For demonstration purposes, either for public or private entertainment, the air-insulated coil is an acquisition. The effects which may be produced by it are spectacular in the extreme and this absurdly simple apparatus has brought fame and fortune to a number of vaudeville artists who were quick to see and take advantage of its possibilities for entertaining the public in a startling fashion. No doubt many readers have seen the intrepid "electrical wonder," who takes hundreds of thousands of volts through his body without flinching, immediately after his manager has made the announcement to the audience that a voltage of only 2,700 is used in the electric chair to electrocute criminals. The electricity the artist takes through his body does reach, in reality, several hundred thousand volts, but the shock is almost entirely absent. The high-frequency discharge if taken on the bare fingers or hand will sting considerably and if the treatment is continued for any great length of time, the skin will become sore and tender. If, however, the discharge is passed into a metal rod or wire held in the hand, the shock is scarcely perceptible providing the primary has been properly "tuned." The high-frequency current merely oscillates into and out of the body and, unless one is making a good ground such as on a damp floor or is standing directly over a water pipe passing through the floor underneath him, the shock can scarcely be felt. Precaution should be taken, however, to guard against the ground, as the shock is very unpleasant under such circumstances.

Among the many experiments which may be performed with this apparatus, none are more important than its application in the X-ray field. While the induction coil is very useful and satisfactory where battery current is available, or where direct current is the only kind on the premises, the Tesla coil may be operated from a small open or closed core transformer on an alternating current circuit with far greater efficiency and more reliable action. The results with the electrolytic interrupter on direct current and a coil giving a short flaming spark are practically as good as with the transformer, but the current consumption is higher and the efficiency, therefore, lower. All of the experiments which may be produced with the induction coil may be reproduced with the Tesla transformer. The absence of troublesome interrupters is one of the greatest advantages, and the operation may be continued for hours at a time, providing the transformer is built.

to stand the work. There is nothing to deteriorate on either of the instruments and the cost of operation is ridiculously low.

For the physician or dentist, who frequently has occasion to use the X-ray, a small high-frequency outfit is low in cost, perfectly reliable in operation and the results obtained on the fluorescent screen and the photographic plate are equal in every particular to those obtained with the induction coil and regular tube. For use with high frequency currents, a special form of X-ray tube must be used. This tube has an arrangement by which the streams from the two terminals are focused upon a target in the center of the tube and from which the X-rays emanate. This target is in no way connected to the terminals of the tube, and therein lies the difference between the high-frequency and the regular or "direct current" tube. If a regular tube is used on high frequency current the glass will be blackened within a short time and the tube rendered useless. The high-frequency current is, of course, alternating and it is thus utterly impossible to cut out the "inverse" from the coil. With an induction coil this is cut out by merely inserting a small spark gap in series with coil and tube. High-frequency tubes which may be run from the coils to be described may be purchased from advertisers and the price is but a trifle higher than for the ordinary tube. By using a somewhat larger transformer and raising the discharger pillars a trifle, the outfit will take care of heavy hospital X-ray work and will give great satisfaction. The coils may be made to give from 6 to 14 in. sparks, according to the size, of the low-frequency transformer and the care with which the apparatus is made.



The importance of properly "tuning" an oscillation circuit is strikingly shown in the operation of the Tesla or the Oudin resonator, which is practically the same with the exception that one terminal of secondary is grounded to the end of the primary, thus making it a form of auto-transformer. Unless resonance is obtained, the spark length and the thickness is greatly reduced. The difference of but two turns on the primary of the Oudin resonator, from which this description is taken, will cause a difference of nearly 3 in. in the spark length. For this reason in particular, the air-insulated coil, in which the primary is wound on a drum or cage the same as a wireless telegraph helix, permits a greater flexibility in use; that is, it may be used with various coils and condensers of different capacity, with high efficiency as the circuit may readily be tuned by moving the primary clips from one turn to another until the proper point is found.

For the reason that many readers may already own a coil or transformer which would operate a Tesla, the construction of the high-frequency coil itself will first be taken up. Later articles will describe both open and closed core transformers suitable for operating the Teslas of various sizes, and another article will be devoted to a description of the experiments, both practical and interesting, which may be performed with the apparatus. Photographic illustrations of the effects produced will be shown and the subject of tuning will receive due consideration.

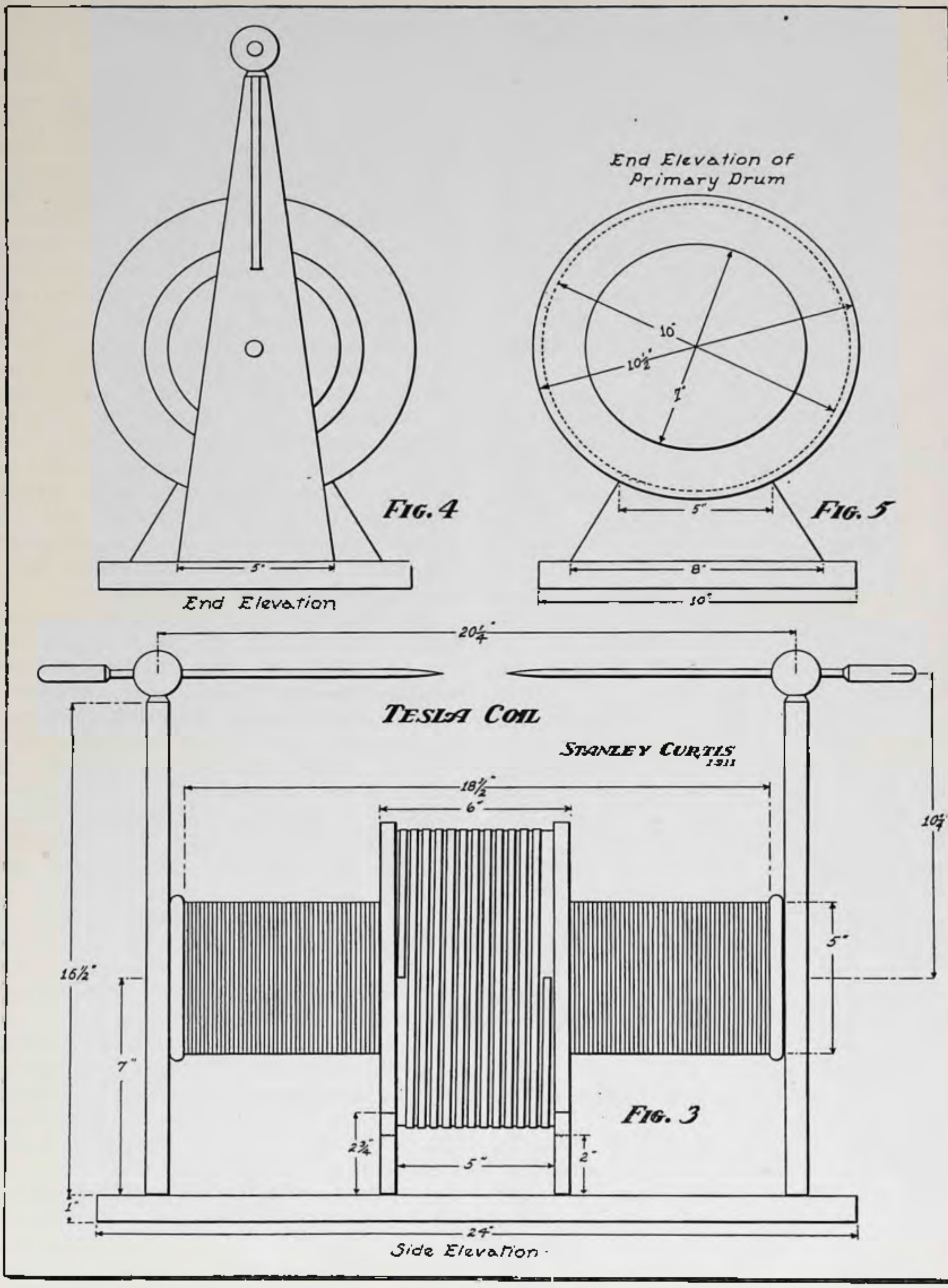
At the start, it may be well to state that an induction coil giving a long thin spark is quite useless for practical work with this apparatus. The sole purpose of the induction coil or transformer in this case is to charge a condenser of large capacity and it is the oscillatory discharge from the condenser across the gap in series with the Tesla primary which produces the high-frequency-sparks. As most readers will understand, the long, thin spark possesses but little current or amperage, although the voltage is enormous. When such a coil is connected to a big condenser there is not sufficient current to charge it, and the discharge is very weak. A wireless telegraph transformer is splendid for the purpose as are also the induction coils which give a very thick and hot spark. A very high voltage is not essential and the writer has obtained some of his best results with a closed core transformer which delivers a secondary voltage of but 5,000. From this figure to 20,000 is a good margin and no advantage accrues from the use of a higher voltage unless the transformer is of large capacity so that the current output may be correspondingly great.

The first requisite in building this apparatus is to have the materials perfectly dry. The cardboard tubing and woodwork should be thoroughly dried in the oven and then varnished while warm. This will seal up the pores and prevent moisture from entering. Complete sets of parts for making these coils may be purchased from advertisers and the materials in these sets are thorougly dried and treated.

The Oudin resonator will first be described, as its construction is somewhat simpler than that of the Tesla coil. The Oudin is more useful in public demonstrations than the Tesla, as it has a single terminal at the top from which sparks may be drawn, etc. Its appearance in the dark is still more striking than that of the Tesla, and the brush discharge is in the form of long, flame-like streamers.

Fig. 1 gives a side elevation of the completed instrument. Fig. 2 shows a cross-section through the center. The secondary is wound on a heavy cardboard tube, 18 in. long and 5 in. in outside diameter. This tube is fitted with turned wooden heads, the upper one of which is made slightly larger, so as to provide a neat finish to the top of the cylinder. The construction is entirely with wooden pegs and glue. No nails should be used. A brass ball is mounted on the top of the head of cylinder and its shaft is passed through into the cylinder. The starting end of the secondary winding is soldered to this shaft or rod. If the ball has a ring around it as shown in the drawings, the effect will be still more weird.

The cylinder may be mounted in a lathe or an improvised winding machine and the wire laid on. The winding consists of 800 to 900 turns of No. 30 s.c.c. magnet wire. The turns should



be spaced about the width of a piece of the wire apart. There are several methods of doing this, and the easiest and best is to use the screw-cutting lathe with the gears set to cut a No. 56 thread. If no lathe is available, the winding may be put on with a piece of heavy cotton thread between turns, the thread being taken off when winding is completed. No. 30 s.c.c. wire winds

64 turns to the inch with close winding, therefore the winding of 56 to the inch will put on rather more than 900 turns if a space of ½ in. is left at top and bottom of cylinder. The spacing is not absolutely necessary if the coil is not to be worked to its greatest capacity, but there will be sparks between turns unless this precaution is taken if a large transformer is used. After completing the winding, the wire should be carefully covered with thin shellac varnish, several coats being applied and each coat permitted to dry before the next is put on. The final drying should be in a warm oven to harden the varnish.

The primary may consist of solid or stranded wire or of copper ribbon. The stranded, tinned-copper wire which is used for aerials gives excellent results; the ribbon is next best and the solid conductor is the least efficient. With the exciting apparatus to be described, the primary should contain from 12 to 15 turns of conductor. In the writer's coil, the point of resonance is on the eleventh turn from the bottom and one turn either way will greatly reduce the efficiency. The drum may be of heavy paper wound around two rings of dry wood, as shown in Fig. 2, or a cage may be made of dowels fastened between the rings of wood. The same precautions for drying apply here, although the extreme care is not so essential. The primary is wound around the drum or cage with a small space between turns. This space may be ⅛ in. The starting and finishing ends of the coil may be secured with a piece of thread passed through the cardboard, in the case of that construction, or the end of the wire or ribbon may be bent around a dowel and clamped with a brass bolt. The use of iron in the construction of the coil should be avoided.

The end of the secondary wire is soldered to the end of the helix and connections are made to the helix by means of brass clips and heavy flexible wire, or, preferably with thin copper ribbon.

The primary and secondary of the Tesla are wound in exactly the same manner as the Oudin. Both ends of the cylinder, however, are finished off with the flange as described for the top of the Oudin. The primary drum is supported on brackets as shown in the end elevation in Fig. 5. The baseboard may be of any dry, well-seasoned wood and it should be provided with short pieces of glass rod at its four corners to serve as feet. The method of supporting the ends of the secondary is illustrated in Fig. 4, which is an end elevation of the completed instrument.

In the Tesla coil the starting and finishing ends of the winding are soldered to pieces of copper ribbon which are carried through slots in the supporting pieces and up to the brass ball terminals as suggested in Fig. 4. The primary and secondary windings have no electrical connection whatever in this case. The discharging rods are of aluminum or brass and they should be sharply pointed and highly polished. The end on which the handle is fastened should be rounded to lessen the leakage in the wrong direction. The handles may be of hard rubber, fiber, or of small glass test tubes which have been filled with sealing wax with the rod inside.

The dimensions given are so proportioned that the coil may be worked with the full output of a ½ kw. transformer without having sparks jump from secondary to primary. For larger transformers, the size should be increased a trifle if longer sparks are desired. If sparks longer than 10 in. are to be taken between points, the discharger pillars should be raised somewhat. This will prevent the discharge jumping to the primary helix.

(To be continued)

Hearing Rain Squalls by Wireless

E. D. ROSENWALD

Mr. Magny, operator on board the French steamship *Niagara*, Captain Juham, referring to discharges of atmospheric electricity in a distant storm and the resulting trouble in receiving wireless messages, states that he can by this means hear the rain falling upon the sea at a great distance. The sound is like the pattering of rain on a zinc-covered deck, and its increasing or decreasing intensity tells him whether the squall is approaching or receding. "I am so sure of this fact," he states, "that when I hear the pattering, I go quickly to the top of my wireless station to grease the insulators."

NOTES ON TRANSFORMER AND ELECTROLYTIC RECTIFIER

THOS. C. STANLEIGH

In view of the fact that a number of readers are having some difficulty in making the transformer and rectifier described in the January issue do their work in a satisfactory manner, the author offers a few suggestions as to how the difficulties may be overcome. In every case the builder is positive that he has followed instructions closely and that the trouble may or must be in the design or specifications of the instrument. Perhaps it would be as well to state at the beginning that the design of this set was not based upon theory, but the description given was taken directly from a finished outfit which was then and is now giving the best of satisfaction in the author's laboratory. A few examples of the most common difficulties which have been brought to our notice will be discussed, and we sincerely trust that the readers to whom these errors apply will not take offence or think that we are casting reflections upon their ability to follow instructions, for our sole motive in bringing up these cases is to prevent other builders from making the same mistakes.

Out of the large number of letters received relative to this set, only one advised us that the transformer would not work at all. Considerable correspondence followed and we were at a loss to place the trouble until we asked for a sample of the iron which was used for the core. Upon the arrival of the "iron" we promptly discovered that the magnetic core of the transformer was built up of sheet zinc,—and the author of this letter was not very particular about the way in which he expressed himself. It was his opinion that the writer for a magazine such as *Electrician and Mechanic* should know his business.

As many as five letters have been received stating that the choke coil had no effect whatever upon the output of the transformer. In one of the cases, the builder afterwards discovered a short circuit between the two wires leading from the impedance under the base. For some unaccountable reason the wires had been twisted together and placed in a single groove under the baseboard. A tack placed also in the groove effectively short-circuited the wires. The other four cases were caused by the use of a piece of brass tubing for the bobbin of the impedance instead of the fiber tubing as suggested in the article. One of these cases, the first one, threatened to become a puzzle. The correspondent stated that his transformer gave excellent results and that its capacity was considerably higher than the rated 200 watts, but that he could secure no regulation whatever from the impedance. He appeared to have closely followed instructions and the only change he mentioned was in the iron core of the choke coil. This he constructed of sheet iron instead of iron wire. We were positive that this alteration could not make any difference and it was not until we had received a second letter from him asking if the use of a piece of brass tubing in place of the fiber would make any difference in the action, providing the wire was carefully insulated from the tube. This solved the problem for us and a little thought will clearly show that the brass tubing forms a closed secondary circuit of very low resistance around the core of the choke coil, thus converting it into a step-down transformer in which the secondary was closed by a dead short-circuit. We know that the current flowing in the primary of a transformer is proportional to the load on the secondary; therefore, when the secondary of this diminutive transformer was short-circuited, practically the full-load current was passed by the primary and the result was little or no impedance in the choke coil.

There is little or no advantage in the use of brass or other metal tubing in this place, and if fiber cannot be obtained the builder may use a tube made of drawing-paper and well coated with shellac between layers. If a metal tube is used, it must be cut entirely through down the wall and this slot should be filled with shellac, sealing wax or other insulator which will harden in place. After this the iron core which slips into the tube must be insulated from contact with the inside of the tube. If these precautions are taken, no difficulty will be experienced, but it will probably be found easier and just as satisfactory to use paper or fiber. The same applies to the covering or the container for the core wire. A solid ring or band of metal surrounding the core must be avoided. If the builder wishes to use sheet iron instead of iron wire for the core, he should avoid the use of bolts passing through the core unless they are insulated from the top and bottom plates as well as from the main sheets of the core. A suitable core may be made by clamping the sheets in a vise with ½ in. or so of the pile projecting beyond the vise jaws. A narrow strip of tape or, preferably, empire cloth, cut diagonally across the weave, having been procured may be passed around the projecting end of the core. By releasing only a fraction of an inch at a time and winding the tape tightly, letting each turn overlap its neighbor by one-half the width, a good solid core will be the result when the last turn is in place. The finishing end may be secured with shellac and the tape held in place with thread until the varnish has set hard. Previous to assembling the plates of the core they should have been insulated by a piece of tissue paper or a coat of shellac. This will prevent eddy currents and heating in the core. The same precaution applies with added force to the main transformer itself, as the original article expressly stated.

If the square core is used some difficulty will be experienced in making the tube for the winding of fiber. It is difficult to bend this substance on such a small job, even though it is soaked in hot water previously. In this event, the brass tube, which may be bent up from a piece of 1/16 in. sheet brass to the form of a square tube, will be found useful. It is absolutely imperative, however, that the wall of the tube does not form a closed circuit around the core. The slot running lengthwise down one side as suggested above will take care of this.

The electrolytic rectifier appears to be giving more trouble than any other part of the set. These rectifiers at best are troublesome, but when their action and "whims" are once understood, the results are extremely satisfactory. The precautions with regard to pure chemicals and water which apply to a storage battery, apply with additional force to the rectifier. The use of faucet water in some places will give splendid results while in other localities, the water will contain impurities and undesirable chemical properties in such quantities as to be totally unfit for use in either a storage cell or a rectifier. For this reason, the author specified rain water (filtered) or else distilled water. If the borax solution is used, the borax which comes sealed up in packages is the best kind to use. The solution should be saturated, *i.e.*, the water should contain as much borax as it will dissolve.

Another solution, which has given the author even better service, is the sodium phosphate solution, which is made by dissolving 15 oz. of clean sodium phosphate in 180 oz. of distilled water.

The aluminum plates must be pure. The commercial sheet aluminum is, as a rule, satisfactory, providing the surface is bright and the metal has a ringing sound when struck by a piece of metal. Out of ten samples sent us, only one was of pure or even commercially pure aluminum. The rest contained zinc in proportion of from 2 to 15 per cent. Such metal will either lower the efficiency or prevent the rectifier from working.

The last and perhaps most common difficulty which has been mentioned is the fact that there appears to be a dead short-circuit through the rectifier when the current is turned on. The article lays emphasis on this point and explains that a sufficient time must elapse before the plates will be "formed," as it were. This process takes from ten minutes to two hours, according to the strength of the current passing through the cells. If a lamp bank is used as the forming resistance, the lamps will be found to grow dimmer and dimmer as the forming continues until at the end of the process they will be only red or out entirely. The author's rectifier only passes .25 of an ampere when connected directly to the 110 volt, 60 cycle mains, if no load is placed on the d.c. side. As much as 8 amperes have been passed without excessive boiling for short periods of time, and the rectifier has stood continuous service charging storage cells with a load of 3 amperes. The d.c. voltage is about 93 with 110 volt a.c. supply. When it is desired to get a direct current of 110 volts, a step-up transformer is used to deliver the a.c. at about 130 volts to the rectifier.

This apparatus is so flexible and useful that no student or experimenter should be without one. If the first trial does not show good results, do not become impatient and throw the whole thing in the scrap pile, but stop to think where your trouble may be. It is usually some trifling point which has been overlooked or altered. When you finally get the outfit in working order, you will wonder how you ever got along without it.

The author will be glad to assist any readers who have experienced difficulty in the construction of this or other apparatus described in the department on receipt of a letter giving in detail the local conditions, such as voltage and frequency of current, etc.

MACHINE SHOP PRACTICE—Part V
The Engine Lathe

P. LE ROY FLANSBURG

One of the many important uses to which a lathe is put is the boring of holes. Several methods are employed, as by use of drills, roughing tools, flat bits and boring heads with cutters. When drilling or boring in a lathe the tool is either held in a chuck while the work is steadied against a plate fitted over the nose of the tail-stock mandrel, or else the work is held in the lathe chuck and tool is clamped in a side rest, fed along into the work. The latter method is, perhaps, the more often used.

If properly used, a common roughing tool (cranked to angle of about 45 degrees so as to cut sideways) is, perhaps, the best tool to use for boring. In theory this tool is the most accurate of all and in practice is considered nearly so. The tool called a boring bar is, perhaps, most often used in practice, and consists of a round bar with square shank having an inserted cutter, whose cutting edge is slightly in advance of the head of the bar. The cutter is held in place by a small binding screw or in some cases by a wedge.

Many lathes have a drilling and boring attachment which is held in some form

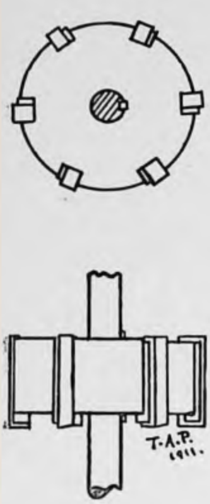


Fig. 1.

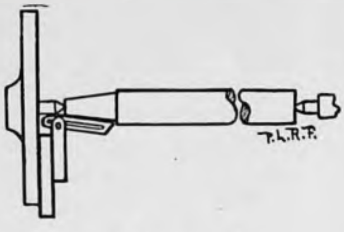


Fig. 2.

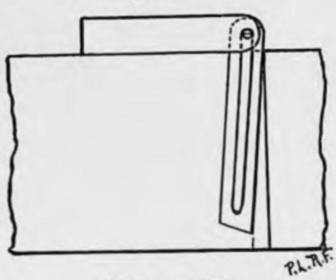
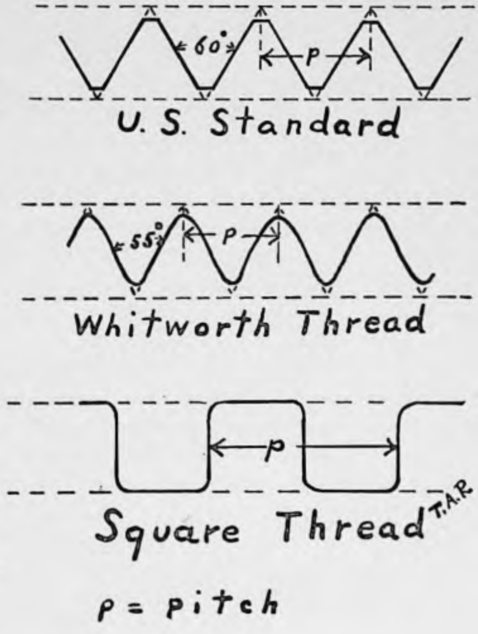


Fig. 3.



of a rest. This attachment is driven by means of an extra pulley on the counter shaft.

The flat bit, while often used for boring, is not particularly good. This type of bit is not really a cutting tool, because it has no top or front rake. All they do is merely to scrape. They are only employed for the enlargement of holes. Where absolute accuracy is not required, drills and flat bits may be used.

Steam engine cylinders of small diameter are nearly always turned and bored in the lathe. In the case of large cylinders, special boring machines are usually found necessary.

For the purpose of lessening the strain on a tool, boring tools are given a top rake. However, such tools should not be used on brass. In this case, a broad cutting surface is wanted. For work on steel, wrought iron, cast iron and copper the tool should be given little side or bottom rake.

Boring tools have cutting edges more carefully and accurately shaped than in the case of turning tools, because the space where a boring tool enters the work is usually small, and for that reason the shank of the tool must be slender, and so more liable to spring.

Where a hole is a foot or more long and needs to be accurately bored, a boring bar, or boring head with cutters, is necessary. This is the case where engine cylinders and long tubes of any nature must be bored. The boring head consists of a circular plate which is keyed to a boring bar upon which cutters are held by means of clamps or cap screws. Fig. 1 shows such a head.

In the case of such a tool with its ring of cutters (each one slightly in advance of the preceding one) we are able to feed the work at a much greater speed than would be the case where only one cutter was used. This is easily explained, since if we use six cutters set in this manner, each follows in the wake of the other, removing its own zone of material, and thus enabling us to feed the boring head at six times the speed of a single cutter. A cutting head is almost always used when boring holes large enough to permit. Many other types of cutter heads besides the one described are in general use.

Turning and boring pulleys is one of the many common operations in machine shop practice. Of course, in places where a large number of pulleys are made, special machines are employed, but in most shops where but a single pulley is to be turned and bored, it is held in an ordinary lathe-chuck, or bolted to the face-plate of the lathe for boring, and turned between the lathe centers on a mandrel or arbor which is tightly driven into the hub. For small work the mandrel is made of iron or steel, while for large work it is made of cast iron with a hardened steel center which is inserted in the end which revolves on the dead center of the lathe. It sometimes happens that a special face-plate is used to enable the boring and turning to be accomplished simultaneously.

Taper work may be quite accurately turned and bored on the lathe. A convenient way to turn a taper (and the almost universal method) is to set the tail-stock of the lathe over in such a manner as to throw the dead center out of line with the live center. Then as the tool travels along the lathe shears the work is turned to the required taper. For instance, suppose a piece of iron 3 ft. long was to be tapered down from 6 in. diameter at one end to 2 in. at the other. The tail-stock would be set over one-half of the difference of the diameters, or 1½ in. The resulting taper would be at the rate of 1 in. per foot. At times a taper attachment is fastened to the back of the lathe or a compound tool rest is employed.

Figs. 2 and 3 show the usual ways of measuring the taper which has been cut.

The taper is first measured from the piece of work, as shown in Fig. 2, and then the angle of taper is measured as shown in Fig. 3. The drawings are self-explanatory.

There are three kinds of chucks in general use: first, where the jaws act simultaneously (universal chuck); second, where the jaws act separately (independent chuck); third, where the jaws act either way (combination chuck). Chucks have usually either three or four jaws. The simplest and probably the oldest form of a chuck is the slotted face-plate chuck. This is by no means the best form, for it is simply a disc of iron which screws over the mandrel nose and which is provided with various slots so arranged as to afford the best facilities for bolt attachments. Almost any piece of work can be fastened to such a plate, but much time is always lost in the operation and the art of rapid and secure chucking is of greatest importance in the work of metal turning.

The self-centering (or universal) chuck is a great time saver and is much used. It sometimes happens, however, that work needs to be chucked eccentrically, and then it is that the combination chuck proves so useful, for when the jaws have been made eccentric, they can, while in this position, be again given the universal or combined movement for the clamping of the work.

When it is found necessary to increase the size of the face-plate, three common link straps may be bolted on and the work fastened to them.

EXTERNAL SURFACES TURNED WITH OR WITHOUT SPECIAL APPLIANCES

When no special appliance is used the work is held and driven in the usual way while the position of the tool is changed by hand, as the tool is being fed along the work by means of carriage feed. When a piece of work must have a definite shape, bars called "formers" are used. These fasten to the lathe in such a manner that by allowing a pointer on the tool to rest constantly against them, the cutting tool will be so guided as to give the required shape to the piece of work.

Interesting methods are employed for turning cranks. It is hard to turn crank pins, because the tool has to extend from the tool post quite a distance unsupported and because it is difficult to chuck a crank shaft in position. A crank shaft is usually either chucked or held directly between the lathe centers. To properly describe the turning of a crank pin would occupy more space than I may devote to it in this article.

Often it is necessary, when turning pieces of work having irregular shape, to counterbalance the weight of the work by bolting a piece of metal of similar mass upon the opposite side of the face-plate than that to which the work is secured.

When it is necessary to reduce the speed of the lathe, back gears are usually used. By throwing them into use a heavier cut may also be taken. The ratio of the reduction of speed when they are used and when they are not used is about 10 to 1 on the ordinary sized lathe. Shifting the driving belt from one cone to another is another way for reducing or increasing the speed of the lathe.

The cones of the lathe usually contain either four or five steps. By shifting the belt from one step to another we either increase or decrease the speed accordingly. The cone used on the countershaft corresponds to that on the lathe, both often being cast from the same pattern and so having center steps of equal diameter.

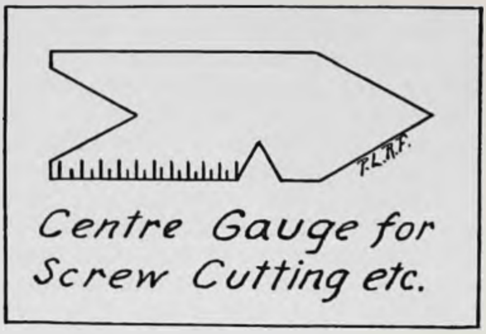


Fig. 4

When cutting threads or screws on the lathe, the first thing which must be considered is the ratio of the number of turns of the lead-screw to those of the spindle. This is governed by the ratio of the change-gear on the lead-screw to the one which is on the spindle. Between these two gears is placed one which is called an idler whose whole function is to transfer the motion from one gear to the other. To better explain the use of gears in screw cutting, I will take an example: suppose we wish to cut a screw with 12 threads per inch and our lead-screw has 4 threads per inch. It is quite evident that the lead-screw must revolve only one-third as fast as does the lathe mandrel, for the ratio between them is 4 : 12 or 1 : 3. Now, if we use a 60-tooth gear on the lead-screw, we must use a 20-tooth gear on the mandrel. Namely, any two gears with a ratio of 1 : 3 might be used, and would give the desired result. When cutting a left-hand thread or screw simply reverse the motion of the lead-screw.

Always use as large change gears as is possible in order to relieve the strain on the gear teeth. Most lathes are equipped with 22 gears, two of them containing the same number of teeth. The smallest of these gears contain 20 teeth, and they advance by 5 teeth each, until the largest, which contains 120, is reached.

For cutting square threads, grind the tool to the desired width at the point and grind its clearance-face, off on one side, to the pitch angle of the work, in order that it may easily enter the thread-groove which is being cut. The tool for cutting V threads should have its cutting end made in the form of an equilateral triangle. For cutting screws the lathe tools should have as broad a cutting surface as possible.

At times it is required to cut a thread which requires a ratio which the ordinary gears will not give. Then we find it necessary to compound our change gears and use what is known as a "compound train." This means that we must use two driving and two driven wheels, the ratio of whose products equals the ratio which we seek. For instance, if we wished to cut 12 threads per inch, the ratio would be $\frac{12}{4}$. This can be written $\frac{3 \times 4}{2 \times 2}$. Now multiply each of the numbers by 10 and we get $\frac{30 \times 40}{20 \times 20}$, the ratio which we require, where 20 and 20 will be the drivers and 30 and 40 the driven. One of the drivers and one of the driven are held together so as to turn freely on the stud. Instead of using the gears which we first selected, we might have used $\frac{60 \times 40}{40 \times 20}$, and arrived at the same ratio, it all depending upon whether we had two gears with 40 teeth each, or two gears with 20 teeth each. Another possible combination would have been $\frac{30 \times 80}{20 \times 40}$.

Various kinds of gauges are used for the cutting and testing of screw threads. One of these is shown in Fig. 4.

Its sloping sides make angles of 55 degrees with one another. Such a gauge is much used when cutting Whitworth V threads. Sixty degrees is the angle used when cutting U.S. Standard or Metric gauges.

A few of the different varieties of threads are given in the drawing.

The Economy of Individual Motor Drive

The power required to drive the line shafting and belts in a factory when the motive power is supplied from one engine, or motor, is about equal to the power required to drive all the machinery in a factory at their maximum output, says R. W. Trost, in *The Generator*. Therefore, one-half the output of the motive power is used to drive the belts and shafting, and this power, which is lost in friction, must be supplied all the time, even though only one of the machines is working.

If a factory is supplied with an individual motor for each machine the power will be more than three times as efficient as one supplied with the line shaft and belt drive.

However, it would not usually be economical to install a small motor for a number of smaller machines, the best results will be often obtained by having a larger motor driving a group of small machines from a short line shaft.

Getting a Horse out of a Manhole

The services of a hundred conduit, telephone, telegraph, ticker and city linemen.

The advice of subway engineers and S.P.C.A. experts.

The presence of an animal ambulance.

The rigging up of a nosebag in such a way that the horse may eat sitting down.

The use of compressed air pumps to keep the animal from suffocating.

The tearing up of a street at one of its busiest corners.

The chloroforming of the brute.

The use of a derrick and a hoisting belt.

The presence of enough spectators to keep a squad of reserves busy.

Eight hours.

ELECTRICITY AS APPLIED TO AGRICULTURE

J. E. NEWMAN

The direct use of electricity as a means of stimulating plant growth is the aspect of the question with which it is here proposed to deal. There are two main systems: one that of overhead discharge—that is, discharging high-tension electricity into the air above the plants; the other the system of passing currents through the earth about the plants. The latter system has never, in any of the dozen or so trials I have made, appeared to make any difference at all to the plants. Reports of other trials are contradictory. Major Blunt, of Castle McLeod, Strathpeffer, has tried alternating currents with no definite results. The method is so simple and inexpensive, merely requiring two metal plates connected by a wire, that it seems inconceivable that, if it were of the least good, it would not have come into use. An electrical reason why, on a large scale, it would be useless, is that it is likely that the current between the plates would never go near the roots of intervening plants, but would dive downwards. On the other hand, the system of overhead discharge has usually given favorable results. The subject was not taken up seriously until the late Prof. S. Lemström, of Helsingfors University, in Finland, who is well known for his researches on the aurora borealis, began those series of experiments which are reported in "Electricity in Agriculture and Horticulture" (published by *The Electrician* Publishing Co.), the only book on this subject, I believe, in this or any other language. Lemström was first led to take up the matter from noticing that while he was experimenting reproducing the aurora in his greenhouse the plants there appeared to thrive to an extraordinary degree. On his journeys to the Arctic regions he had also noticed the vigor and rapidity of growth of the vegetation there, which could not be accounted for by the long hours of sunlight obtaining in the summer.

He carried out experiments, first in Finland, then in Burgundy and in Germany, and at Durham University for two years in succession, where the experiments were superintended on the agricultural side by Mr. R. B. Greig (since Professor of Agriculture at Aberdeen), who has told me that the results were, to him, convincing.

In the course of his trials he experimented on almost all the common vegetables and cereals, as well as with strawberries and raspberries. The results show a definite increase in the case of most crops. His system was to run a wire network, consisting of fine iron wires, about 4 ft. apart, 16 in. above the plants to be electrified. These wires were provided with points something like barbed wire, and they had to be raised as the crop grew. The network was kept charged by an influence machine of his own design. It is extremely doubtful if he was in every case actually electrifying the plants at all; leakage over the insulation in some of the larger scale trials when the air was at all damp must have absorbed most of the small amount generated by his machine, and this may be the cause of the very varying results he reports. My own experiments on Lemström's plan were made in 1904 at the Golden Valley Nurseries, Bitton, Bristol.

While tomatoes showed no difference, probably they received no current, for they were grown in the cucumber houses, and it was not possible so to run the wire as to electrify the plants after they had grown to the third bunch of flowers. I mention this particularly, because tomatoes have since shown themselves peculiarly responsive to electrification.

Celery, which was one of the plants Lemström had found to give good results, at Bitton gave only 2 per cent. increase. This I attribute to non-discharge of the current from the network—in fact, no effect was produced because there was no electricity to produce an effect. The reason for the non-discharge was that we used comparatively thick wire not provided with fine discharging points. On one small portion of the network such suitable discharging points were fixed, and beneath this portion the celery was markedly better, the demarcation being clear. At that time I was working without the electrical resources which, thanks to Sir Oliver Lodge, have since been available, and I mention this experiment with celery simply to illustrate the difficulties and pitfalls which beset those who venture into fresh fields without the help of the knowledge of previous failures of bolder explorers.

There is one curious effect I noticed during the course of the Bitton trials: A clear and well-marked earlier germination of peas. About 20 rows of peas were sown all on the same day. Wires were run over 13 of them—one wire to two rows. All the rows under the wires were up about two days before the non-electrified rows, the difference being marked to the row.

Lemström's system, suitable though it was for experimenting with, is, of course, out of the question for practical and commercial use. The network close to the ground entirely prevents horse labor, and is an intolerable hindrance to hand labor. The obvious remedy is to raise the wires high enough. This means that to produce the same electrical results the pressure on the wire must be also raised, the wires being high enough to avoid interfering with men working beneath them, who are also in this way free from the danger of shocks. To test this idea I made a very small scale trial, placing the discharging points 6 ft. above the ground and using a corresponding pressure. The trials were made on wheat, carrots and beetroot, the results all showing a big increase. But influence machines are not powerful enough for this method, except on a very small scale. There is only one method of producing the kind of current required—high tension continuous current—in comparatively large quantities—that is, the method invented by Sir Oliver Lodge. We approached Sir Oliver and asked him if he could provide the high-tension continuous current (or, rather, the apparatus for a large scale experiment). He at once agreed and put his son, Mr. Lionel Lodge, at the work.

Why have leaves got points? Why do the ears of cereals generally end in spikes? There are few, if any, things in Nature without some basis for their existence. Whatever reason there may be for their existence, these points form admirable collectors or discharges of electricity. The air being always more or less charged with electricity, plants not only being conductors of electricity, but apparently shaped for that purpose, must be continuously traversed by currents of electricity. As to whether these currents play any part in the vital functions of the plant nobody knows. Several theories have been suggested of the action of electric current on plants. Pollacci believes that leaves may manufacture carbo-hydrates from the carbon dioxide of the air, when traversed by an electric current, in a feebler light than they otherwise could. There is also Berthelot's suggestion that the plant, when electrified, is able directly to make use of atmospheric nitrogen. This differs from the popular explanation that the effect is due to the addition of nitrogen to the soil itself.

In my own opinion, the observed results can only be accounted for by supposing that the current stimulates the life processes of the plant, coupled with, in field trials, the continuous addition to the soil in very minute doses, of ammonia (nitrogen). If the results were simply and solely due to the addition of nitrogen to the soil, then we should obtain the greatest increase of crop from experiments conducted on poor soil. The reverse is, however, the case.

The second year of the trials at Bevington Hall, the non-electrified wheat was given a dressing of 1 cwt. to the acre of ammonia sulphate, the electrified wheat not receiving any. In about three weeks the unelectrified received a further dressing of ½ cwt. ammonia sulphate and the electrified a dressing of ¾ cwt. The net dressings being thus ¾ cwt. to the electrified and 1½ cwt. to the unelectrified. The result of these dressings was that at the beginning of May the unelectrified looked distinctly the better plant, but the electrified gradually grew equal to it, and the threshing result gave 29 per cent. increase to the electrified. On other occasions I have seen much the same thing happen, suggesting that a slight but continuous addition of nitrogen is going on, the whole of which, because it is slight and continuous, is taken up by the plant. But if the whole effect of the discharges was simply this addition of nitrogen I do not think there would be any future before the system, as nitrogen could be added more cheaply by means of artificial manures, except, perhaps, as compared with electrification on a very large scale. As I have said, the observed results can only be accounted for by assuming a general stimulation of the life-functions of the plant, or as Sir Oliver Lodge has said, a process of electrical massage.

With cucumbers in greenhouses at Bitton we have found that if the current be applied in the day time only, we get a considerable increase of leaf growth and a slight increase in the amount of fruit produced, but when the current is applied at night only, a greater increase of fruit is obtained, coupled with slightly less vigorous foliage. The day current stimulated the leaf growth, but without the current at night to make use of this increased growth but little good, other than what might be expected from the more vigorous growth, resulted. Current at night only made the leaves produced during the day work harder, so producing more fruit without greater leaf growth. From this it would appear that the current should be applied both by day and night to produce the best results. But this theory we have not yet been able to test conclusively.

—*The Electrician.*

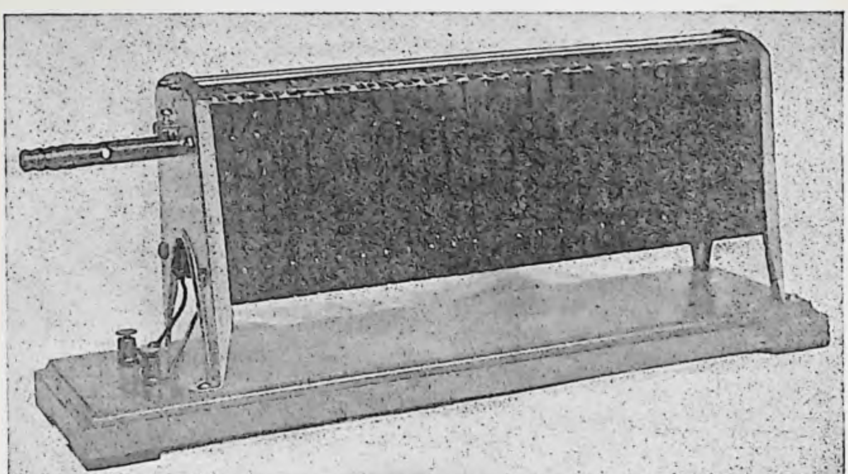
AN ENGLISH THERMO-GENERATOR OF ELECTRICITY

FRANK C. PERKINS

It has been known for more than a quarter of a century that electricity could be generated by the heating of certain metals in contact with each other, forming thermo-electric couple or thermo-pile. Various forms of thermo-electric generators have been devised for supplying electricity from the heat of gas, but as the amount of current is small, they have not been extensively utilized.

A unique English thermo-generator of Davidson type may be seen in the accompanying illustration designed and constructed in London, which is said to be a most practical form, by means of which an electric current is generated from the heat supplied by a gas burner or by means of a vaporized gas generated by a lamp burning methylated spirits.

This English thermo-generator consists of two metal plates, the lower part of which forms legs fixed to a base board, with two rows of hollow copper tubes placed vertically between them. These hollow copper tubes are connected at the top, each with a neighboring element, forming a series of electric couples. These are heated by a gas burner or a lamp burning to a round tube which runs



directly through the apparatus between the copper tubes, the round tube being perforated at intervals throughout its entire length, the ends of the series of elements of this thermo-generator are connected to terminals supplying the current to a storage battery of two to four volts, for charging the same or for illuminating small surgical lamps or operating faradic coils.

A steady electric current is provided by this thermo-generator for light cautery work, or for a ophthalmoscopic lamp. When a lamp using methylated spirit is utilized for supplying the heat, a gas is given off which travels through the perforated tubes and a light is applied to each of these perforations. It is held that within a minute electricity is generated which may be used for lighting surgical electric lamps or recharging small accumulators. When ordinary illuminating gas or natural gas supplies the heat it is only necessary to attach one end of a rubber tube to the apparatus and the other to a gas jet, turning on the fuel and lighting up the gas at the perforations of the tube, when electric current is at once generated, the apparatus operating for hours continuously, doing away with dry batteries entirely for the light service for which it is intended.

There is a 20 ampere hour accumulator of 2 volts connected to the thermo-generator for cautery service, a two-way switch being provided. It is held that after the gas has been turned on full or the spirit lamp lighted, for three or four minutes the flame should be lowered to one-half the normal height, as only sufficient heat should be employed to supply enough current to eliminate the lamp. It is stated that too much heat continually employed will melt the metal connection, while no more electric current will be generated than with less heat. It is held that after awhile an oxide deposit will form between the rows of terminals above the flame, and this should be removed while hot when the gas is still burning. Those thermo-generators weigh from 4½ lbs. to 8¼ lbs., and measure from 15 to 22 in. in length, and from 6½ to 7½ in. in height, with a width of from 4¼ to 5½ in., according to the size and output of the generator.

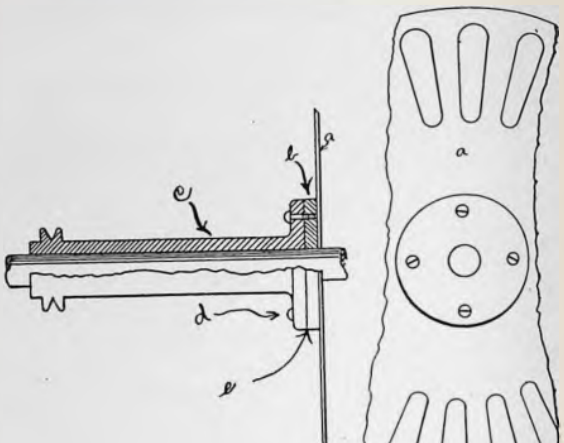
MOUNTING WIMSHURST MACHINE PLATES

JOHN A. COOK

I doubt very much if anyone who ever tried to construct a Wimshurst machine failed to have trouble in making the plates run true. I had always had great difficulty and never was quite successful until I tried the plan in the rough sketch inclosed.

Instead of attaching the plate *a* directly to the boss *c*, I glued it to the intermediate washer *b*. This washer is tapped for the round head screw *d*. Then if plates run out we can line up by placing paper or whatever is needed, between *b* and *c* at *e*. By making the screw holes in *c* larger than the screws, and the shaft hole in *b* larger than shaft we can also adjust in the up and down direction, making the outside of plate run true.

I have a machine with 18 in. plates. When uncharged they run 1/64 in. apart without touching, but when charged, on account of the attraction between them, have to line to about 1/32 in. I think this is excellent, and believe many amateurs will be glad to know of this kink.



AN INLAID WORK TABLE

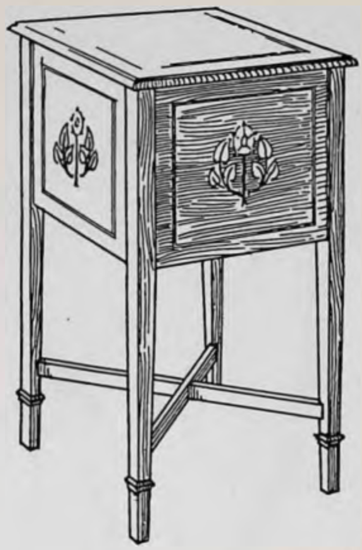
VICTORIA WILLIAMSON

Right down through all the generations of needlecraftsman, some contrivance, we may be sure, has been in use wherein the fair worker might place for safety the various implements of her gentle craft.

The woman of today is no exception and will welcome in place of the somewhat cumbersome workbox or basket the dainty and capacious work table illustrated herewith (Fig. 1), having small troughs either side to hold such articles as scissors, thimble, etc., and ample space in the center for any article in process of making. Either oak or walnut may be used for the framing with satinwood and ebony for the inlay. The over-all dimensions are 2 ft. 3¾ in. x 1 ft. 3½ in. x 1 ft. 3½ in., and by reference to the illustrations, Figs. 2, 3, 4, and constructional notes hereunder, the amateur cabinet maker should find no difficulty in reproducing the design. Get all stuff cut to the following dimensions which allow about ⅛ in. each way for sawing and planing waste.

The parts required are: 4 legs each 2 ft. 3¾ in. x 1½ in. x 1½ in.; 4 panels each 1 ft. 2 in. x 10¼ in. x ¾ in.; 1 top 1 ft. 4 in. x 1 ft. 4 in. x 1 in.; 1 bottom 1 ft. 3 in. x 1 ft. 3 in. x ⅝ in.; 2 cross stretchers each 1 ft. 7 in. x 1½ in. x 1 in.; 4 pieces for troughs, two 1 ft. 2 in. x 3¾ in. x ½ in., two 1 ft. 2 in. x 3¼ in. x ½ in.

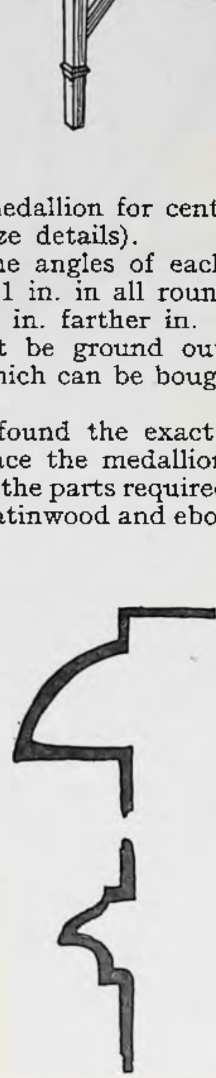
Plane up and prepare stuff in the usual way. Now, a few notes as to general construction. An extra 1 in. has been allowed on the length of the legs. This should be worked so as to come to the top, when it should be planed off after tenoning in the panels. About 2 in. below the base of the table, the legs taper from 1¼ in. above, to ¾ in. at the foot. Out of the waste in tapering, the small molding at foot can be worked round the leg. There are two tenons on each panel which should be cut next and the framing knocked together. Plough the grooves inside for the troughs, and run the moldings on top and bottom after which some attention may be given to the inlay, which consists of a ¼ in. banding

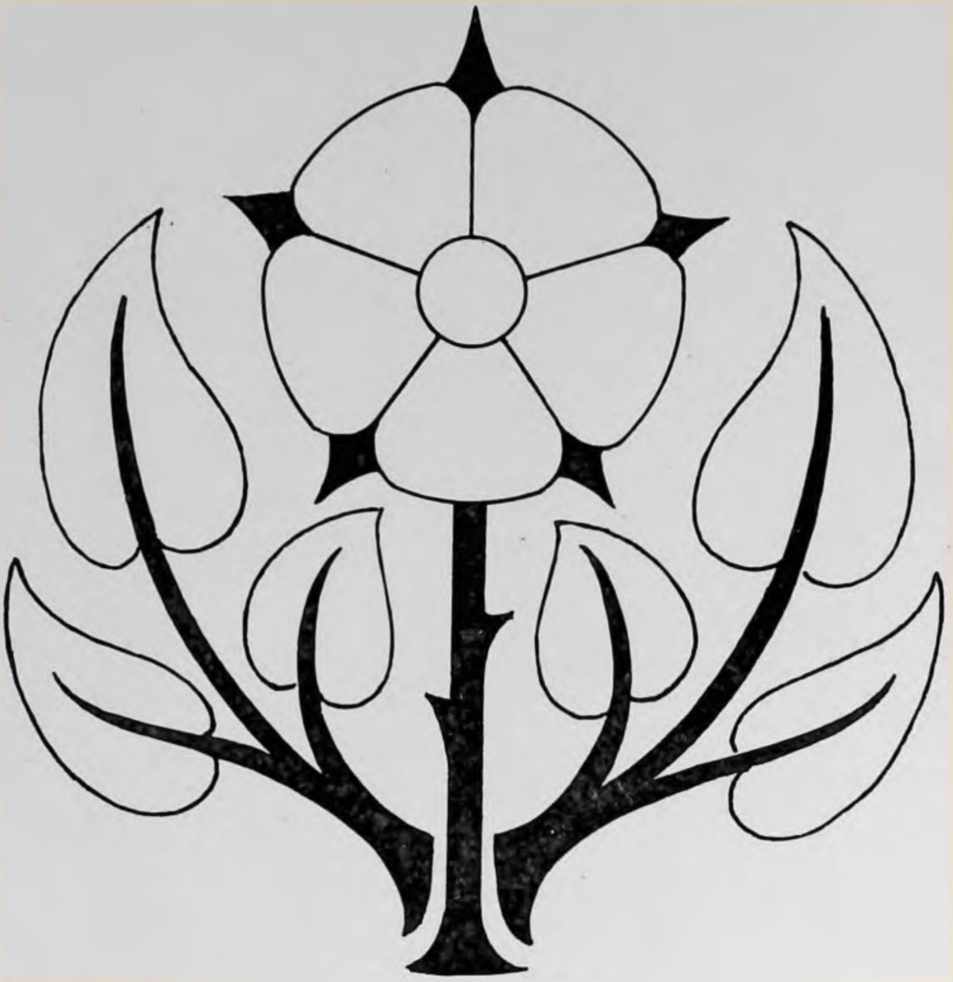


and rose medallion for center of panels (see full size details).

Bisect the angles of each panel and run a line 1 in. in all round, and then another ¼ in. farther in. This ¼ in. space must be ground out to receive banding which can be bought ready for use.

Having found the exact center proceed to trace the medallion on panels. Then trace the parts required alternately on 1/16 in. satinwood and ebony and care-



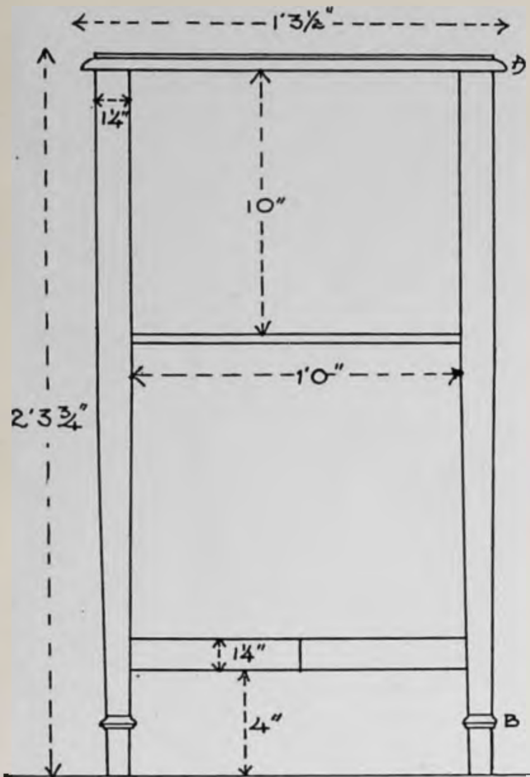


fully saw out with a fine fretsaw. The fretted portions should next be laid in their respective positions, and holding firmly with one hand scratch round with a needle point, and with the usual tools, ground out to 1/16 in. bare.

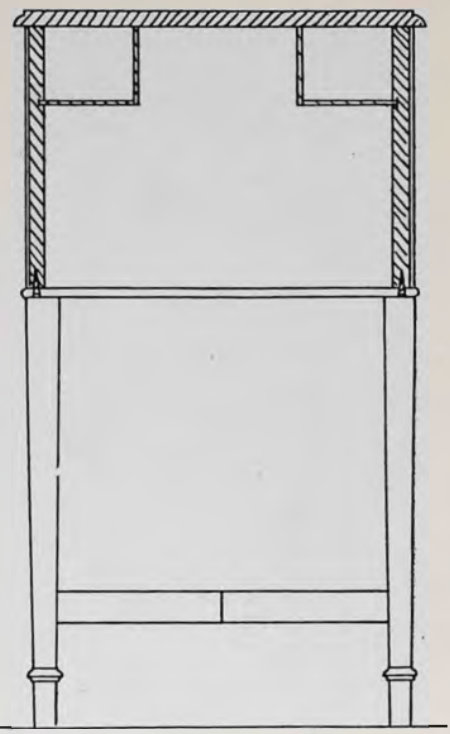
Glue in the satinwood and ebony portions, pressing them down with a hammer previously dipped in boiling water. Wet the face of each panel and clamp down a piece of oak to prevent warping. For the lid, inlay the 1/4 in. banding, placing it about 2 1/4 in. in from outer edge. After leaving for about a day, the panels may be cleaned off with a scraper and glass paper.

Glue up first of all back and front, and when dry add the bottoms of the two troughs, and side panels. These latter, by the way, are set back 1/8 in. all round. Drop the side of trough into position and nail through to bottom with panel pins. Turn the whole upside down and fix bottom by notching back round legs and screwing through into sides. Notch back stretchers (these are halved over in center) round legs, and fix by means of screw-eyes driven horizontally into legs, and screws vertically through eyes into stretchers.

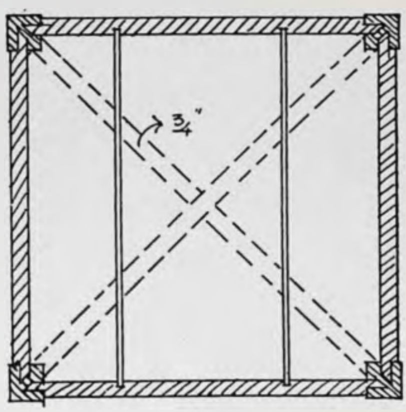
Finally hinge lid, and finish with oil or wax polish in the usual way.



ELEVATION OF WORKTABLE



SECTION



PLAN

Self-Electrification

Several years ago Prof. A. Heydweiller observed the remarkable phenomenon of self-electrification of the human body. The needle of a quadrant electrometer having been charged to a potential of some hundreds of volts, one of the pairs of quadrants was connected to the earth, and the other to an insulated metal plate. The subject then raised one of his hands to about 4 in. from the plate, and holding it in this position stepped on an insulating stool, when the electrometer showed a deflection indicative of a negative charge of the hand. The magnitude of this deflection and the interval of time occupied by its slow disappearance would vary according to the personal disposition of the subject and meteorological conditions. The same problem has been taken up recently by two Russian physicists, Drs. Tereshine and A. Georgievski. Whereas the qualitative results of the first series are mainly identical with those of Prof. Heydweiller, the electric tensions (of 10 to 15 volts) found by the Russian experimenters are much inferior, and experiments made on naked subjects gave very different results. And hence they draw the conclusion that the self-electrification of the human body is due, not to the contraction of the muscles but to the friction of the feet on the insulating stool and to that of the clothes on the body and on one another.

THE CONSTRUCTION OF ELECTRIC DOOR LOCKING DEVICES

JAMES P. LEWIS

There are several types of electrically operated door locks, some of them possessing advantages not possessed by others. The purpose of this article is to show how most of these faults can be overcome so that we will have a really reliable lock. One that can be depended upon to be safer than the majority of common key door locks.

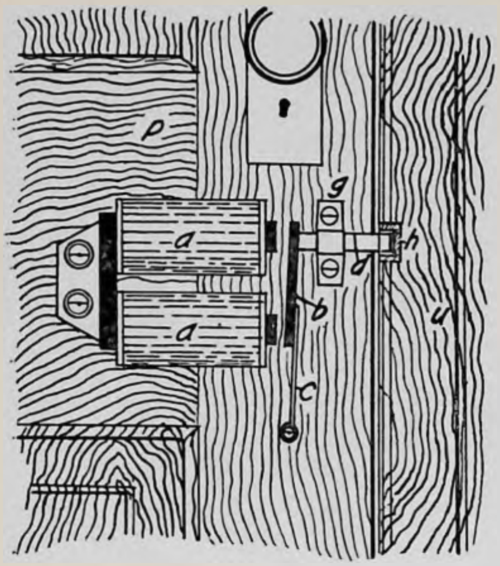


Fig I.

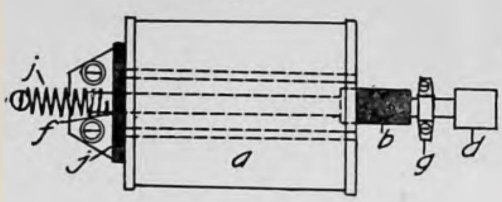


Fig. II.

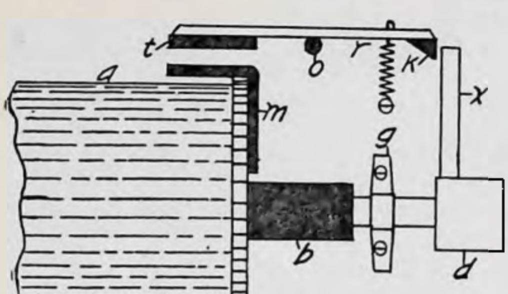


Fig III.

The simplest lock, perhaps, is that shown in Fig. 1. It consists of a pair of electro magnets (*a*, *a*) mounted on the door just below the handle and 3 or 4 in. from the edge. These magnets may be taken from an old bell, if desired. An armature *b* and spring *c* are mounted in front of these exactly the same as for the construction of a bell. On the free end of this armature, at right angles to its length, a brass bar *d*, ¼ x ⅜ x 2 in. is secured. This slides easily in the bearing *g*, and projects about ⅜ in. from the edge of the door, as the armature is held away from the magnets by spring *c*. This projection slips into a socket *h* fitted on or in the door casing *u*. The back edge of the projection can be beveled so that when the door is closed it will be forced back even with the edge of the door until in a position to enter the slot, or socket *h*.

A modification of this type of lock is that shown at Fig. 2. In this a hollow electro-magnet or solenoid *a* is substituted for the horseshoe magnet of Fig. 1. This is preferable, as it is much stronger and more efficient. In Fig. 2 *b* is a soft iron plunger 2 in. long with a diameter ⅛ in. less than that of the inside of the solenoid. Passing through the center of this plunger is a ¼ in. brass rod. It projects at one end for a distance a little longer than the length of the solenoid and for about 1½ in. at the other. This rod slides in bearings *g* and *f*, the latter may be the supporting piece *j* of the solenoid. They are both in such a position that the plunger may slide in and out of the solenoid without touching. The short projecting end of the brass rod carries the locking bar *d*. To the other end of the rod is fastened the spiral spring *i* supported at the other end by a screw in door. This spring should be so wound that it tends to normally keep the plunger to its farthest position to the right.

Both the above locks are operated by connecting the magnets in series with an ordinary push-button and battery, but may be operated by the combination of push-buttons to be described later. As will be seen, they lock automatically when the door is closed; but they both have the common faults of being rather easily opened by the insertion of a penknife if there is a slight crack between the door and frame, and forcing back bar *d*; and requiring a rather powerful magnet and battery, or they will fail to open if there happens to be a little friction. The first disadvantage may be overcome by employing a little device in connection with 1 or 2 and shown attached to the latter in Fig. 3. It consists of a light brass bar *r* pivoted at *o*, carrying at one end a small soft iron armature *t*, and at the other end a small triangular-shaped piece *k*. This is of such a length, and so situated that when *t* is held about 1/8 in. from *m* by a small spiral spring, and the bar *d* is in its socket in the door frame, *k* slips behind or overlaps *x* which is a brass rod fastened at right angles to *d* for about 3/32 in. *m* is a piece of 1/2 in. sheet iron bent at right angles, one end of which makes good magnetic contact with the end of solenoid.

When this device is used there should be no bevel on bar *d*, the door being locked by pressing the button the same as for unlocking.

The operation is as follows: assuming the door to be locked, and the various parts in the position of Fig. 3, the magnet being energized *m* is also magnetized, and draws down armature *t*, causing the other end of bar *r* and *k* to be lifted and allow plunger to be drawn into the solenoid. The plunger being released, by reason of bevel on back of *k*, it is raised until in a position to slip back of *x*, and effectively prevent *d* being actuated by any other means than the magnet; as forcing back on *d* merely pushes *r* against its pivot and has no tendency to open it. Of course, if desired, a separate magnet may be used to control *r*.

Still another type of lock is shown at Fig. 4. In this we merely have the magnet control a trigger or release, which allows a heavy spring *f* to draw back the locking bar *d* which is capable of sliding in the two bearings *g*, *g*. The rest of the construction will be clear from the drawing, with perhaps the exception of *v*. This type of lock has the disadvantage of having to be set by hand, but can be made very positive in action. The setting is accomplished by the deivce *v* which is a small brass bar pivoted at *o*, one end has a rod *v* fastened to it, perpendicular to the

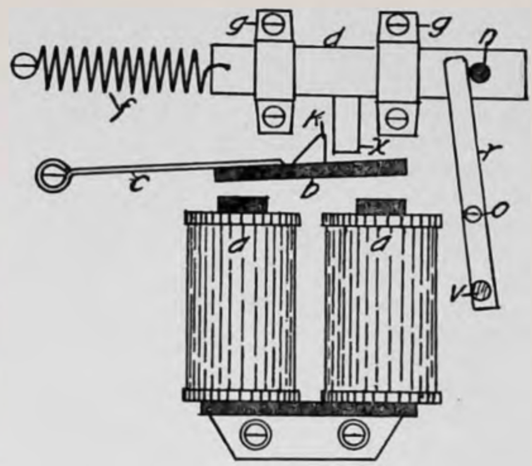


Fig. IV.

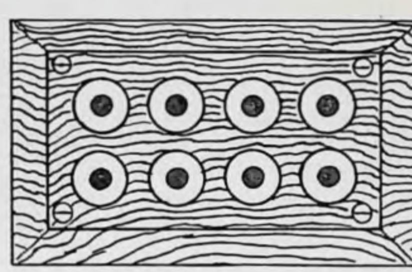


Fig V.

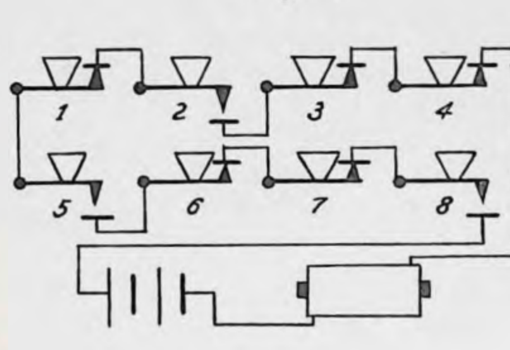


Fig. VI.

plane of door, and projecting through a slot in it so that it may be worked from the opposite side. Then when it is pushed to the left the other end of bar *r* pushes against the projection *n* on *d*, and forces it into its socket where it is locked there by *k*. To eliminate any possibility of handle *v* being used to forcibly unlock the door by crumbling up the armature spring the end of *r* should not be fastened to *n* in any way.

If the reader desires to make this lock automatic on closing the door, he can easily do so by employing a beveled piece similar to *k* which will be forced back when the door is closed and actuate the handle end of bar *r*, the projection through door and handle being omitted.

All our precautions for a dependable electric lock are futile, with a single push-button that is difficult to conceal where it is not pretty easily found by anyone desiring to.

A scheme to use in connection with any of the above locks which might be termed a "combination push-button," is illustrated in Figs. 5 and 6. Essentially, it is three or more push-buttons, so connected, that to complete the circuit through them, it is necessary to push part of them, but if any of the others are pushed, the circuit will remain open, even though the correct ones be pushed at the same time. Thus the combination consists in knowing exactly how many, and the right ones to push. At first glance it looks as though it would be easy after a few trials to strike the right ones, but consider that, taking eight buttons there are fifty-four combinations of three buttons alone, and several times that many all together. By increasing the number of buttons, the "factor of safety" can be made as large as desired. Thus taking ten buttons there are 120 combinations of three. Fifteen buttons there are 455 combinations of three. Twenty buttons has 1,140, etc.

Fig. 5 shows the front of an eight-button board, and Fig. 6 a diagram of one combination. In this case the buttons to be pushed are 25 and 8. They may be of the ordinary kind, but the rest must be so constructed that they are normally closed and *open* when pushed. They must all look exactly alike from the front.

It is hardly necessary to point out that the above locks are mounted on the inside of the door.

Handy Magnet Winder

P. MERTZ

A handy magnet winder that can be easily made from a hand or breast drill is as follows:

Simply tighten up the magnet or coil in the chuck, in the place where the drill usually goes. Then hold the breast drill in the bench vise, as shown in the illustration. This method is better than the ordinary home-made winder, as the magnet turns much faster than the crank, thus making the work of winding less tedious.

MIRACLES OF FLIGHT

H. MASSAC BUIST

During the last year such a deal of attention has been devoted to aeroplane achievements in Europe, that the public is already very familiar with that story and will be well aware that it is a tale almost wholly concerned with competitions for prizes. A consideration of the list of certified pilots in the different countries of the world also reveals that of the leading nations the United States of America is the poorest off, having about half the number of qualified flyers that there are in England, and that despite the fact that practical aeroplaning really had its inception in the States. Furthermore, well nigh every 1910 competition in the world of aeroplaning has gone, no matter what the nationality of the victorious pilot, to a French-built machine, hence one might form the erroneous impression that the Americans had been far surpassed. Let us examine a little into the facts of the case, however, and we shall discover evidences of the contention that has been constantly advanced in these columns, to the effect that as they have so far been conducted, competitions for aeroplanes do not necessarily bring out scientific merit or touch on all the things that can be done already with flying machines. In respect of American-made products pure and simple, about the only things that the public in Europe knows is that during the last flying year Wright biplanes practically tied with Bleriot monoplanes in the matter of high-flying achievements, and that only a few weeks ago a Curtiss biplane made the most memorable point-to-point over-seas flight in the story of aerial navigation, this American firm having quickly evolved, from machines designed to fly off and land on a specially prepared deck of a steamer, aircraft equipped with floats so that they can be, and have been, lowered from the side of a steamer, started up on the water, and have flown their journey and alighted on the water with equal ease and safety alike when the termination of the aerial voyage has been voluntary and when it has been involuntary.

Why, however, has not the American aeroplane, particularly of the parent type, namely, the Wright flyer, figured more successfully and prominently in competitions during the last year? The answer is really to be found not with the designers, but with the financiers. It may be recalled that an important syndicate runs the Wright enterprise in the United States. That syndicate, deciding on the year's programme a twelvemonth ago, came to the conclusion, quite rightly, that the time was not ripe for selling a great number of machines, and decided in consequence that the work for the year should be demonstration. It mattered not that Messrs. Wilbur and Orville Wright had always been, and are, averse to circus tricks; the science of flight had to be demonstrated, consequently three men of a suitable temperament were engaged, namely, Walter Brookins, Archibald Hoxey and Ralph Johnstone. The first named is a really scientific flyer, as was the second, whereas Johnstone was a trick cyclist of extraordinary nerve, who was always apt to take risks, for he felt that what Brookins or Hoxey could do he could do also, though he had not had their amount of training concerning the science of flight; consequently, he did not fully understand the varieties of risks he was running when he did given things. The policy of demonstration having been decided on, machines were built which were capable of doing extraordinary performances in the air, and which embodied in them, as usual, an amazing degree of efficiency and, though later in the season the various pilots of Wright machines appeared at big meetings, such as Belmont Park, where there were aeroplane competitions, they never stood a chance in ordinary competitions, for the two-fold reason that they had not dependable motors and, far more important, that they did not understand the competition game at all. To complete the story of what has been done in the year's competitions, however, it is essential to study what, failing success in competitions, the Wright pilots have demonstrated with their machines, because it is a chapter of aeronautical progress that has never been written in this country, yet it behooves us to know the facts of it if we are to be in a position to understand what we may look for in this year's competitions.

Let us begin with the high flying. When it is pointed out that Wright biplanes on which the high-flying performances were made could rise in the air at the rate of 500 ft. a minute, and maintain that rate of elevation, it will be understood that the angle of ascent is steeper than anything we have seen in Europe. That rapidity may incidentally account for what is beginning to be recognized as a factor, "mountain sickness," which may possibly have been the cause of Hoxey's death during one of his descents, for unquestionably an enormous strain is put on the human physique by those rapid rises and falls. There is about these performances, however, something much more marvelous than the mere rate of lift. In the new Wright machine there are no powerful elevating planes in front, but only a very small stabilizing tail plane that scarcely carries a weight of 5 lbs., while the control of the machine is now according to Orville Wright's method—which has always differed from Wilbur Wright's in that Wilbur believed in a single lever with a universal movement for controlling warp and steering, whereas Orville divided the functions by having a hinged handle to the lever, so that becoming "rattled" in an emergency the pilot could not make a mistake. Orville Wright, it may be mentioned, attends to the testing, training, and demonstrating, being what is called a "hog" for flying, while Wilbur Wright concerns himself more with running the business, drawing up patents, and so forth, but both do the inventing on their old system of endless argument. Now, inasmuch as on these biplanes the pilot sits on the edge of the under main plane, and there is nothing in front of him but the jutting out of two skids with "blinkers" on the end of them, it can be readily appreciated that when the machine is rising to a great altitude it is a very difficult thing for the pilot to know after a while if the aeroplane is getting what is called "stalled"; that is to say, to judge whether she is rising at all, or whether she is rising too abruptly, so much so, indeed, that she is in danger of falling back on her tail. In the beginnings of French aeroplane constructing, to achieve fore and aft stability, two pairs of weight-lifting planes were employed, set at a considerable distance one behind the other, so that the center of gravity of the machine was somewhere between the two pairs of planes, the whole aircraft being on the lines of a damper-out of wind oscillations as regards fore and aft movement.

We were wont to be told that the Wright machine was unsafe, because it depended wholly on hand control and an enormously powerful hand-worked elevating plane. As has been mentioned that is dispensed with now, yet there are no weight-lifting tail planes to take its place. What is still more miraculous is that now you can fix the lever for controlling the angle of elevation by the tail, and though flying in a high wind the machine then only wants balancing sideways and steering, for as regards lift and the preservation of a regular flight path—otherwise fore and aft stability—the machine acts as though automatically, in that there is no tendency for it to plunge and rear. This is something in practice which must be mighty upsetting to the theorist; yet let us look at the actual facts. When about to set forth on a high-flying performance during the last year it has been usual to make a preliminary canter with the machine, during which Orville or Wilbur Wright from the ground would observe the angle of ascent, and the position of the elevating lever for controlling the non-weight-lifting tail plane; then, when the machine was brought down they would mark that lever position. The lever in question has a sort of auto-lock, so that when put in any one position it will remain there till moved by the pilot's hand. This elevating lever having been put in the observed position, the pilot would be given instructions to leave it there for a certain number of minutes until he has completed his ascent to the predetermined altitude to be attained at a rate of 500 ft. a minute. That is to say, as regards fore and aft stability the machine is left to look after itself even while it ascends two miles high in the air. In that respect, though it has not been commented on, the Wright aeroplane has shown itself to be as wonderful as the British machine of which we may be so proud, but which has been so little recognized, namely, Lieutenant Dunne's self-balancing aeroplane. If you look at the barograph records of some of the high flights with Wright machines you will find that they go quite regularly up to some 7,000 ft. or so; then there may be a wavy line showing that the machine went up and down; then presently a regular ascent begins again. Where the line gets "wobbly," it means that the pilot had got the idea, merely by reason of his great height, either that he had ceased to be ascending or that he was near "stalling" his machine, in consequence of which he had taken charge of the lever himself. When Johnstone came down and his barograph showed such a marking it was amusing to hear the Wrights admonish him for making a muddle of his flight. Of course, it means much for military service that it has now been proved possible to predetermine the rise of the machine with well nigh mathematical accuracy.

That is not the only point of marvelous achievement this year. It may be recalled that the late Mr. Cecil Grace was the first pilot in Europe to appreciate that it did not matter how swift a wind a man was flying in so long as the direction of it was constant; also that M. Hubert Latham, a couple of years ago, many a time went up in winds opposing him at a rate equal to the independent forward travel of his machine, so that sometimes he appeared to hover in the air. But Latham originally had the notion that when the speed of the wind became in excess of the independent rate of travel of his aeroplane, so that he appeared to be driven backwards in relation to the land, it would be dangerous. Now let us note the sort of thing that has happened as a matter of course during flying demonstrations in America last year. On the "Baby Wright" on October 27, 1910, the late Ralph Johnstone rose from Belmont Park, facing a puffy wind on the ground of from 25 to 30 miles an hour, but of a greater rate higher up, as was discovered by Hubert Latham, who is certainly second to none in point of pluck in flying in high winds. Shortly after going up the Frenchman was seen to come down again owing to the force of the wind, head-on to his Antoinette monoplane, which was seen to hang seemingly motionless like a huge dragon-fly in the air. Those were the conditions in which Johnstone rose with fixed elevating lever to a height that day of 8,471 ft. sheer, what time he appeared to be flying backwards in relation to the land, and that at a great rate, for the higher he went the faster was the head wind against him, so that he actually flew backwards a total distance of no fewer than 42 miles before he again came to earth; while on the same day, rising within a few minutes of him on the same ground, Archibald Hoxey flew backwards from Belmont Park to Brentwood Park, a distance of over 20 miles. These are only two occasions of many on which the same feat has been publicly performed. The independent rate of travel of the average Wright biplane is about 40 miles an hour with a not very powerful motor. Time and again the Wright pilots have been seen, with their machines head on to wind, apparently, rising sheer off the ground, and, on alighting head to wind, seemingly to descend in a vertical line onto the ground. In connection with this phase of flight there arise interesting problems which pilots will undoubtedly have to learn to deal with at no distant date. For instance, when going higher and encountering still faster winds if, after an hour or so's flying, the man should find himself over a country on which he wants to land, and that near the ground the faster wind rate still obtains, how is he to land? Take the experiences of those Wright pilots who rose in 40-mile-an-hour winds, then were driven backwards at the rate of 20 miles an hour by encountering 60-mile-an-hour head winds higher up. Suppose after an hour's flying or so they wished to come down when, close on the land, the wind was still 60 miles an hour. Dare they make contact with the earth while they are being blown backwards at the rate of 20 miles an hour, or would they have to turn tail to wind and run before it at the rate of 40 plus 60 miles an hour, making the rate of landing actually 100 miles an hour? One sees in any case, that the tail end of landing skids should be curved like the front ones to provide for a certain amount of slip in case of a forced alighting while the machine was actually moving backwards in relation to the earth. It is not realized in this country that the Wright machines have done 80 miles an hour with their big engines and small wing surfaces, but the motors themselves are no good, nor, as far as one can discover, is there likely to be any successful American aeronautical engine on the market at any rate for the next six months.

There have been published just lately sundry photographs showing a Wright biplane in the air nearly on its side. Many people, including experts, have imagined that this is what is called a "fake." Let us see what has actually happened. One of the trick performances, if you might so describe it, of Walter Brookins has been to ascend to a great height, then, with the motor still driving the aeroplane, to come down one or a couple of thousand feet, so that the machine gets up a terrific speed. This achieved, he suddenly banks her over at an enormous angle and makes the aeroplane do a couple of circles in such a fashion that it appears to be standing sheer up on its side, for you can see the sky between the two planes thus presented endwise on. These are, of course, the abruptest turns that have ever been made with any sort of flying machine, each circle taking only six seconds to complete. Mr. Alec Ogilvie describes the appearance from immediately under the machine, when it is performing this feat, as being much more striking than any photograph can convey, because you look up between the two planes, the actual abruptness of the machine being indicated by the fact that it is only ten degrees out of the true vertical. The fear, of course, of many of those concerned was that during the last year the late Ralph Johnstone would "loop the loop" on one of the Wright biplanes, for that is a feat which in calm weather conditions is certainly possible, though, it cannot, of course, be argued that it is of the slightest use; therefore the Wrights and others are fully justified in hoping that it will never be performed. The achievement depends merely on calculating the amount of speed that has to be got up on a machine, provided it is sufficiently strong to stand the strains. The point is merely mentioned, first, because it was likely that such an attempt would be made without authority last year, and, secondly, to show what marvelous things, though not necessarily serviceable, it is possible to achieve in aeroplaning.

One would like to add one further point discovered in the course of aeroplaning in America during the last year. This concerns what Hubert Latham, as fearless a flyer as the Wrights themselves, describes as his worst experience. He had been flying with his Antoinette monoplane on a rising tack when the engine suddenly stuttered. In that condition, of course, it behooves the pilot at once to put the machine from a flying into a gliding angle to avoid her getting what is called "stalled," otherwise losing momentum and falling backwards on her tail. Being careless by reason of familiarity with engine failures, Latham, who was at a goodly height, put the rearward elevator rudder over at the full movement of the control wheel to bring the machine down, but did not touch the motor. Evidently the cause of its stuttering must have been some interruption of the petrol feed. Scarcely had the machine begun the abrupt descent than the flow of fuel to the engine was resumed and the motor started up, so that the machine was dashing to earth under power, assuming a more and more acute angle of descent every instant; in fact, the engine took charge of the aeroplane. The pilot, of course, could not do everything at once, so used his every endeavor to get the tail to answer to his control, for at every instant the machine was in peril of getting out of a manageable angle. The motor, therefore, went on having its will with the aeroplane, while Latham turned the wheel to put the machine over from a descending into an ascending position. She dived down, and, when she did answer, it was at the full lock in the opposite direction, so she shot up an invisible hill at a dangerously steep angle, with the motor still pulling and the pilot wrestling to get the tail back to get a less acute rise. He did not succeed until the machine had very nearly lost its momentum and was in peril of falling backwards onto its tail, particularly as the engine might fail at any instant. Finally, he got the monoplane over at its proper flying angle and landed in some field 3 or 4 miles away from the aerodrome. He describes that as the

(*Concluded on page 419*)

WIRELESS TELEGRAPHY

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

THE ADJUSTMENT OF CRYSTAL DETECTORS

W. C. GETZ

There have been a number of inquiries from experimenters of late regarding the adjustment of detectors of the silicon and perikon type, inasmuch as these types are in most general use at this date. With respect to the silicon detector, the method of making and adjusting this well-known type has been treated so many times in wireless articles in this magazine that nothing need be said of same.

Every experimenter who has a wireless receiving outfit should have a testing buzzer for use with his detector, as it is invaluable at all times for quickly testing the conditions of the apparatus, and saves much needless "hunting" for stations, when perhaps the detector is out of adjustment. But few of the experimenters know how to connect up the buzzer properly.

In Fig. 1 is given a diagram showing an ordinary type of buzzer that may be purchased at any electrical supply house for 25 or 30 cents. This buzzer is connected to a couple of cells of dry battery, with a push button in series in the same manner that you would connect up an electric door bell. But from the point where the inside magnet winding is connected to the interrupter of the buzzer, we solder on a wire that we are to use for our testing.

If a sensitive detector is being used, it is always best to carry this wire over to the ground wire, and if the latter is insulated, wrap the wire from the buzzer around the ground wire several times. This will give an inductive coupling, and will prove much better for the detector, as if it is directly connected to the ground, it will frequently be intense enough to "knock" the detector out of adjustment itself.

The buzzer should be placed in a small box and packed with cotton, so that the noise it makes will not interfere with the operator. The push button should be conveniently located near the operator so that he can depress it with one hand while he is adjusting the detector with the other.

It is frequently desirable to have a buzzer that has a very high frequency of vibration, especially when it is to be used as the exciting source for a wavemeter, as will be described in another

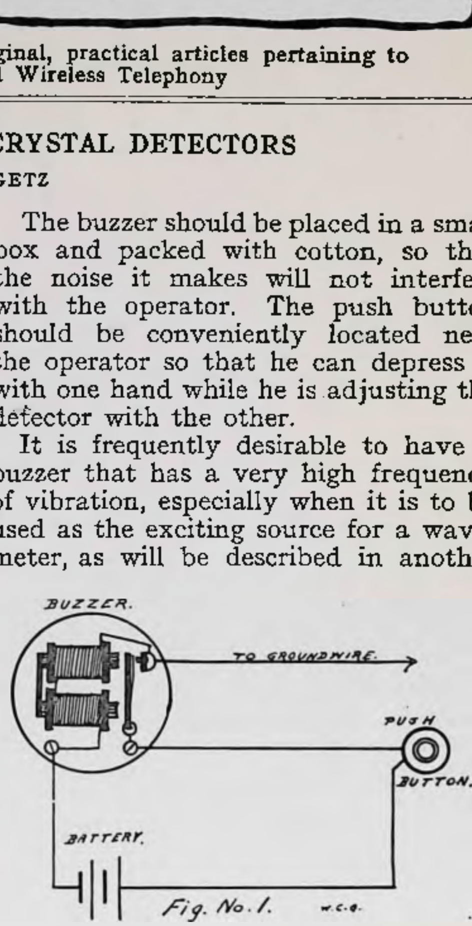


Fig. No. 1.

article, where the wavemeter is used to calibrate the receiving circuits. One of the commercial type will hardly answer for this purpose, and so I will therefore describe a type used by the Signal Corps Laboratories, at Fort Leavenworth, Kansas, in connection with the calibration of wireless apparatus.

In Fig. 2 is shown a pair of electromagnets mounted in a vertical position upon a backboard of suitable wood. These magnets are about 4 ohms resistance together, and the heads are facing downward. Directly under these magnets, within 1/16 in. or less, of them, is stretched a piece of steel piano wire, about 9 mils in diameter, which is

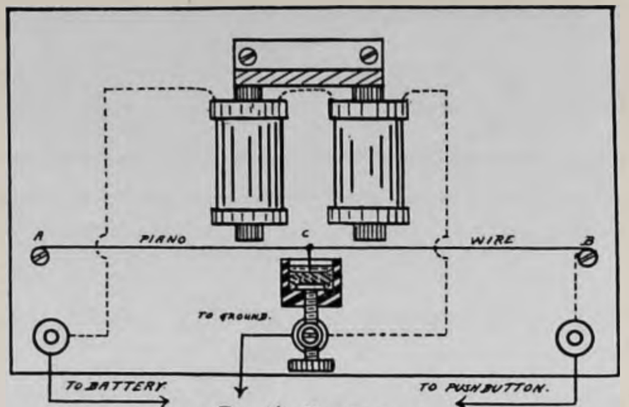


Fig. No. 2. W.C.S.

fastened to two wood screws A and B, these being placed 4½ in. apart. At C on the wire, is soldered a small piece of platinum or silver wire, which is about ¼ in. in length. Under this is placed a cup made of hard rubber and which contains several drops of mercury, covered by a layer of alcohol. The mercury, in turn, completes the circuit through an 8-32 thumb-screw which is held by a supporting post fastened to the backboard. This screw also serves to adjust the height of the cup so that the mercury will just barely come in contact with the wire. The connections are made as shown in the dotted lines. Two binding posts are placed on the lower edge of the board for the battery and push-button wires, and the ground wire connection is carried to the post which supports the thumb-screw.

In operation, this will give an exceedingly high-pitched note in the telephone receivers, thus making an admirable tone by which to adjust the detector. This pitch may be greatly varied by loosening or tightening the wire A, B, which may be done by turning either of the screws A or B in the proper direction.

With the perikon detector, using the zincite-bornite elements, it frequently happens that the experimenter does not select the best crystals or places them in the wrong direction, when he fastens them in the detector cup. The author has always found the best way is to place the crystal in the cup, so that the line of cleavage of the crystal is about at an angle of 45 degrees with the plane of the cup. This allows the detector point to be readily placed on all sides of the crystal.

For mounting a crystal in a detector cup, either what is known as zinc amalgam, or Wood's metal may be used. Zinc amalgam is the cheapest grade of dental amalgam that can be obtained. It may be bought at any dental supply house. It comes in fine flakes, and must be kneaded into a consistent paste with a drop of mercury. Wood's metal is an alloy of very low melting point, and is composed of the following elements: tin, 12 parts; lead, 25 parts; bismuth, 50 parts; cadium, 13 parts. 1 oz. of either metal will be sufficient for several detectors. The author usually prefers the zinc amalgam, inasmuch as it requires no heat to fix the crystals in place; but the amalgam has the disadvantage of having the mercury in it eat into the metal cup and weaken it in time.

In operating the perikon detector, some points are often found on the zincite that are "dead." These are usually of a black and hard strata, and are what is known as Franklinite. This occurs with the zincite, and the experimenter in selecting his crystals for mounting, should avoid having the Franklinite on the operating surface.

After several months constant use, the zincite element will become "fagged" to a more or less extent. When this occurs, by cleaning the crystals with carbon bisulphide, using an old toothbrush to apply same, the sensitiveness may be renewed. However, when using the *carbon bisulphide*, do not get in a room where there is a fire or light burning, as it is liable to explode if brought near a flame.

The buzzers previously described may be used to adjust the detector. After a sensitive spot is found, it should be remembered, so that it may be quickly located again. A light pressure between the bornite and the zincite will be found much more sensitive than a heavy pressure. For that reason, a delicate spring should be used in the detector.

Where battery is used in connection with the perikon detector, always remember that the positive side connects to the point or the bornite side, and the negative battery to the zincite side. Only .1 volt or less should be used. The potentiometer described in the January, 1911, issue of this magazine will be found valuable in this case. The addition of properly poled and regulated battery to a perikon detector increases the sensitiveness by from 25 to 30 per cent.

When using the transmitting outfit, keep the detector elements out of contact with each other, as that is the only way to prevent "burning" the crystals. And don't try to use 100 ohm telephone receivers with the perikon detector and expect to get good results. A standard high resistance receiver set of from 1,800 to 3,000 ohms per receiver should be used.

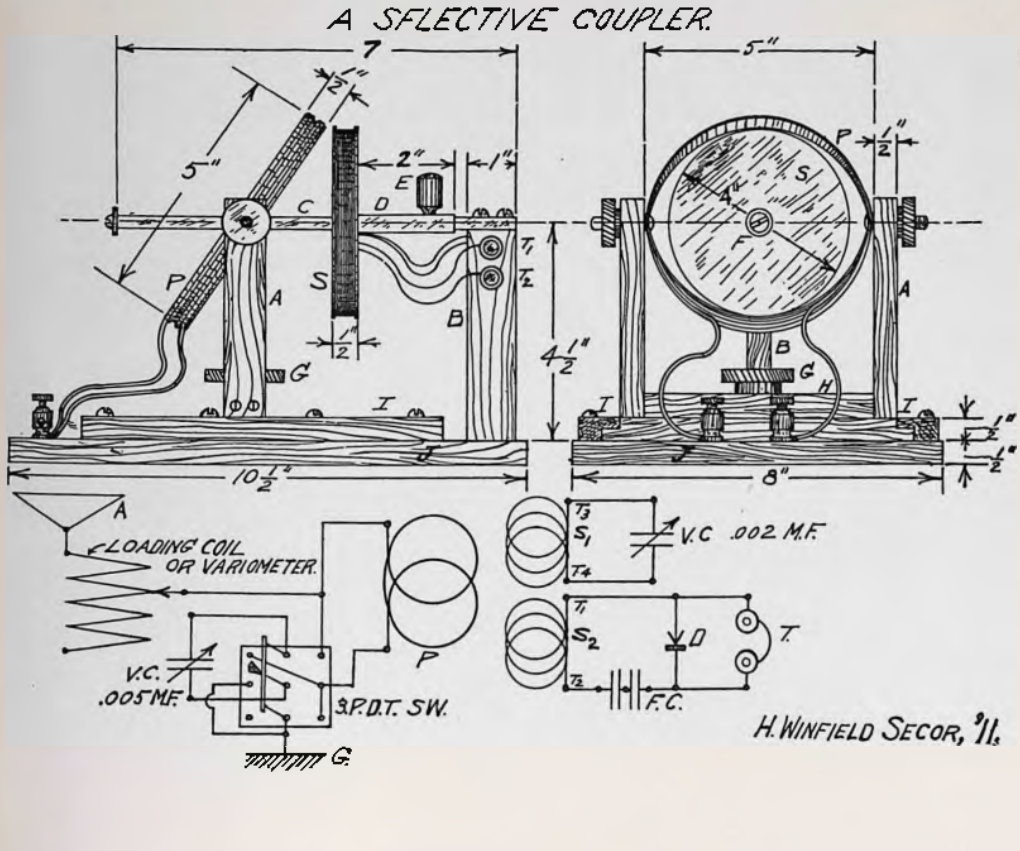
The next article of the series will give the construction of several types of detectors, inductive tuners, etc., as well as the calibrating of receiving circuits, and data on the most recent types of receiving apparatus.

A SELECTIVE COUPLER

H. WINFIELD SECOR

A new form of loose coupler for use in wireless receiving sets, and capable of very selective tuning is illustrated in the drawing.

It will be seen that the primary coil, *P*, is quite small and is wound with four turns of No. 16 rubber-covered fixture wire. As low as one turn has been used on this type of coupler, with good results. It is understood, as shown in diagram, that some artificial loading arrangement to take in the longer waves is necessary,



such as a variometer or loading coil.

A loading coil suitable for use with this instrument may be constructed of a paper or built-up wooden cylinder 12.5 in. in diameter by 12.5 in. long, wound with one layer of No. 24 enamel wire, taking off taps at every 50 turns to a 10 point switch, making the coil a 10 step loading coil; each step will have 200 meters wave length and the total capacity wave length is 2,000 meters.

Referring again to the coupler the primary tube ½ in. wide and 5 in. in diameter (outside) may be made of cardboard or a piece of hard rubber bent to this size. The primary is free to swing on its axis from the two trunnion screws. The upright frame *A*, is arranged to swing horizontally about the tightening screw *G*, as an axis. Also the whole primary may be slid to and from the secondary along the slides *I*, fastened to the base *J*.

The secondary *S*, is composed of a hard rubber or wooden disc turned with a slight groove on its face, into which is wound two independent, well-insulated layers of No. 28 enamel wire. The leads from each layer are brought out to four separate posts T_1, T_2, T_3 and T_4; T_1 and T_2 represent the terminals of the outer layer and are connected to the receiving instruments; T_3 and T_4 are connected to a variable condenser, which forms a weeding-out circuit.

It is evident that the primary coil can be placed in any relative position to the secondary desired, and will be found very effective in close tuning. The secondary coil may be moved in or out of the primary coil along the bar *C*, by means of the insulated handle *E*.

A special arrangement of the variable condenser in the primary circuit is shown, and by means of the three-pole double-throw switch the condenser can be shunted across the primary coil for the reception of long waves and placed in series with it for receiving short waves.

NAVY SERVICE REGULATIONS

CHAS. H. COLLINS

The following extracts from the naval and commercial wireless telegraph service should prove of interest to amateur operators whose ambition is to do first-class work. The majority of the regulations can be used to advantage in the operation of most amateur sets.

The instructions to govern communication between ship and shore stations of the U.S. Navy as issued by the Bureau of Equipment is as follows:

I. A vessel wishing to communicate with a station, and having learned by "listening in" that she is not interfering with messages being exchanged within her range, should make the call letter of the station.

II. The call should not be continuous but should be repeated at intervals of about three minutes, in order to give the station a chance to answer.

III. After the station answers the vessel should send her name, distance from station, weather, and number of words she wishes to send; then stop until the station makes the O.K. signal; signals the number of words she wishes to send to vessel and signals Go Ahead (GA).

IV. Then the vessel begins to send her messages, stopping at the end of each 50 words, and waiting until the station signals OK and GA. When all messages have been sent the figure 30 indicates that sending station is through sending.

V. When a vessel has indicated that she has finished, the station will send to the vessel such messages as she may have for her in the following order:

(*a*) Government business (official).
(*b*) Vessel's business (captain's or companies' reports).
(*c*) Urgent private dispatches.
(*d*) Press dispatches.
(*e*) Other dispatches.

VI. A naval station has the right of way over any other sets with the exception of vessels in distress.

VII. When two or more stations desire to communicate with a land or ship station at the same time the one whose call is first received will have the right of way. Others will be told to wait, and will be taken up in order. Vessels being told to wait must cease calling.

VIII. When a naval wireless station is unable to get an aerogram through, the sender of the message is notified through the wire line from which it was received.

IX. Vessels within calling distances of wireless telegraph stations should always report, in order to get storm warnings or any telegram that shore stations may have for them.

X. Time Signals: (Particulars received through the courtesy of R. S. Griffin of the Navy Department.)

(*a*) Time signals are sent out by the naval wireless land stations in the following order: commencing at 11.55 a.m., every tick of the clock is transmitted excepting the 29th second of each minute, the last five seconds of each minute excepting the last, and finally the last ten seconds of the last minute before noon; the instant of noon is indicated by a dash.

(*b*). Therefore the groups of signals would appear as follows, assuming the signals to begin exactly at the beginning of a minute: 28, 25, 28, 25, 28, 20—.

(*c*). Sometimes the first number of signals may vary, due to the fact that the relay was connected to the wire lines at some other time than exactly at the beginning of a minute.

XI. Cipher messages.

(1) In checking cipher messages the receiving operator shall (when he has received the whole of the message) repeat it back, group by group, the sending station checking each group from his original written message.

(2) Operators should use their utmost judgment in determining the correctness of messages, and all peculiar words or groups of figures, letters, etc., should be checked by the sender.

XII. Log books.

(1) All naval and commercial stations keep log books showing the weather, atmospheric conditions, individuals with which the station has communicated with, or received communication from, techincal reports and notes. Log books are turned in to the main station for examination at stated intervals of time. Efficiency of operators is generally judged by the log book records.

XIII. Copies of messages.

Messages received for delivery shall be written in duplicate by means of carbon. Carbon copy is forwarded or given to addressee; original copy retained and filed in numerical order.

By adopting the majority of the above regulations and obeying same, much of the disturbance about amateur interference could be avoided and governmental supervision would be avoided.

Miracles of Flight

(*Concluded from page 414*)

worst scare he has ever had when flying; and it must be remembered that he is certainly a man of extraordinary pluck, as example the incident in the Gordon Bennett race in America last year, when he was flying below Mr. Alec Ogilvie and considerably slower: for the British pilot's information, Latham pointed at one of his wings. A large strip of the canvas had torn loose and was flapping in the wind. Yet Latham flew round with his aeroplane in that condition for a couple of more laps before he was forced to descend. Then he had a new wing fitted, and, without any trial, set off again and actually finished the race in the prescribed time.

A Lamp Bulb Experiment

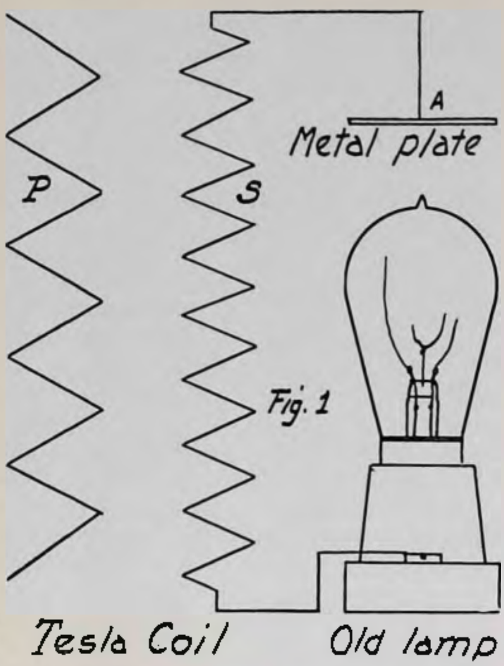
PHILIP EDELMAN

Those of you who own a Tesla coil may have the pleasure of performing the following experiment.

Connect up a burned-out incandescent lamp to one terminal of the secondary of your coil. Suspend a small metal plate about 1 in. from the top of the lamp. Connect the other terminal to this plate. This is shown in the drawing. The plate *A* should be about 1 in. square and is made of tin-foil or thin metal sheeting.

To operate, close the circuit, starting the Tesla coil and allow a heavy blue brush to discharge into the bulb. The lamp will light up a brilliant green with little webs of sparks near the top. Then open the circuit, stopping the spark. Now bring your hand near to the lamp. Immediately you will hear a hissing sound, and, if in the dark, a thin stream of sparks will be seen to pass to your hand. As your hand comes near enough a bright spark will pass to it, and at the same instant the lamp lights up feebly, and the metal plate is seen to glow.

At this moment touch the metal plate with your other hand, either while you hold the bulb or if you do not grasp it.



A tiny spark or stream of sparks will pass to your hand with a very weak little sting. The circuit remains open all this time, of course.

Now touch the bulb again, and once more you can draw a spark from the plate. This may be repeated several times without again closing the circuit. Indeed, you may even go off and leave it for a half hour and still be able to use it and draw sparks when you come back. The experiment may be varied at will. If after closing the circuit and allowing a fresh torrent of brush to enter the bulb, you open the circuit and suddenly grasp the bulb, the effect will be greatly increased, *and the bulb will light up.* If the bulb is properly charged it is capable of giving quite a powerful little shock. When charged in this manner it may be detached from the coil and held in the hand. It will now act much the same as the charged plate of an electrophorus acts, and sparks will jump from the metal cap of the bulb to any conductor which comes near enough.

An Aerial Help

STANLEY BEVERAGE

In wet weather the ropes on the aerial always shrink and cause trouble. This trouble can be entirely eliminated by using a weight. The weight should be a little heavier than the aerial. A good weight can be easily made by taking a kettle or old pail and filling it up with rocks until the proper weight is obtained.

Winding a "Pancake" Coil

CLIFFORD HIGBY

The amateur who does not possess a lathe is often put to his wits' ends to devise some scheme for winding his coils easily.

Generally, the first "pancakes" wound on some wobbly contraption has more resemblance to a "last year's bird nest," than anything else.

Here is a simple method I have used to wind several spark coils and is entirely successful.

Remove the handle from a breast drill and fasten the drill to the edge of a piece 2 x 4, so that the crank revolves in a horizontal direction. Several holes should be bored in the 2 x 4 that the frame of the drill may fit snugly. They are then fastened together with screws or nails and mounted on a plank.

The section former is constructed of a piece of round wood with a hole through the center, and two perforated iron discs. They are assembled upon a piece of bolt and held firmly by a nut at each end; one end of the bolt projecting far enough to fit in the drill chuck.

The wood mandrel is not tapered to facilitate removing the coil, but the following plan is used: two layers of thread are wound upon the wood core, then a layer of paper, after which the wire is wound on and the whole boiled in insulating wax. When cool one of the nuts and perforated discs is removed, the two layers of thread taken out by pulling both ends at once and the coil comes off easily.

Coils wound in this manner retain their shape without bobbins. They can be assembled with better insulation between them and fit the insulating tube closer, thus insuring higher efficiency.

A Novel Aerial Lead-in

CHAS. HORTON

Having set up a station one day and erected the aerial I was confronted with the problem of how best to bring the aerial into the operating room. The best way which suggested itself was, of course, to bore holes in the window panes, in the usual manner. This method, however, was barred, as I was given to understand that no such method would be allowed by the owners of the building, also that no holes whatever should be bored in the casing. Here was a predicament which I finally solved in the following way.

I coated the inside and the outside of the glass window pane with tin-foil to within 2 in. of the edges of the pane, thus forming a condenser of small capacity. The aerial rat-tail was connected to the outside of the window-pane condenser and the aerial switch to the inside. Then I shellacked the glass and tin-foil to prevent leakage. In this novel way I overcame a difficulty which appeared to be insurmountable. I was never able to test this device, as the station was shortly dispensed with. However, I see no reason why the device should not work well with stations of small power. As is readily seen loop aerials might be brought in by using two adjacent panes.

Open Circuit Telegraph Lines—Using Dry Cells

HOWARD S. MILLER

Although various methods of connecting open circuit practice lines for our wireless friends have been published, the three here given I have never seen in print. For simplicity of operation these cannot be surpassed, for it is merely necessary to depress the key to communicate with the other stations, there being absolutely no auxiliary switches or circuit closers to attend to. Our friends who have been unable to call a station because some auxiliary switch had been left open will appreciate what this means.

The diagram, Fig. 1, fully shows the connections, *S* being the sounder, *K* the key, and *B* the battery, which may be all at either station, or partly at each, or between the stations, as long as all the cells are connected in series.

In Fig. 2, upon depressing the key, the sounder at the other station only, responds. Therefore, with this method there is nothing to prevent messages being sent both ways at the same time. With two persons at each end, one to receive from the other station, and one to send to it, this method of practicing should prove interesting.

Fig. 3 shows an arrangement requiring only two line wires. It has the disadvantage of requiring double circuit keys, *K* 2, and a battery at each end of the line, but as the battery is used only for messages sent from that station, it will last longer.

Fig. 4 shows the method of adding intermediate stations between the two shown in Fig. 1. Any number of such may be added, and all will work simultaneously on the depression of any of the keys.

In all the above diagrams, if regular keys are used, the circuit closers should always be left open. Indeed, it would be well to remove them, lest someone used to the ordinary system should close the circuit from force of habit.

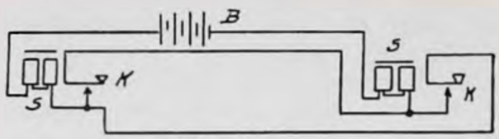


Fig. 1

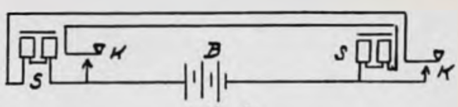


Fig. 2

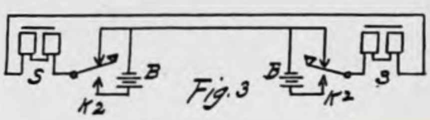


Fig. 3

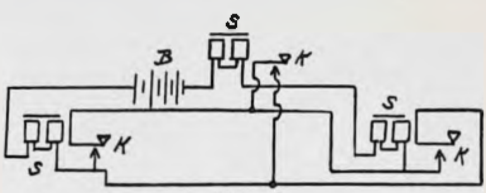


Fig. 4

S = Sounder K = Key

K2 = Double-circuit Key

B = Battery

A PERIKON DETECTOR

HOWARD TUCKER

As every amateur knows, a perikon detector is of the first rank, and is every bit as good as an electrolytic detector, and is, in many respects, better, because it does not get out of adjustment as easily, and one does not have to bother about the acid. In the following lines we have a description of a detector of this type, which has proved very efficient in its operation.

We may as well start with the base first; this is of hard rubber, ½ in. thick. It is cut till it measures 4½ in. by 2¼ in. The corners may be rounded or left square, as you prefer. Four holes that will just pass an 8-32 binding-post screw are drilled one in each corner of the base, about ⅜ in. in. Next, a hole of the same size is drilled midway between the sides of the base and 15/16 in. from the end. Opposite this another hole of the same size is made, but is drilled 1 7/16 in. from the opposite end. Fig. 3 explains quite clearly.

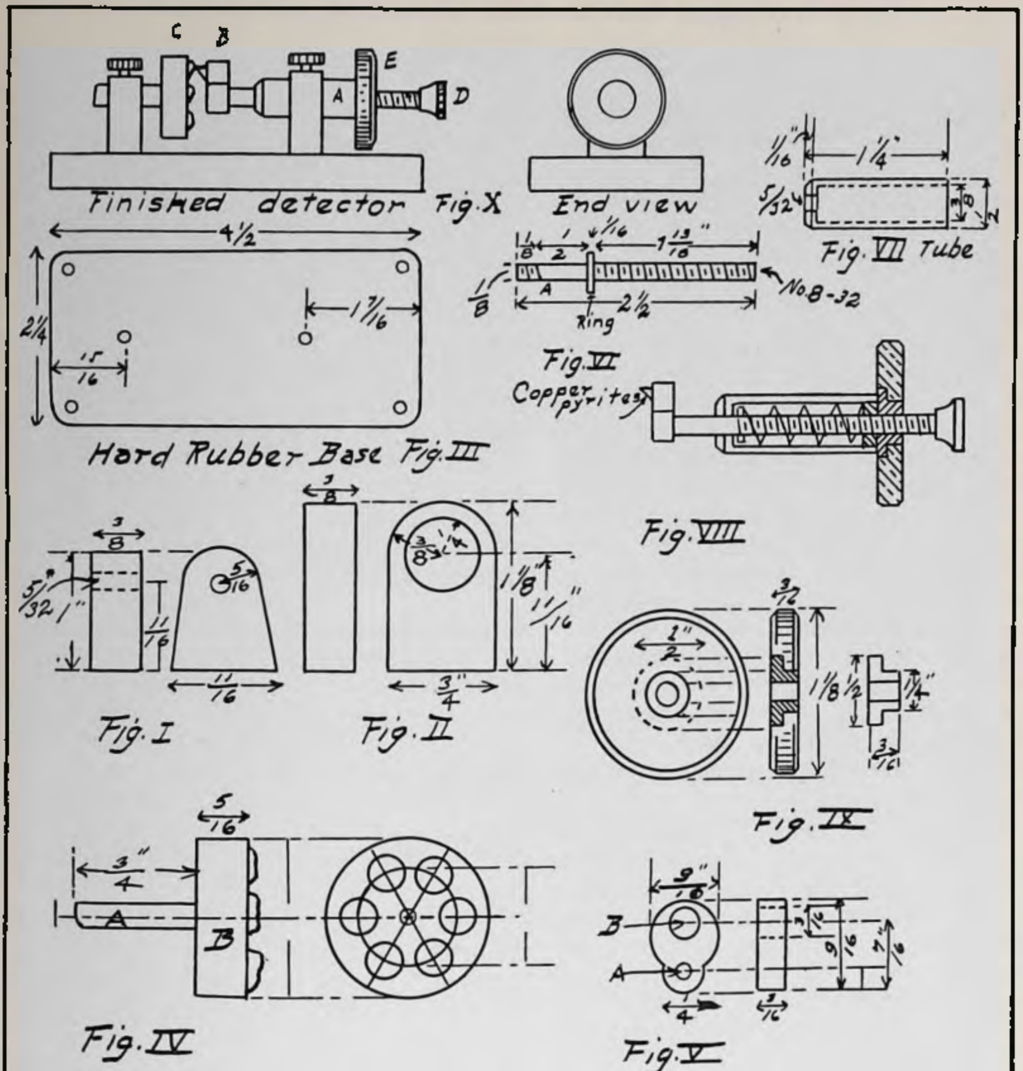
Next, come the standards. These are made of brass. The smaller one is 1 in. high, ⅜ in. thick, 11/16 in. wide at the bottom, and tapers to 10/16 in. at the top. The top is rounded to correspond to a circle having a radius of 5/16 in. The center of this circle is 11/16 in. from the bottom. At this point a 5/32 in. hole is drilled. A ⅛ in. hole is drilled in the top of this piece down to meet the other hole, and threaded for an 8-32 screw. In the center of the bottom of the piece another hole is drilled upwards for a distance of ⅜ in., and threaded with an 8-32 top. The large standard measures 1⅛ x ¾ x ⅜ in. 11/16 in. up from the bottom a hole is drilled ½ in. in diameter. A hole is drilled down from the top and threaded the same as in the other piece. A hole is also drilled in the bottom the same as in the other piece. Figs. 1 and 2 give details.

The tube, that part which holds the working parts of the detector, is a common brass tube, 1¼ in. long, ½ in. in diameter, and having a 1/16 in. wall. The inside diameter is ⅜ in. A ⅛ in. washer is jammed into one end and soldered. A 5/32 in. hole is then drilled in the center of this. The end may then be tapered. The shaft next calls our attention. This is turned from a piece of 5/16 in. brass rod. It is 2½ in. long. ½ in. from one end a 1/16 in. collar is turned. The rest of the piece is turned down to 5/32 in. The part to the right of the collar is threaded its entire length. On the left of the collar only ⅛ in. is threaded (Fig. 6).

Hard rubber adjusting screw head is 1⅛ in. in diameter. A ½ in. hole is drilled halfway through the head and then the hole is finished up with a ¼ in. drill. The bushing is merely a piece of brass and is turned to make a tight fit in the holes drilled in the head (Fig. 9). The bushing is threaded with an 8-32 top.

We may now proceed to put the working parts together. Fig. 8 shows this quite clearly, but we will go over it, anyhow. The shaft (Fig. 6) is first put into the tube (Fig. 7), the hole in the tube will no doubt have to be made slightly larger, but do not make it too large; then the spring, which is one of medium tension, is put on the shaft; next, a ⅛ in. washer, ⅜ in. in diameter, is soldered in the other end of the tube. After this comes the hard rubber head (Fig. 9), and then a small composition knob. This finishes that part of the detector.

The holders for the crystals next call our attention. The one to hold the zincite is shown in Fig. 4. It is made of brass and consists of two parts, the wheel *B*, which is 1 in. in diameter and 5/16 in. thick and the stud *A*, 1 in. long and ⅛ in. in diameter. The part *A* is merely a piece of rod rounded at one end and threaded at the other for a distance of ¼ in. with 8-32 threads. *B* has six ¼ in. holes drilled around the perimeter of circle having a diameter of ⅝ in. The method by which these holes are laid out is shown in Fig. 4. A ⅛ in. hole is drilled in the center of the piece and threaded. It may be said here that the ¼ in. holes do not go completely through, a wall being left to retain the molten metal which is to be poured in afterward. The copper



—Perikon Detector—

pyrites' holder is shown in Fig. 5, and is best made by following closely after the figure. The hole *A* is threaded, and *B* is not drilled quite through.

An alloy is made up of lead, 2 parts; bismuth, 4 parts; tin, 1 part; and cadmium, 1 part. These should be melted in the order named. When the alloy is well mixed it may be poured into the holes in the piece *B* (Fig. 4), the piece being slightly warmed first. Half a dozen pieces of zincite are now put into the holes and the whole thing is stood away to cool.

The copper pyrites crystal is set in the same metal, the only difference being that the zincite crystals are flat while the copper pyrites one should have a blunt point. The crystal is set in so that it appears as in Fig. 8. The whole is then assembled as in Fig. 10, the zincite crystals being connected to the two binding-posts at the left, and the copper pyrites to the two at the right.

In operation the tube *A* (Fig. 10) is slid through the hole in the post till *B* is about ⅛ in. away from *C*. The handle *D* is then turned. By turning *D*, *B* necessarily turns also, and it may be turned so as to come in contact with any of the crystals in *C*. *E* is then turned, either to the right or left, thus regulating the pressure of contact between *B* and *C*.

HOW WIRELESS WAVES ARE SENT AND RECEIVED

ERNEST C. CROCKER

Wireless telegraphy depends for its action on what is known as "Hertzian Waves." These waves, first made known through the experiments of Hertz, and also known as electro-magnetic waves, travel through the "ether" which exists everywhere, much as sound waves travel through the air.

In order to establish a wireless telegraph depending on the use of these waves, we must have four things, namely: a source of waves, a means of sending them out, a means of receiving them, and a means of interpreting them.

The waves are commonly produced, at present, by the discharge of a condenser, which sets up an oscillating or alternating current of a high frequency, usually from 200,000 to 2,000,000 reversals per second. For the present, we will assume that we know how the waves are produced in the first place, and skipping the next two steps, will see how they are interpreted at the receiving station.

Through the process, which will be described at length, of transmission and reception, the waves are received at the receiving station in much the same form in which they were sent out, namely: an alternating current of high frequency, although enormously weakened by the great distance through which they have traveled. This feeble alternating current may be led through proper instruments and be made to cause a sound in a telephone receiver which is held to the ear, or be made to work a recording instrument.

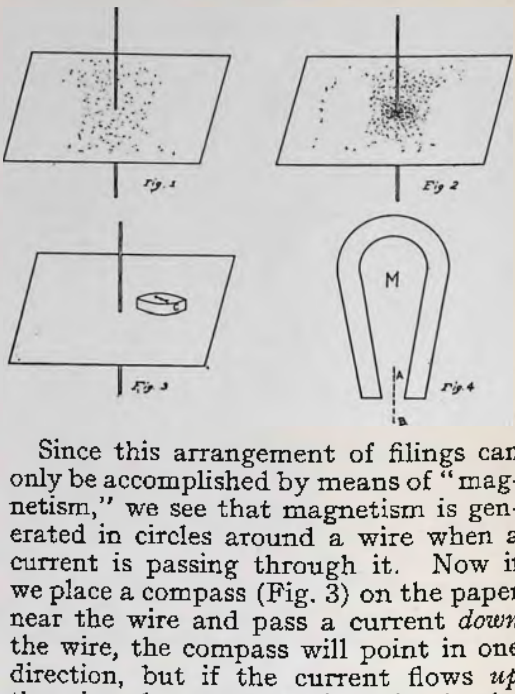
Now that we have an idea of the nature of the waves, the method of producing them, and the method of recognizing them, we will consider their transmission and reception.

As the name "electro-magnetic" implies, these waves are dual in nature, that is, they have both electrical and magnetic properties, and, as we shall see later, we make use of both. It will be necessary to recall two elementary electrical experiments to show how the two forces, electricity and magnetism, may be interchanged.

EXPERIMENT 1

We will need a piece of paper, a wire, a compass, a battery and some iron filings.

If we (Fig. 1) pass a wire *W* through a piece of paper *P*, and sprinkle iron filings on the paper, nothing noticeable will happen, and the filings will fall in no particular way, but if we pass a current through the wire and then sprinkle filings on the paper, we will notice that they arrange themselves around the wire in regular rings (Fig. 2).



Since this arrangement of filings can only be accomplished by means of "magnetism," we see that magnetism is generated in circles around a wire when a current is passing through it. Now if we place a compass (Fig. 3) on the paper near the wire and pass a current *down* the wire, the compass will point in one direction, but if the current flows *up* the wire, the compass will point in the opposite direction. If the current is alternated, the needle swings back and forth. The compass shows the direction of the magnetism, while the filings show the way it is distributed. Thus it will be seen that "lines of magnetic force" are produced by passing a current through a wire and vary with the current.

EXPERIMENT 2

We will need a magnet, a wire and a galvanometer.

If the magnet is placed horizontally, as in Fig. 4, and a wire *W*, held perpendicularly to the paper, is moved from A to B, the wire is said to "cut the lines of force" which flow from one pole of the magnet to the other. If we consider the wire W to be a knife and the lines of force to be made of soft material, we can see how this expression of "cutting lines of force" is derived.

Strange as it may seem, when we cut the lines of force in this manner, and the galvanometer G (Fig. 5) is connected with the two ends of wire W, an electrical current will be indicated by G. If W is moved from A to B it will be in one direction, and if from B to A, it will be in the opposite direction. If W is moved back and forth, an "alternating" current is produced, that is, a current that is continually changing its direction of flow. This is the principle upon which dynamos work, to produce current by moving a conductor through lines of magnetic force.

It makes no difference whether we have a stationary magnet and move the wire, or whether we have a stationary wire and move the magnet. The only essential in producing an electrical current from magnetism, is that we shall have a wire which in some way cuts lines of force.

After having seen the relationship between electricity and magnetism and how they are mutually interchangeable, we will proceed on our wireless discussion.

Electricity cannot travel through the great distances separating wireless stations; indeed, it takes 20,000 volts of electrical pressure to force an appreciable quantity of current through a single inch of air. Magnetism comes to our help here, however, for it can readily travel through air, as was seen in our magnet, whose poles were perhaps an inch apart and yet the magnetism readily flowed through this gap.

As we desire to send magnetism across the space between our two stations, we will proceed to see how it may be produced and sent from the sending station, when we have only electricity to begin with, and how, when it reaches the receiving station as magnetism, it may be changed into electricity again.

Remembering how, in Experiment 1, magnetism was produced when a current was sent along a wire, we will erect a wire, or grids of wires, at our sending station, for the purpose of furnishing the conductor to carry the current.

In the case of high-frequency alternating currents, we find by experiment, that when the current reaches the dead end of a wire that it practically "bounces" back along the wire. Now, if we, with our source of high-frequency currents, send a current up the wire, it will immediately on reaching the end return down the wire by reason of the "elasticity" or "springiness" of the electrical circuit, and if, when it comes down, we push it up again by a new impulse, we will keep up a continuous surging or alternating current in the wire as long as we can supply the impulses.

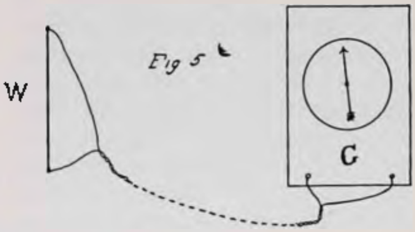
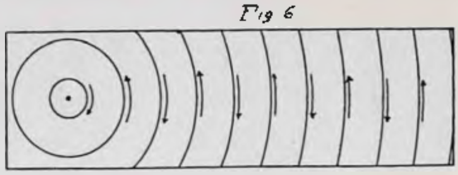


Fig 6



As we saw from Experiment 1, that when we pass an alternating current along a wire, we get an alternating magnetism, we shall expect to get an alternating magnetism in this case, and, in fact, we do. The current forms circular rings of magnetism around the wire just as in Experiment 1, the rings being piled on top of each other from the ground up to the top of the wire in the form of a big cylinder.

We have a very rapidly alternating current flowing in the wire and no sooner is a "cylinder of magnetism" formed, than the current changes its direction in the wire and a cylinder of magnetism flowing in the opposite direction is formed within it. This new inner cylinder repels the outer one and this causes the motion of the cylinders away from the wire. No sooner has the inner cylinder pushed the outer one away than the current has reversed again and a new cylinder pushes it away. This is kept up as long as the current flows.

We have seen how the magnetism was produced and sent out from the transmitting station. The cylinders of magnetism expand and their walls travel away from the wire at the tremendous rate of 186,000 miles per second, but maintain the same distances from their neighbors. Thus we see concentric cylinders of magnetism expanding rapidly through space, each cylinder being opposite, in the direction of its lines of force, to that of its neighbor on either side. These cylinders grow to very great size and follow the curvature of the earth, travel up and down hill, and go upwards into the atmosphere to a height estimated at from 30 to 50 miles, where its further increase is checked by the peculiar conductive condition of the atmosphere.

We saw from Experiment 2 that when either a wire was moved through lines of magnetism or the lines of magnetism were made to go by a wire and thus cause the wire to cut the lines of force, that a current was produced in the wire. We also saw that when the lines of force alternated in direction, that the current alternated in the wire in the same way.

Since we have lines of force moving through the air from the transmitting station, it follows that if we place a wire in such a position as to cut these lines, that we will have a current produced in the wire, and, as the magnetic lines alternate in direction, our current will be alternating. It happens, that if we simply erect a vertical wire, it will cut the lines of force as they pass by it. This constitutes the receiving air-wire or antenna, in which an alternating current is produced as the waves of magnetism pass by it.

At another time we shall see how it is that the feeble alternating currents thus produced in the receiving wire can be made to convey the message that was intrusted to them hundreds, and, perhaps, thousands of miles away.

PRACTICAL HINTS

SHOP NOTES

WM. C. HOUGHTON

The shop kinks given below have all been successfully used in actual practice, and are recommended for the purposes indicated. Many of them are, of course, capable of modification to suit particular cases.

Extracting Pins or Plugs from Blind Holes

A drill chuck which had an old plug driven tightly in the taper hole, and broken off short, furnished quite a problem until the following scheme was adopted: a short piece of steel rod about ⅛ in. diameter was selected, and a hole of the same size drilled through the old plug connecting with the small open space at the bottom of it. The hole was then filled with oil, care being taken to displace all air bubbles. The rod was then inserted in the hole and one smart blow with the hammer started the old plug. Hydraulic pressure did the business.

Templets for Turning Half Round Beads and Concaves

Beads and concaves may be turned quickly and uniformly by the use of templets. For beads take a thin strip of hard, close-grained wood, such as maple or birch, about 1½ times as wide as the bead. Bore a hole through it near one end, using a bit of the diameter of the bead. Cut the stock across the center of the circle and form the other end to a convenient handle. Cut the edge of the half circular outline very thin. Apply to beads from time to time as the work progresses, to show whether beads are of required shape and size.

For concaves turn a "collar button," the base of which is a disc of the required diameter, and the shank will serve as a convenient handle. The circular base, which should have a thin edge, is held in the concave and shows the shape.

Outline templets of thin wood or thin metal may be cut to any required outline, and use in a similar way in making tool handles and other more complicated shapes.

Concealing Screws, etc., used in Fastenings of Furniture

It is often quite a problem to fasten the various parts of furniture together without showing screw heads, etc., in objectionable places. One way is to counterbore the hole to ½ in. or less depth, and a diameter somewhat greater than the head of the screw. Put in the screw and fill the counterbore with a neatly turned plug of the same wood as the furniture. The end of the plug should be slightly rounded and project the round above the surface. Fasten in place with glue.

Hold Small Screws in Awkward Places

Take a bit of small wire, make a loop in the end to fit the neck of the screw. Bend the end to a convenient angle. When the thread is caught, pull off loop and drive screw home.

The wire should be soft, and small enough to bend easily. Sometimes a slip of cardboard is more convenient than the wire. Punch a small hole in the end, bend, insert screw and pull off before tightening the screw.

To Wind Springs

Take a metal rod somewhat less in diameter than the inside size of the inside of the desired spring. If the wire is very springy, like piano wire, it should not be more than ¾ in. size. Bend ½ in. or more of the end of wire at right angles, and with a pair of round-nose pliers, make one full turn of the spring coil. Put the rod in a drill chuck in the lathe. Slip the coil of the spring over the rod, and the bent end in between two jaws of chuck. Turn lathe slowly away from you, holding the wire taut. The bent end and the first hand-made coil prevent the wire from slipping. If a tension spring is wanted, wind closely. If a compression spring is to be made, wind two wires together, and when spring is made, unscrew them. If accurate winding is not necessary the turns may be simply wound more or less open. In winding stiff wire, always reverse lathe for a few turns before letting go of the end, or you may get a severe scratch when the wire flies back.

Making Rings

To make a number of rings perfectly round, true, and of uniform size, first wind a spring of a sufficient number of turns of suitable wire, using a rod somewhat smaller than the inner diameter of rings.

Beginning at the end of the spring cut each turn off with a fine tooth hack saw. The coil may be held in a vise for this purpose, if the wire is stiff enough. A slight twist of each coil will bring the ends of the ring in line. If desired, they may then be soldered or brazed.

Finishing Irregular Curved Surfaces

In finishing more or less irregularly curved surfaces of woodwork, such as hammer handles, curved legs of furniture, etc., rough out to nearly the required size and shape with ordinary tools. Take a strip of rather coarse emery cloth, and holding it stretched between the hands, saw it back and forth across the work.

It must also be kept in motion lengthwise of the work to keep from cutting in grooves. The "strap" will automatically cut down the high points and leave the work smoothly rounded. Sandpaper cuts wood better than emery cloth, but breaks so quickly as to be useless for this purpose.

Pencil Sharpener

Where large numbers of lead pencils are to be sharpened frequently, a sandpaper wheel used in the lathe or on a grinder, will do the work better and faster than any of the usual machines sold for the purpose. Turn a wooden wheel 6 or 8 in. in diameter, and 1 or 2 in. face, with hole to fit grinder or lathe arbor.

One of the small hand emery grinders is very good for this purpose. Glue No. 1½ sandpaper around the wheel not on the side. In use, run the wheel toward the pencil point, which will be quickly ground to a sharp concave shape. A very light pressure should be used, and the pencil rolled quickly around. Eight or ten pencils per minute can easily be done after a little practice.

Turning Tools

In wood turning, it is customary to use a parting tool to cut work wholly or partly off, or in cutting down square shoulders. This tool is, however, somewhat difficult to keep in good order, and also hard to use correctly. In many cases, the skew chisel may be used to better advantage. If the space to be cut down is wide, hold a ½ in. chisel flatwise against the work and at right angles with it, but with the edge as high on the work as it will cut. Push rapidly inward, gradually lowering the cutting end. If the space to be cut is narrow hold chisel edgewise with sharp corner up and the upper edge radial with the work. The tool will clear itself and cut quickly to the center.

Truing and Sharpening Whetstones

Whetstones often get badly out of true on the face, usually being hollow in the center, or grooved by grinding narrow tools carelessly. When in this condition it is impossible to put tools in really good order with them. They also get *dull*, that is, the exposed abrasive gets rounded or so gummed up that it will not cut. It is sometimes recommended to grind the stone flat on the side of a grindstone. This, however, destroys the cutting properties, that is, the whetstone will be dull. To true up and renew the cutting qualities at the same time, proceed as follows: If possible, get a flat iron plate; if not, a hard wood board will do. Sprinkle the iron plate or board with rather coarse emery, say No. 60, and wet down with water or kerosene. Water for a water stone and oil or water for an oil stone, but not oil for the water stone. Place the stone face down on the plate and grind true, using moderate pressure and renewing the supply of water or oil and emery from time to time, as required. A true and sharp stone will soon be produced.

Emery cloth may be used in the same way, but it must be thoroughly wet so that the emery will be loose and roll under the stone. If used dry it will cut slowly and dull the stone.

Holding Long and Slender Stock in the Lathe

It is sometimes desired to turn a shoulder or ball on the end of long and slender stock, such as a dowel rod. It is impossible to do this in the ordinary way between centers. To do it easily, take a scrap of hard wood and turn a plug of the size and taper of the lathe centers. Drive it tightly in the lathe spindle. Spot and drill a hole through it lengthwise of the same size as the stock to be turned. Take out and slit one side of it with a saw. That is, make a split bushing to fit the stock, and tapered to fit lathe. Slip the bushing on the dowel with the end to be turned projecting, and drive in place with the stock through lathe spindle.

The same method may be used to make a temporary chuck for holding a straight-shank drill. The same drill is used in making the hole, holding it against the back center of the lathe. If well made it will hold drill perfectly true and drive very strongly.

A Depth Gauge

In turning or carving small depressions, cutting cams, rebates, etc., it is often difficult to measure the depth directly. A depth gauge may be very easily improvised for the purpose. Take a small flat slip of thin wood and drill or punch a small hole through it. Drive a shoe peg, match stick or small dowel through the hole and adjust to length corresponding to depth of hole required.

EDITORIAL

We have taken pleasure in presenting the past few months a department entitled "Home Craftsman," edited by Mr. Ralph F. Windoes. From month to month descriptive articles, which will be of service to all those interested in this line will be given, and we trust they will be very acceptable to nearly all of our subscribers and followers. Mr. Windoes will be glad to answer questions which may arise on the subject of woodworking.

The next number, namely, our July issue, we have planned to be a special one on storage batteries. Rapid strides have been made in the manufacture of this product, and one improvement seems to be followed by another. We are spending considerable time and expense on the preparation of articles, and hope to make an excellent showing. If our readers will tell just what lines they are particularly interested in, we are prepared to meet their demands for future articles, possibly in special numbers. We have in mind one devoted largely to the subject of telephone systems, possibly another on small motors, and a variety of other commercial topics. We would welcome with pleasure any suggestions from our friends and supporters.

We had anticipated presenting in this number Mr. Collins' twelfth and last instalment in his series of articles under the heading "The Bulletin's Free Wireless Course," but unfortunately Mr. Collins has been delayed in preparing the matter, and it is, therefore, unexpectedly omitted.

We are requested to make the announcement that the articles by Henry Townsend, Jr., which have appeared in recent numbers of *Electrician and Mechanic*, were written by H. Winfield Secor, of New York. We hope to present other subjects by this gentleman. One, on a Selective Coupler, appears in this issue.

The July issue will begin a new volume, namely XXIII, and we anticipate showing a new cover design which we hope will be acceptable.

The magazine has been so well supported by its many thousand of readers, all over the country, especially since the increase in price the first of this year, that we take this time to express our gratitude.

After all it is the readers who do so much in procuring a bigger and better publication. In calling for your ideas, your support and friendliness we do so in order that we may develop the magazine which you read, from cover to cover, in every possible way.

A new index for Volume XXII which ends with this, the June issue, will soon be ready for distribution, and will be sent free on request. Owing to the increased size of the magazine as it is now published, it has become necessary to make the volumes in six instead of twelve numbers.

To those who delight in calling attention to the alleged special dangers of aviation, one can point out the fact that during 1910 the gentle art of mountain climbing, as practiced on the Alps, caused the death of one hundred and twenty-eight people. In 1909 the list totaled one hundred and forty-four. In two months out of the twelve, forty-five were killed. The fatalities of aviation totaled in 1910, twenty-seven. Unfortunately, no figures are at hand on the number of people who enjoyed the pleasures of mountain-climbing during this period. It is likewise impossible to arrive at a total of the flights made, but it is safe to assume that there were at the close of the year in all countries in the neighborhood of two thousand aeroplanes making short to long flights.

QUESTIONS AND ANSWERS

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

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for reply, but is simply to cover clerical expenses, postage, and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time.

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

1604. **Transparent Paper.** M. C. S., Catskill, N.Y., asks: How much castor oil he should put with turpentine to use for making transparent paper. Ans.—We are not familiar with the formula you mention, but recommend the following which is frequently used for making tracing paper: Open a quire of smooth unsized white paper and place flat upon a table. Apply, with a clean sash tool to the upper surface of the first sheet, a coat of varnish made of equal parts of Canada balsam and oil of turpentine, and hang the prepared sheet across a line to dry; repeat the operation with fresh sheets until the required quantity is finished. If not sufficiently transparent, a second coat of varnish may be applied as soon as the first has become quite dry.

1605. **Transformer.** H. S. M., Syracuse, N.Y., sends a sketch and specifications of a small step-down transformer of the closed core type and asks: (1) Will the construction and dimensions give satisfactory results for experimental purposes where the instrument will be used for only a few hours at a time? (2) How many circular mils area of wire should be allowed per ampere of current for this type of construction and would the same allowance hold for both primary and secondary? (3) Is the turbine described in the April *Electrician and Mechanic*, capable of running a small dynamo; and if so, what h.p. could turbine deliver, and what pressure of steam would be required to give said h.p.? Ans.—(1) We have no criticism to make with respect to the dimensions of core or method of construction. Your primary wire, however, is of too small a cross section to carry the proposed amount of current without undue heating. For continuous duty, it is customary to allow 1,000 circular mils per ampere, especially in the case of the primary, as in this winding there is practically no chance for radiation of the heat developed. With the type of iron you propose to use, there will also be some heating in the core, therefore, we would suggest the use of No. 20 wire on the primary. With very close winding you can get 70 turns per layer and winding 7 layers deep, you will have 490 turns on each leg. You will be able to get 25 turns per layer and 2 layers deep of No. 10 wire on each leg for the secondary, and with this winding you should obtain slightly over 10 volts and an available current of 10 amperes. For short periods of time you will be able to exceed this latter figure considerably. (2) See answer to question (1). (3) Approximately 1/12 h.p. A small coil boiler would be most satisfactory. The pressure required would be about 75 to 100 lbs. The turbine would drive a small 20 or 30 watt dynamo, providing steam pressure was high enough.

1606. **Ignition Tube.** R. W. B., Springfield, Ill., asks (1) for the name of a firm which can supply him with an "ignition tube," such as is described in T. C. Stanleigh's article on the Six-inch Coil in the April issue. (2) Where he can get the holes put in the tube and where the glass rod can be obtained. Ans.—(1) We refer you to Stanley Curtis whose announcement appears on our advertising pages.

1607. **Wireless Receiving.** H. R. C., Chicago, Ill., asks: (1) which is best for long distance receiving, a silicon or an electrolytic detector? (2) Is it better to use two 1,000 ohm receivers or two 75 ohm ones and a potentiometer? Ans.—(1) The electrolytic detector is considered more sensitive than the silicon for very long-distance work, but it is surpassed by the perikon, a description of which will be found in this number. (2) The 1,000 ohm phones are by far the better.

1608. **Condenser—Aerial.** D. W. D., Montrose, Col., asks: (1) If a glass plate condenser, 5 x 7 inches is good enough for the sending condenser for a 2 in. spark coil. (2) (*a*) His sending radius with instruments he mentions and using battery for power. (*b*) With 110 volt 60 cycle A.C. and electrolytic interrupter? (3) Which aerial is better, a horizontal one consisting of 4 wires, 50 ft. long and 30–40 ft. high or one 150 ft. high of 2 wires suspended from a box kite? Ans.—(1) Yes, if it is of the proper capacity. (2) (*a*) Your sending radius is dependent upon so many unknown conditions, such as insulation of aerial, proper degree of tuning, quality of ground, type of battery and the type of coil used, that we prefer not to make an estimate. Such an estimate would necessarily have to be in the nature of a pure and simple guess. (*b*) Where 110 volt A.C. is available, it is utter foolishness to use an electrolytic interrupter unless long sparks are desired. For wireless work, the function of the coil is to change a condenser, and a short flaming spark is far better than the long, stringy ones usually found in most coils. For use on a 110 volt A.C. circuit, we advise the use of the coil as an open core transformer. Clean the vibrator contacts carefully and then screw the adjusting screw down tight. Make an impedance coil by winding 4 layers of No. 18 D.C.C. wire on a core of soft iron wire 1½ by 12 in. Connect impedance in series with coil and line in place of the electrolytic interrupter. The impedance may be made variable by bringing out taps at various points in the winding. This will entirely do away with the troublesome interrupter and better results will be obtained. (3) We believe that the vertical aerial would be more effective, but do not consider it as practical as the horizontal one which is always in position ready to use.

1609. **Rotary Spark Gap.** L. W. S., Marlboro, Mass., asks: (1) Will the result be the same if a six-inch rotor is used instead of a 12 in. one, described in the article on a rotary spark gap in the February number of the *Electrician and Mechanic*? I have not been able to get a 12 x ¼ in. aluminum plate. (2) Are there any firms selling aluminum plates of the above stated size, and if so, their addresses? (3) Would it be possible to get an aluminum casting of the required shape made, and are there any firms doing this kind of work? Ans.—(1) We would say that a 6 in. rotary could be used in the construction of a rotary spark gap, provided it was not called upon to handle the output of a heavier transformer than a 1 k.w. Another advantage of the larger size plate is that the teeth may be placed at a greater distance apart, and that the greater surface which is exposed in the larger gap renders it less liable to heat up to any great extent. (2) You may obtain aluminum plates or castings from the Aluminum Castings Co., Fairfield, Conn.

1610. **Aluminum.** H. C. B., Langdon, Kans., asks: (1) Can aluminum be nickel-plated? (2) Why cannot aluminum be used for the plates of a storage battery? Ans.—(1) No, in spite of extensive experimenting, this metal has not been plated with nickel or with anything else. If only it could be copper-plated immense additions to the usefulness of this light-weight metal would be gained. Once having succeeded in getting the copper to adhere, the surface could then be nickeled, soldered, or covered with other plating. All attempts thus far have met the uniform experience that the aluminum merely acquires a scum of oxide instead of the desired metallic coating. (2) Certain unique conditions must be complied with in order to make a storage battery. First, the solution must not contain the metal of which the plates are composed, that is, the plates must not dissolve in the solution. Second, the passage of the electric current must perform certain chemical changes. Third, the solution must be of a nature both to permit such chemical changes, and be a good electrical conductor. Thus far, only lead and sulphuric acid, or nickel and iron with caustic potash have been found to fill the conditions. Aluminum, on the other hand, offers just the opposite properties from those requisite for such a battery. Current will go *from* the aluminum plate, but not *towards* it, and on this principle is based the construction of the aluminum electrolytic rectifiers and lightning arrestors. Physically, the belief is that the aluminum plate sets up an exceedingly energetic polarization (or counter) electromotive force.

1611. **Motor.** S. R. W., Stoneham, Mass., has a General Electric direct current fan motor which he desires to change into a low voltage generator for electro-plating. Can this be done without rewinding armature? Ans.—This is a series motor, and the field winding probably requires 20 volts; the armature resistance may also waste 20 volts, so that the machine may be called upon to set up a counter electromotive force, when running, of perhaps 75 volts. Thus the whole of the applied 110 volts may be accounted for. Electroplating will not require more than 5 volts, so it is practically necessary to wind both armature and field. The latter should be shunt rather than series wound. By use of thick woven wire brushes on the commutator, sufficient current-carrying capacity will be allowed, for the carbon brushes will not be suitable. Perhaps No. 18 wire on armature and No. 21 on field would give the desired results.

1612 **Thermo-battery.** E. P. S., Providence, R.I., asks some questions as to the practicability of making thermo-elements to operate by heat of the sun. Ans.—Various extravagant statements as to the commercial developments of such sources of electricity are occasionally appearing, but seem to fool no one except the presumed inventor. The last public proposition was to install a mammoth device of this sort in Arizona, where the sun is both hot and dependable. For ordinary localities, even if otherwise practicable, the operation would be so variable with climatic conditions as to make the investment even more ridiculous. For the operation of a thermo-couple, not heat alone is needed, but cold. A *difference* of temperature must be maintained, and with the sun shining directly upon one side, the other could not be over 10 degrees or 15 degrees cooler. About 4000 couples would then be require to give one volt. Ordinary batteries would certainly be cheaper.

1613. **Small Dynamo.** L. N., Buffalo, N.Y., sends description of a small machine which he proposes to build, and asks if the proportions are good, and what the probable output will be. Field magnet is of the Edison type, cores being 1⅝ in. in diameter, and 2¼ in. long; bore of pole pieces, 3 in. and 3 in. long axially; armature core is 3 in. in diameter and 3 in. in length, with 12 slots wound with 60 turns per section of No. 27 wire. Shunt portion of field has 4,000 turns of No. 33 wire; series portion, 3 layers of No. 23 wire, per spool. Ans.—From your description we are not just sure whether you mean that there are 60 wires in a slot, or 120. Assuming the latter, you ought to get 50 to 60 volts from the machine. The current should not be over 1 ampere. The reason for this small output is due to the slender nature of the field cores and fineness of wire on armature. The iron could well have been 2¼ in. in diameter. You could then have used No. 24 wire on armature. With the No. 33 wire on field, we have a suspicion that the resistance will be too high to permit the machine to build up its magnetism, but you can remedy this if you will connect these two fine wire windings in parallel with each other, rather than in series.

1614. **Underground Apparatus.** J. F., Chelsea, Quebec, asks: (1) Will enameled wire be as well for electromagnets for underground use as cotton covered? (2) Should electromagnets in such a location be immersed in oil, and if so, what kind is proper? Ans.—(1) The principal advantage of the enameled wire over the cotton covered is found in the fine sizes, say in the case of measuring instruments. When the winding is immersed in oil, the cotton is quite as good for insulation purposes, and cheaper. (2) Oil will be a great advantage, perhaps imperative. The good operation of present transformers is often found in the fact that the insulation is preserved by use of oil. The latter is merely paraffin oil, but pure and neutral,—that is, neither acid or alkaline. Further, it must be free from moisture, and an important process in the preparation is to dry it, by heating it for a number of hours to a temperature somewhat above the boiling point of water, whereby the moisture passes off in the form of steam.

1615. **Storage Battery.** E. M. Y., Littleton, Mass., wishes to make a storage battery of 20 volts and 2 amperes capacity for operating a 1/12 h.p. motor. He asks several questions as to the number and size of the plates, also in regard to the control of the motor. Ans.—You could not expect such a small motor to have a gross efficiency greater than 50 per cent., that is, in order to get 1/12 h.p. from the motor, you might have to put in 1/6 h.p. of electrical energy. With 746 watts per h.p., you will then need to allow for a battery of about 125 watts capacity, or three times as much as you have proposed. For a simple yet highly satisfactory construction of battery made from easily obtained materials, we can do no better than refer you to the new edition of Watson's book on Storage Batteries. Many other things you will find in this publication that will be of value if you intend to embark in this line of experimenting. For the control of the motor you can adopt the scheme frequently found in automobiles,—have the cells arranged in various groups that can be connected in series or parallel with each other, thereby allowing for impressing quite a wide range of voltage on the motor. With this arrangement you will not be likely to need rheostats.

1616. **Induction Motor.** B. C. M., Cincinnati, O., is proposing to rewind a "Century" single-phase motor,—a make that closely resembles the well known "Wagner" type. Stator punchings are 9 1/2 in. in outside diameter and 6 in. inside. There are 32 slots, each about 3/8 x 7/8 in. in size, and present winding is of the sort that resembles the formed coils commonly found in direct current machinery; each coil occupies one-half of a certain slot and half of another 90 degrees distant. Each coil consists of 23 turns of No. 16 wire, embracing eight teeth. The writer proposes to replace this burned-out winding with the concentric sort of coils, such as was described in the October, 1907, magazine, each coil thereby completely filling pairs of slots, 46 turns per coil then being accommodated. The inmost coil is to embrace only one tooth, the next coil surrounds this one and embraces three teeth; the next will include five, and the last one for a given group, seven teeth. He asks if his idea and certain accompanying sketches are correct? Ans.—Just which form of coils will give the best results in this particular motor, we cannot readily state. Both forms are used by motor builders. The direct current shape seems to be preferred for two and three phase motors, especially for the reason that it permits the "fractional pitch" spacing, which slightly reduces the self-induction of the winding. For single phase motors, we think the concentric coils are more often used when economy of labor is not the ruling factor. Certain it is that in the original Heyland single-phase motor,—which still stands out as a foremost type, the concentric coils were used, and are now to be found in the latest General Electric "RI" (repulsion-induction) motors. Your description is correct, but the sketch shows the first coil embracing two teeth, the next four and a third six. This winding will work almost as well as the one you proposed, but the Heyland motor had a single large tooth for this inmost coil. With a single small tooth enclosed, there is a considerable introduction of ohmic resistance without proportional gain in magnetism. You could accomplish this in the case of your machine by thus including two teeth, then four teeth, then six teeth, thereby filling seven slots, each coil consisting of 46 turns. Now wind the next slots half full. Similarly in the four other groups, whereby each pole will be energized by four coils, three of 46 turns each and one,—the outer,—of 23.

1617. **Electromagnet.** Reply No. 1575, in the April number of the magazine, contained an error that we wish to correct. The correspondent overlooked the fact that he was deal ing with an alternating current, for he prescribed the same solution for the flow of current as would be true by Ohm's law for direct currents. Quite likely most of the readers discovered the error. In an alternating current circuit consisting of coils wound on an iron core, the reactance and not the resistance is the principal controlling factor. With the winding given, it is quite likely that so small an alternating current would flow as to be scarcely readable with an ordinary ammeter. Further, if 5 amperes did flow, it would be tolerable for momentary use only, as specified, else the wire would soon heat to the point of burning off the insulation. The design of such an electromagnet follows exactly in the line of designing the primary winding of a transformer, and this cannot be done without a fairly accurate drawing of the particular piece of apparatus and rather extended calculations. We would refer to Underwood's "Electromagnet," as a reliable book that devotes some space to problems of this kind.

TRADE NOTES

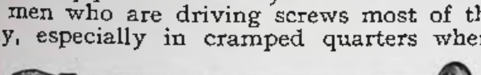
We take pleasure in calling the attention of our readers to "Potmend," a mending agent which certainly possesses some remarkable qualities. This cement is in the form of a fine, white powder, and it is only necessary to add the powder to a few drops of cold water to produce a cement which is absolutely fireproof, waterproof and a good electrical insulator. The cement may be used for closing holes in and repairing practically any material. It cements all metals, including aluminum, just as readily as it does wood, china, amber, ivory, porcelain, meerschaum, glass or marble. The cement, when hard, ensures a joint, the permanency of which is not affected by intense heat nor extreme cold. Neither boiling nor cold water have the slightest effect on this substance, and it would seem that it should prove most useful in the repairs of machinery, such as the cracked water-jacket of a gasoline engine, etc.

Our investigations of the cement as an insulator of electricity showed that when the moisture is thoroughly dried out of the mixture, the insulating qualities are of a high order. Where great mechanical strength is required of an insulator, this preparation should prove invaluable. Its heat-resisting and insulating qualities should render it very useful in the construction of small electric furnaces, etc.

The Potmend Co., 305 W. 24th St., New York City, will be glad to supply a trial can upon receipt of fifteen cents.

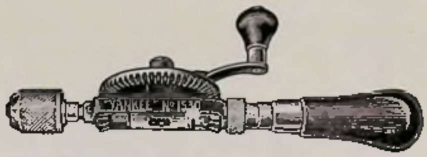
North Bros. Mfg. Co., Philadelphia, Pa., announce three recent additions to their popular line of "Yankee" tools. No. 130 is a spiral ratchet screw driver, similar to the well-known No. 30, with the addition of a "quick return" attachment consisting of a spiral spring in the handle. This feature

entirely dispenses with the necessity of pulling back the handle as the spring causes it to come back for the next push. The tool will undoubtedly prove extremely useful in the hands of men who are driving screws most of the day, especially in cramped quarters where



the left hand cannot be used to hold the chuck end of the driver. This tool takes the same bits and attachments as the regular No. 30.

The "Yankee" Push Brace, No. 75, will hold all the small tools used in a bit brace, but is operated by pushing the handle to revolve the tools in the same manner as a "Yankee" ratchet screw driver. It is said to excel a bit brace in its greater rapidity and convenience in the lighter work ordinarily done by the brace. On account of its straight and cylindrical form it can be used in many places, such as corners, holes and back of obstructions where a brace cannot be operated.



The "Yankee" Hand Drill, No. 1530, has a right and left-hand ratchet movement, and is made on lines similar to the regular "Yankee" Breast and Hand Drills. The size, however, is somewhat smaller, and the tool is intended for light work. By moving the small shifter on cylinder between small gears on the spindle, the various combinations of the ratchet and gears are brought into play.

A recent test of S. C. Johnson & Son's line of dyes, stains and wood finishes on the cases of some apparatus constructed in the *Electrician and Mechanic* laboratory, gave conclusive evidence as to the ease of application of these finishes. The appearance of the cases after treatment was strikingly rich and handsome, even though the wood employed was of the most common variety.

Of the various samples tried, the Dark Mahogany, No. 129, proved to be one of the most satisfactory. This stain with waxed finish produces a beautiful color and durable finish on cypress. For a higher gloss, though less durable finish, the "Underlac" is applied. This preparation appears to have many advantages over shellac or varnish. It dries within half an hour and after a good rubbing down with wax over the varnish, the surface acquires a hard and brilliant gloss.

The Mission Oak, No. 125, stain was used with excellent satisfaction on a case of Georgia pine. The naturally beautiful grain was brought out in a most artistic manner.

These stains and finishes are made in all shades and colors and the handy-man, who is building furniture, instrument cases or other articles of wood, as well as he who takes pride in the appearance of the floors and furniture in his home, will do well to investigate the merits of Johnson's finishes. S. C. Johnson & Son, Racine, Wis., will be glad to forward their booklet and samples to any interested reader.

April 25, 1911.

Sampson Publishing Co.,
Boston, Mass.

Dear Sirs: Our MESCO automobile horn has now been on the market for something over a year, and owing to its reasonable price, its efficient but not annoying alarm, and its comparatively small consumption of current, it has proved a success in every way. In fact, its points of superiority are becoming so generally recognized in the trade that it has evidently disturbed the makers of the Klaxon horn to such an extent that after nearly a year's delay, they recently brought suit against us for a pretended patent infringement.

Apparently, the only patents on which they could claim infringement by our MESCO horn are two sets of absurd claims, which they obtained May 13th, 1910,—one for one drainage hole in the front plate of the horn, and the other for two drainage holes. Of course, there was nothing new or patentable about this drainage hole idea. Christopher Columbus had it four hundred years ago when he had "scupper holes" in the sides of his vessels to drain the water from the decks, but the Klaxon people thought they had a cinch on us because we had handled their Klaxon horns with their unfair license tags, and on a motion which they brought for preliminary injunction they set up the argument that because of the restrictions of those license tags on the Klaxon horns we had no right to dispute the validity of these ridiculous patents.

On the argument for the motion for preliminary injunction, Judge Coxe, of the U.S. Circuit Court, decided otherwise, and said that we were not "estopped" (as the lawyers say), to deny the validity of their patents, and the Judge *refused* their request for an injunction against our making, using and selling our Mesco horn.

Prior to the suit we had handled Klaxon horns, but when the Klaxon people treated us,—one of their good customers,—in this high-handed way, by bringing this motion for preliminary injunction, with practically no previous notice, we made up our minds that we could not handle the Klaxon horns any more, and so stated to the Court, and our counsel consented to an order against our handling the Klaxon horns *without the consent of the Klaxon people*. This is all the injunction, and the only injunction, which the Lovell-McConnell Company got against us, and whenever and wherever that Company says or implies that it got an injunction against the MESCO horn, it says or implies that which is not true. Its application for injunction against the manufacture, use or sale of the MESCO horn *was refused by the Court*.

We are ready to sell our MESCO horn to everybody and anybody, and we guarantee that it does not infringe any valid patents owned or controlled by the Lovell-McConnell Company.

Yours truly,
MANHATTAN ELECTRICAL SUPPLY CO.
(signed) E. Whitmore,
Sec'y and Mgr.

BOOK REVIEWS

Metal Work and Etching. By John D. Adams. Chicago, Ill., Popular Mechanics, 1911. Price, 25 cents.

This is the eighth in the series of twenty-five cent handbooks published by Popular Mechanics, of Chicago, and consists of eighty-eight pages bound in cloth. It contains simple and explicit directions for making numerous attractive articles, out of etched brass or copper and metal, and it is remarkable how the publishers can contrive to produce such excellent books for the low price. We cordially recommend it to any of our readers who are interested in decorative arts.

Questions and Answers for Automobile Students and Mechanics. A Book of Self-Instruction for automobile students and mechanics, as well as for all those interested in motoring. By Thomas H. Russell, A.M., M.E. Chicago, Chas. C. Thompson Co., 1911. Price, $1.00.

The questions and answers in this book will be found useful by every student and mechanic of motor cars and motoring, as a handy means of reviewing systematic study or in daily work. It has long been recognized that the question and answer method is most effective in fixing in the memory facts gained by study or problems that confront the mechanic in his daily work; hence, it is adapted for the purpose. The more important subjects connected with motor cars are treated individually, there being a separate set of questions and answers for each. For the greater convenience of the reader, the questions and the answers in each set appear on separate pages; the questions can thus be used alone for self-instruction, while the answers if needed are close at hand for reference. Minor subjects are covered in a special catechism, which deals with all the factors which go to make up the power plant of a modern motor car.

The Boy Scouts of the Eagle Patrol. By Lieut. Howard Payson. *Ben Stone at Oakdale*. By Morgan Scott. New York, Hurst & Company, 1911. Price, 50 cents each.

These two books of adventure are of the kind that every live boy likes. Full of excitement and adventure from start to finish. They are well and attractively printed, and substantially bound, so as to form a very satisfactory addition to the boy's library.

Principles and Design of Aeroplanes. By Herbert Chatley. New York, D. Van Nostrand Co., 1911. Price, 50 cents.

In this handy little book, No. 126 of Van Nostrand's series, the author has treated in a simple manner the elementary principles which lie at the basis of the current design and construction of aeroplanes. Without confining his consideration to any particular type of plane, he covers the features of the several types now in use, and considers future development as well as present conditions. Some slight attention is given to other types than the aeroplane, which, however, the author does not consider to be of much practical use. The book is well worthy the attention of every student of aeronautics.

Things a Boy Should Know About Wireless. Containing much practical and some theoretical information regarding the operation and explanation of wireless outfits, together with numerous wiring diagrams. By Thos. M. St. John. New York, Thos. M. St. John, 1910. Price, $1.00.

This is one of the simple and practical series of science manuals written and published by the same author, and is adapted to the comprehension of young readers. It contains, nevertheless, a large amount of every practical information in regard to ether waves, their utility, propagation and detection, and it will give any intelligent youngster a good idea of wireless telegraphy.

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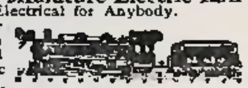

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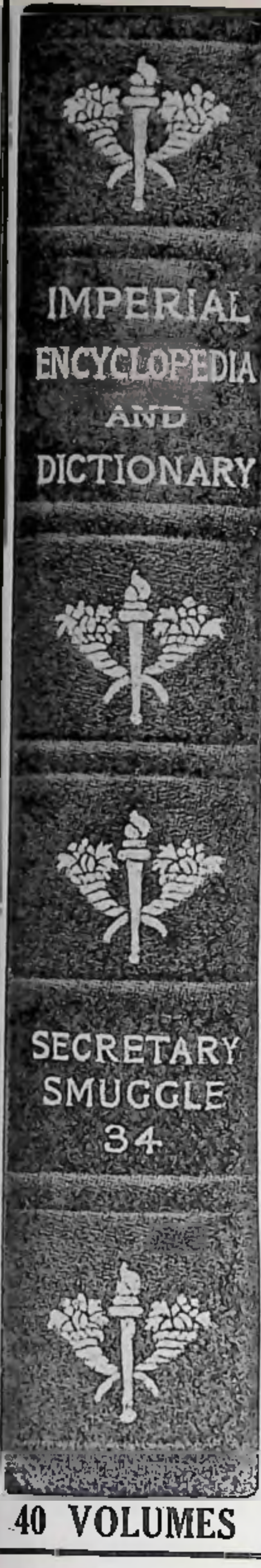

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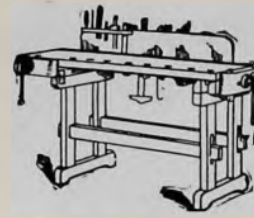

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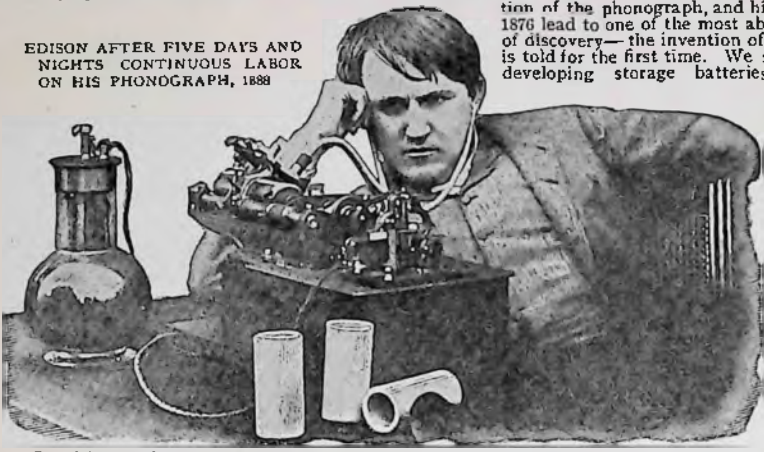

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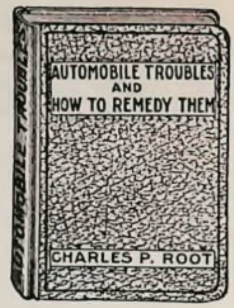

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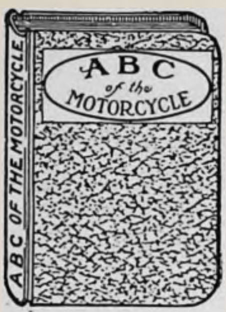

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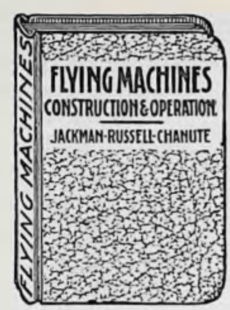

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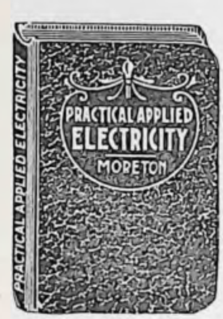

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This Screw Driver is the same as our No. 557, illustrated on Page 188 of our No. 18 Catalog, except that the handle is covered with hard rubber for insulation from electrical currents, and is nicely ribbed so as to insure a firm grip when using the tool. It has four blades of different widths, any one of which may quickly be taken from the telescope handle and inserted in the end, where it is automatically locked and firmly held for use. Any or all of the blades are carried in the handle, where by a spring pressure they are held from rattling when carried in the pocket, or from being lost when the cap is off. While the cap may be readily pulled off or put on it is rigidly held from turning and frictionally held from coming off, with no screws to bind or bother.

The smaller blades may be used to make holes in wood for screws as well as to drive them home. Every electrical mechanic, or operator working among electrical wires or machinery, will appreciate these insulated Screw Drivers as a valued protection against electrical shocks.

The widths of the blades are 3-32 in., 5-32 in., 1-4 in. and 3-8 in.

Price Complete, $1.50 **Extra Blades, each, 10 cents**

Ask for free Catalog No. 18 W of Fine Mechanical Tools

THE L. S. STARRETT COMPANY

ATHOL, MASSACHUSETTS **U. S. A.**

A New Battery Motor—Reversible

LIGHT-WEIGHT **HIGH-GRADE** **POWERFUL**

NO. 35 K. & D. MOTOR, with starting, stopping and *reversing* switch contained within the motor casing.

This motor is one of a *new line* just brought out by KENDRICK & DAVIS—a guarantee of quality. The field pieces are of wrought metal; armature of best charcoal iron, *laminated*, slot wound and perfectly balanced. Standard K. & D. mica-insulated commutator, and dependable *self-adjusting* brushes. The pulley is ⅝ inch in diameter and fastened to the steel shaft by a screw.

It runs to full efficiency on two or three dry, or other cells of similiar capacity. Height 3¼ inches; weight 15 ounces. Finished in black enamel and nickeled trimmings **Price $3.00**

No. 35A K. & D. MOTOR. A plain motor without switch; otherwise like No. 35. **Price $2.25**

N.B.—These motors will *not* be wound for lighting circuits. For the other motors of this line, and other up-to-date types, see the Kendrick & Davis Book of Electrical Goods, No. 9.

MANUFACTURED BY

Kendrick & Davis, Lebanon, New Hampshire