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ELECTRICIAN AND MECHANIC

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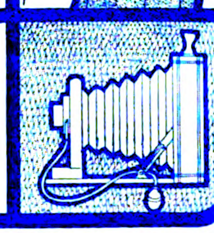

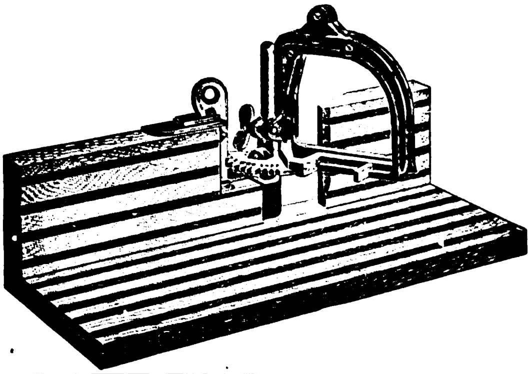

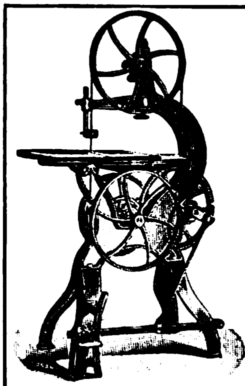

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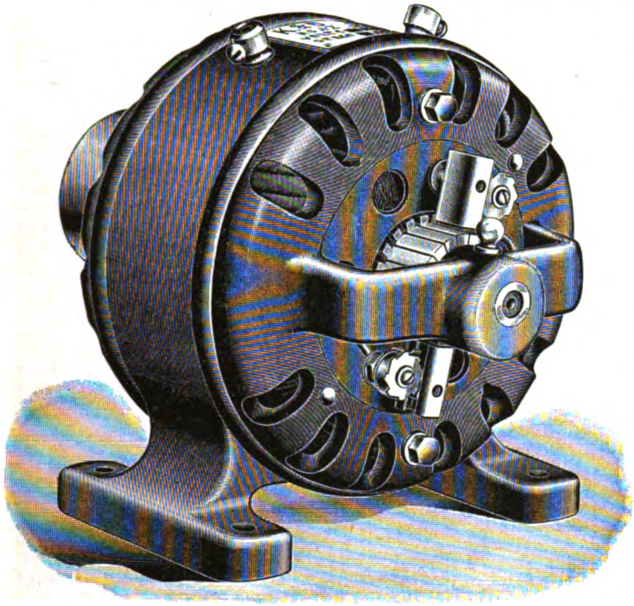

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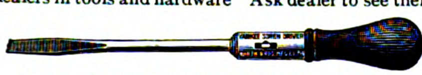

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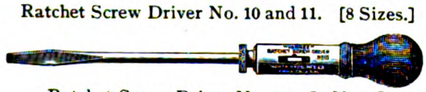

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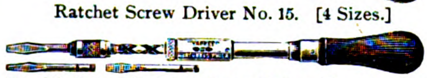

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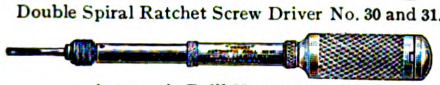

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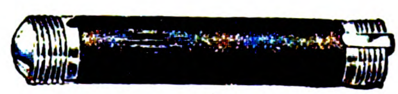

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VOL. XVIII NOVEMBER, 1907 NUMBER 5

ELECTRICAL ENGINEERING—Chapter XVII.

Transformers and Transformer Systems

A. E. WATSON

By a "transformer" is meant an assemblage of iron core and two copper windings used for exchanging one alternating voltage for another. Various other names have been used to refer to the same thing, such as induction coils, inductoriums, converters, and secondary generators. In the necessary limitation of certain names to represent definite things, the first of these is now understood to mean the ordinary form of sparking or shocking coil; the second refers to the same device, but is seldom used; the third has a new qualification, to be explained in the next chapter; while the last is a historic name only.

Two things which a transformer, unaided, cannot do, are either to change alternating current into direct (or vice versa), or to change the frequency of the alternations. Apparatus which will actually do these things usually works in connection with transformers, but cannot be treated in this chapter. In this article the attempt will be made to explain not so much in what ways different manufacturers construct transformers, as to bring out prominently the essential principles involved in all of them, and also in a group as arranged or distributed upon a circuit. In no branch of engineering is an epoch more clearly marked than that which demonstrated the practicability of the transformer. Expensive and almost crushing mistakes accompanied the pioneer experiments but when once on the right track constructions of higher efficiency than the dynamo itself were possible, and the business of long-distance electric lighting and power transmission was rendered highly profitable.

The transformer system was first introduced into the United States in 1886; and to appreciate the significance of its advent and the opportunities before it, one has only to consider the limitations experienced by the low-tension direct-current systems, commonly typified by those using original Edison apparatus. Even though heavy copper conductors were used, it was found impossible to keep the voltage constant even over a single city block or group of business houses. It was therefore necessary for a station of this sort to locate in the close neighborhood of its largest customers, where real estate was limited and expensive, where the carting of coal and ashes must be by wagons in the street, where no condensing water was available, but where smoke, exhaust steam, noise and vibration were apt to be declared nuisances. With the introduction of the three-wire system, allowing the use of double voltage, conditions were sufficiently improved to admit the economical lighting of lamps half or three-quarters of a mile from the station. Still the station managers regarded extended residence lighting as quite out of their reach. Meanwhile, series arc lighting, experiencing no difficulties from lengths of circuits, developed into a service that was then believed well-nigh perfect.

With the advantages of the high voltages and series connections real-

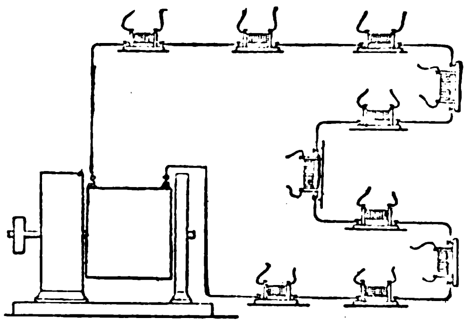


FIG. 75
Gaulard and Gibbs' System of "Secondary Generators" in Series

ized in the arc lighting systems before them, Gaulard and Gibbs brought out in England, in 1882, the scheme diagrammatically represented in Figure 75. In this it is meant to show an alternating current generator of reasonably high voltage, with its circuit extended through one of the windings of each of ten induction coils. These latter had straight cores of the well-known Ruhmkorff type, but with this difference; that both primary and secondary windings were composed of the same size of wire and of the same number of turns. These coils were to be placed at convenient points, and their secondary circuits then connected to rows of incandescent lamps, in the ordinary multiple method. In consequence of the surety of the same current passing through each primary, and incidentally energizing it, there seemed the surety of each secondary generating the same electromotive force; therefore, however distant from the source, lamps would everywhere burn with the same brilliancy.

At a public exhibition in London, in 1883, two such induction coils were operated on a comparatively short line, but actually lighted lamps. Later in that year, four coils were placed at widely different points on a circuit 16 miles in length; and in the next year, at the Turin, Italy, exhibition, a primary circuit 50 miles in length was constructed. In all these cases, regulation of voltage for each particular load was effected by varying the number of secondary conductors, or by moving, in or out, the straight bundles of iron wire of which the core was composed. George Westinghouse (then Junior) was so impressed with the possibilities of this system that he bought the patent rights for this country, and at once sought to equip actual stations. An improvement in the efficiency of the induction coils was made by having the iron of the magnetic circuit continuous, instead of compelling the magnetic lines to go a long distance in air, but all the primary coils were still connected in series. Actual results were as crude and unsatisfactory as with the inventors' original apparatus. The fault was this, that the act of turning on or off a lamp supplied from one transformer affected all the rest of the lamps, whether supplied from that transformer or from any other; and with reduction in the number of lamps,—when it was expected that the dynamo potential could be correspondingly reduced,—an actual increase in voltage was found necessary. With the critical condition of exactly the same load on the same capacity transformers, the system made a splendid showing; but under ordinary conditions of variable loads, the interference of one customer's lamps with another, to say nothing of the expense of renewing ruined lamps, and the difficulty of attending to the dynamos, made the system a conspicuous failure. Certainly, it is easy to see that any effect produced on the primary circuit of one transformer, by varying the number of lamps, would equally be communicated through the series circuit to all the rest. The promoters made the mistake of supposing that by reducing the number of lamps on a secondary circuit, they would thereby allow the primary current to flow all the easier through the other winding. In this they missed the fundamental point of transformer action and regulation, for the very opposite of their beliefs was the truth. Primary and secondary windings are in such sympathetic relations that whatever contributes to resistance to the flow of current in one is equally felt by the other. The so-called lines of force produced by one winding so link themselves with the other that to all intents and purposes —except for the ratio of the number of turns—they might as well be the same winding.

Kennedy, in an article in the English "Electrical Review," in 1883, showed that by connecting the primaries of the different transformers in

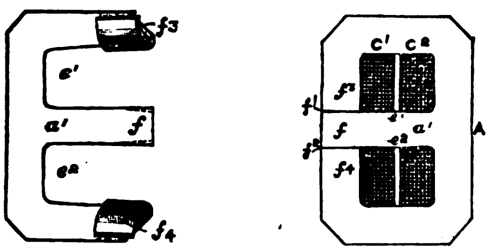


Fig. 76
Sheet Iron for Westinghouse Transformer

parallel with each other, rather than in series, self-regulation would be possible. He had in mind, however, the existing experimental coils of Gaulard and Gibbs, with the same number of primary and secondary turns; and with such, the cost of conductors would exceed that for ordinary direct-feeding systems. To William Stanley, in 1885, seems due the credit for seeing just the solution of practical means for securing the benefits of high-tension transmission with low-tension supply for customers. The same high-voltage generator as tried with the series-connected transformers was proper; but each individual transformer, instead of being wound for low voltages only, should have its primary wound to withstand the full voltage, the various primaries should be connected in parallel with each other, and the generator, instead of being forced to supply a constant current, should merely act like a direct-current machine for incandescent lamps: i. e., supply all the current asked for, but always keeping the voltage fairly constant. Not being convinced of the practicability of this proposal, the Westinghouse Company would not try it; so Stanley was led to make the original proof at his own expense, and upon the practical proof of his surmises to organize his own company, in Pittsfield, Mass.

Once upon the right track, the applications of the transformer system of distribution were seen as almost unlimited. Gaulard and Gibbs sought to amend the specifications of their patent so as to embrace the parallel method of connecting, but failed; and the field was thrown open in this country and England to the free exploitation of alternating currents. In other European countries, however, Ganz & Co., of Buda-Pesth, Hungary, had been allowed some fundamental patents on similar systems, and through their unprogressive business methods and the lack of popular appreciation, rather small use was made, for a number of years, of the advantages of alternating currents. In England the development of supply systems met with some retardation by virtue of onerous regulations as to the construction of the high-voltage mains imposed by the Boards of Trade; but in this country, permission to erect pole lines was usually not difficult to obtain, and electric lighting grew apace.

One of the first constructions adopted by the Westinghouse Company for its transformers was very effective, and even now hardly susceptible of improvement. Elongated coils of copper wire, with parallel sides and semicircular ends, were placed side by side, or one within the other, and formed the primary and secondary members. Each coil was insulated with cloth, paper and mica, so as effectually to separate the two circuits. Thin sheets of annealed iron, punched in the form shown in Figure 76, were then assembled on and over the coils and tightly clamped together by means of external bolts, until the complete structure appeared as shown in Figure 77. The exact shape of the sheets of iron deserves special mention. There are cuts at f^1 and f^2; and to slip the sheets in place, the ends are temporarily bent over, as seen at f^3 and f^4. The central part, or tongue, as it is called, is then thrust through the open

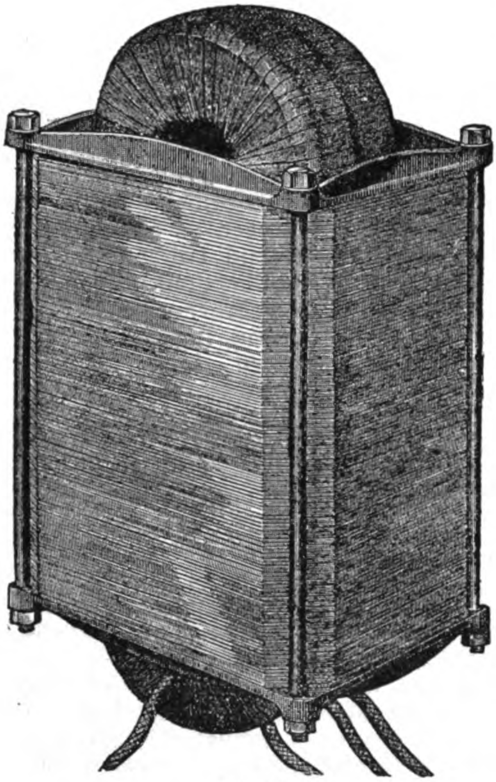


FIG. 77
Early Pattern of Westinghouse Transformer Complete, but without Box

centre of the coil, and the ends again bent down flat. The next sheet, instead of being passed through from the same side of coil, is put in from the other side, letting the cuts come at the side marked A. Then when the clamping is applied, each cut sheet is held between two at the outcut edges, therefore bringing the cuts as intimately together as if the metal was continuous. By making the magnetic circuit thus without sensible air gap, a very small amount of energy suffices to set up the necessary magnetic flux. The energy allowable for providing this magnetism must be of the smallest amount possible, for the primary coil is permanently connected to the mains from the generator; and whatever loss from this source is tolerated must be continued twenty-four hours a day, although the lamps may be used but a few hours during that time. Some transformers have been made with their clamping bolts passing through holes in the sheets, but this construction is faulty, and is not now tolerated. The reason is that though insulated from the rest of the iron, they lie directly in the path of the lines of force, and suffer the generation of wasteful and heating eddy currents. Even if the bolts are made of some non-magnetic material, their presence introduces an unnecessary narrowing of the section of the iron for the magnetism. In Figure 77, the bolts are seen to lie quite outside the field. For out-of-door use, the structure is of course placed in an iron box, sometimes provided with ventilating spaces at the bottom, but securely closed from entrance of water at the top. The box itself is sometimes made to do the clamping of the sheets, the coils themselves being depended upon to hold the iron until transference, or the sheets prevented from slipping on each other by means of wooden pins through holes punched in the corners. In order to provide room for the holes, the corners of sheets are left square, instead of being clipped, as shown in these figures.

With the coils thus nearly concealed from view or enclosed by the sheet iron, the construction is technically designated as the "shell" type, as if the electrical part was placed in a shell. One defect of this arrangement is found in the fact that the coils do not have a very good opportunity to radiate their heat. Another construction has been developed and approved by some of the largest users. This is known as the "core" type, and its principle can be seen from the elementary diagram given in Figure 78. In this a ring is supposed to be wound of annealed iron wire, and on opposite sides of this the fine and coarse copper wire coils, respectively, are placed. Every time the primary current reverses, the direction of the resulting magnetism changes, and as the flux passes around the complete circuit of the ring, there is induced in the secondary winding an alternating electromotive force. In this diagram the fine wire is designated as the primary, and this conception is usually in accordance with the ordinary uses of transformers for distributing electric energy to customers;

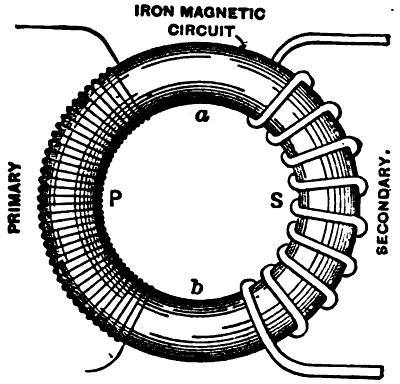


FIG. 78
Typical "Core" Type Transformer

however, for very long-distance transmission, it is common to employ step-up transformers, and in such cases the coarse wire would properly be called the primary. This case is seen to agree with the phraseology regarding induction coils, in which a meagre battery voltage is exchanged for an alternating one of considerably high value. That is always the primary which is connected to the source of energy. Identical transformers could be used: one connected to a generator, for raising the voltage and delivering the energy to the line, the other receiving the energy and lowering the voltage to a suitable value for distribution. In one the coarse winding would be regarded as the primary, in the other as the secondary.

Cores of the ring form have actually been made; but like an ordinary ring armature for a dynamo, they are tedious and expensive to wind, and the same results can be obtained in a better way by having the iron sheets in the shape of a U, with square corners, the straight sides being of two lengths. The coils can be wound in a lathe, or its equivalent, slipped onto these ends, and the magnetic circuit then completed by alternate long and short cross strips of sheet iron. This modification of the core type presents good opportunities for insulating the coils, even in small sizes, exposes a large surface for radiating the heat, and is rather more easily repaired than the shell type. For improving the regulation, primary and secondary winding are equally disposed on both limbs.

For outdoor use, on poles, or on the walls of houses, there is a fairly good chance for preventing excessive rise in temperature; but even a small amount of heat continued indefinitely drys the insulation to crispness, and often reduces its strength. A practice now very common is to fill the transformer boxes with paraffin oil; this in itself is a good insulator, but further it keeps the other insulations in a flexible condition, serves as a carrier of the heat, generated in the coils, to the outer walls, and in case of a puncture of the insulation between the windings, often due to lightning, the oil extinguishes the arc and seals the hole. For indoor use, large transformers are usually made of the shell type, with numerous air ducts, through which lively currents of outdoor air are driven by means of a blower. Still others are immersed in oil in tanks of boiler iron, and the oil continually cooled by circulation of cold water through a series of iron pipes suspended in the upper part of the tank. Of course this expenditure of energy in cooling the coils should be taken into account in estimating the working efficiency of an installation; but really, the percentage of total energy is very small, the practical point being that if one per cent. of the total be thus expended, considerably smaller transformers may be able to carry the load. The case is not essentially different from that of a dynamo; in that, considerable dependence is placed upon the fanning action of the revolving member to keep the coils from getting too hot. The transformer, having no revolving part, can as well have this circulation supplied by some exterior device.

Common primary potentials for distribution circuits are 2000 to 2300 volts, and the secondary coils have one-twentieth as many turns as the other. A customer will then be supplied at 100 or 115 volts, closely imitating the direct-current service. Formerly, it was regular practice to give each customer a separate transformer, and this was usually located on the wall of his house. This practice introduced an unnecessary fire risk, and the monotonous hum produced by the

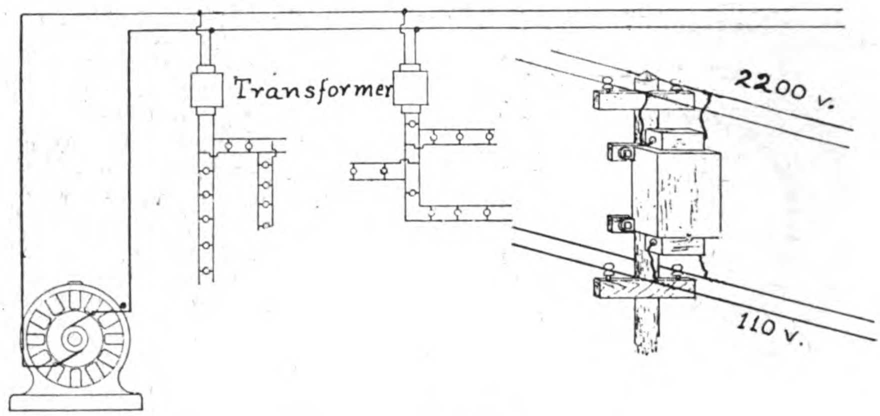


Fig. 79
Transformer Alternating Current System for Multiple Circuits

vibrations of the iron sheets as they experienced the alternating magnetism often communicated a disagreeable noise throughout the whole house. These conditions are removed and greater economy in first cost as well as in operating expenses is attained by using a lesser number of transformers, though of somewhat larger size, but mounted on the poles, or at convenient centres, and with their secondaries connected to mains of their own. Customers are supplied from these latter. A representation of such an arrangement is given in Figure 79. In this, the parallel rather than the series method of connecting the primaries is clearly brought out. In case of reasonably large loads, or considerable distance between different houses, the secondary circuits would usually be of the three-wire variety, giving double voltage between outer wires. Such an arrangement can be obtained from most transformers; for the secondaries are usually formed of two coils that for some service can be connected in parallel, but for other service in series, and a tap for the neutral led out from this junction. Another method for furnishing a three-wire system is to have two identical transformers, their primaries being connected in parallel, as usual, but their secondaries in series, with the neutral led from this junction. The primaries, too, of standard transformers are often composed of two separately insulated coils that can be put in parallel for use on 1000-volt circuits, or in series for those of 2000 volts.

Although the parallel method of connecting transformers has now entirely supplanted the other, yet somewhat to recuperate itself for its early expenditures, the Westinghouse Company once manufactured and advocated a series system for arc lamps that was fairly operative, the faults being largely confined to the impossibility of making good working lamps. Such a system is a consistent one, for if the primaries were in series, the secondaries had their load also of series-connected lamps. When the generator is made to supply a constant current, as would be the case with a direct-current dynamo, these secondary circuits, too, would supply a fairly constant current. To turn a lamp off, it should simply be short-circuited, exactly like one of the direct-circuit sort; and when the last in a given circuit was turned off the secondary of transformer would thereby be on a complete short-circuit. This would mean no harm, however; for with the primary current kept at a limited constant value, the secondary would be powerless to do differently. Through such a short-circuited secondary the current could flow with the least expenditure of electromotive force, and relieve the dynamo of that proportionate load. This, it is recognized, is the very object aimed at by Gaulard and Gibbs; but they made the mistake of mixing series and parallel methods of distribution. With the primaries of the transformers in series, the various elements of the loads must also be in series, while for parallel operation of these loads the primaries must likewise be in parallel. Just as in the case with direct-current apparatus, if the lamps are to be in series, the dynamo must be series wound; while for incandescent lamps or motors in parallel, the field must have its independent, or shunt, winding. In other words, the generating and utilizing parts of the apparatus must have a certain harmony or consistency of arrangement.

The comparison of three possible arrangements of transformer systems is well brought out in Figure 80. For clearness, ring transformers, resembling the one shown in Figure 78, are shown. No. 1 represents what Gaulard and Gibbs and the Westinghouse Company first tried, but for other than particular and critical loads found inoperative; No. 2 is actually practical, and was exploited by the Westinghouse Company until better means for accomplishing the same results were devised; No. 3 shows the ordinary and remarkably satisfactory arrangement.

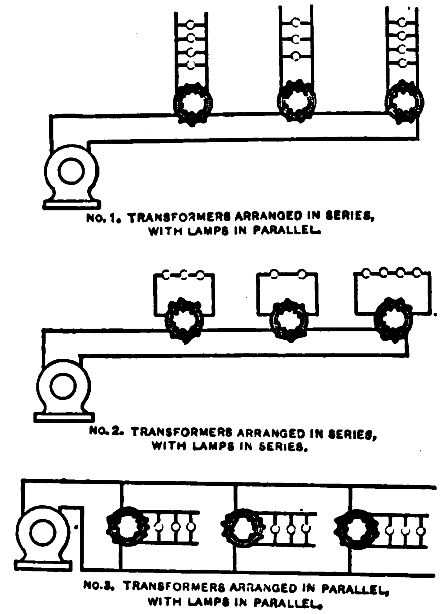


FIG. 80
Comparison of Three Methods of Arranging Transformer Systems

To operate several hundred, or even several thousand, arc lamps for street lighting, all from a single generator, has been the aim of many an engineer. For economy of wiring it is certain that as many lamps as possible should be placed in series, yet the possibilities of large generators quite clearly lie in those of the constant-potential order. The problem then was to operate series circuits, each with its control for constant current, in parallel with each other from a constant-potential source. The conditions involved are just the reverse of the Gaulard and Gibbs proposal; but without special transformers the operation is just as impracticable.

The theory of the proper construction of the latter shows that there must be a large leakage path for the lines of force; that is, when diminished electromotive force is desired of the secondary, more of the lines of force produced by the primary shall not cut through the former, but find opportunity to pass across a purposely-prepared magnetic sort of shunt. By taking this alternative path, the primary will act more like a choking coil, and consequently draw less current from the generator—just the end sought. Reverse conditions will give the opposite results. For years it was sought to embody such a transformer in an entirely stationary structure, but the outcome was discouraging. The efficiency was low and the regulation bad. Then Elihu Thomson, with the vision before him of the shifting brushes of his arc dynamo, and the coincident complexities of the magnetic circuit, resolved to imitate those conditions in a transformer. A long magnetic circuit was provided, with large opportunity for leakage between opposing flanks. Thin flat primary coils were at top and bottom, with similarly shaped secondary coils movable between them. Since, in the two sets of coils, currents flow in opposite directions, a repulsion will exist between them, and by suitably counterbalancing, the secondary current may be adjusted to any desired value. Some of the small sizes of this style of transformer are made with single primary and secondary coils, and in Figure 81 is seen a representation of the arrangement of the parts. The directions of the currents and various paths for the lines of force at some one instant are suggested. The region between the coils is permeated with numerous leakage lines, and for a greater or less secondary current, the upper coil moves into a closer or more remote part of this field. This variable position of the secondary coil is equivalent to driving the armature of a dynamo at variable speeds, therefore just enough electromotive force is generated always to keep the secondary current at the same value. A view of the complete transformer is given in Figure 82. In practice, the large sizes are placed in a tank of paraffin oil, whereby, in addition to the gain in the insulating qualities, some retardation is offered to sudden movements of the secondary. In this respect a close imitation of the function of the dash-pot of the direct-current dynamo is made. In those dependent upon air-cooling, the dash-pot is actually used, as seen at the right in Figure 82.

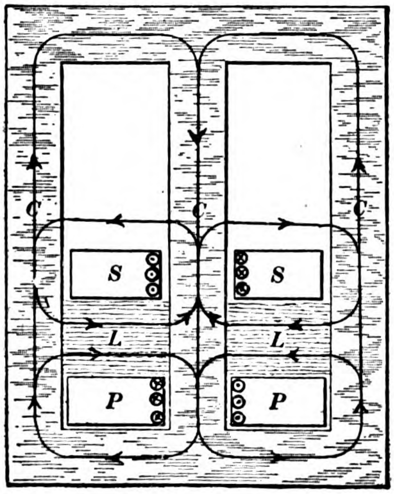


FIG. 81
Magnetic Circuits of Constant-Current Transformer

The constant-current transformers are thus seen to be devices not appropriate for mounting on a pole, but need to be kept under supervision in a station. In addition, they are not as cheap as it was once hoped to make them; but their finely working qualities have made them very popular. With no revolving part, and requiring small floor space, they occupy even in connection with the constant-potential generator for supplying the primary current, not more than one-tenth the space demanded for the former direct constant-current dynamos of the familiar Brush or Thomson-Houston style. Of course, the arc lamps receive alternating currents; but where such are not allowable, the constant-current transformers can operate in connection with the modern device known as the mercury arc rectifier, and deliver to the exterior circuit a direct current.

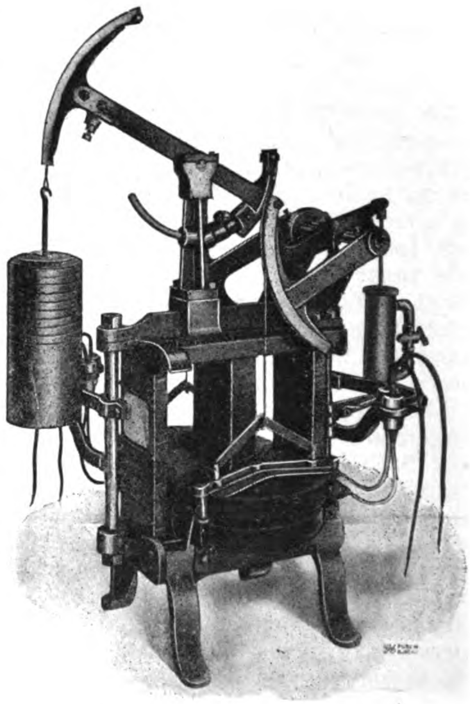


FIG. 82
Small Size Constant Current Transformer (Air-Cooled). Complete, but with Case Removed

The eighteenth chapter will consider devices that, for lack of a more suggestive name, may be called "current reorganizers."

One of the best dry cells is said to be filled with the following mixture: Oxide of zinc, 1 part by weight; sal-ammoniac, 1 part; plaster of Paris, 3 parts; chloride of zinc, 1 part; water, 2 parts.

A Portable Wireless Telegraph Outfit

J. B. VAN BRUSSEL

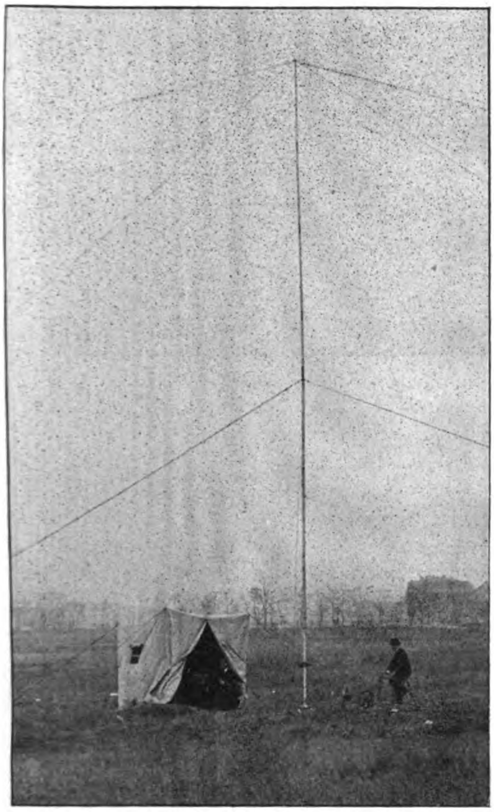


Fig. 1
Wireless Apparatus Erected

Wireless telegraphy has made great progress these last five years. An important need is being filled for temporary wireless telegraph stations for military purposes, which can be quickly erected and which do not require the transport of heavy or clumsy apparatus, so that the whole equipment can easily follow the movements of troops in the field, and can, if necessary, be carried by men only.

In the construction of apparatus for these requirements, the following points are of great importance: lightness of the apparatus and convenience of transport, reliability in working, high efficiency considering the size of the plant, suitability for war purposes, and durability and simplicity of all parts of the apparatus. An equipment of this nature on the "Telefunken" system has been recently brought out by the "Gesellschaft fuer drahtlose Telegraphie," and is especially intended for employment in scouting service either by cavalry or infantry.

The portable station is shown as erected in Fig. 1.

The aerial network is supported by a magnalium mast fifteen metres high, consisting of eight sections each 1.85 metres in length. This carries an umbrella net, consisting of six bronze stranded wires of twenty metres in length. Below the aerial wires are six radiating wires forty metres in length forming the lower capacity or "counterpoise" fastened to a ring attached to the mast one metre from the ground, but insulated from it. The mast itself is insulated from the earth and forms the conductor to the aerial wires.

As a source of current a small continuous shunt dynamo with an output of one ampere at forty-five volts at 1,300 revs. per min. is used. This is driven by a pedal gear after the man-

Fig. 4
Apparatus in Operation

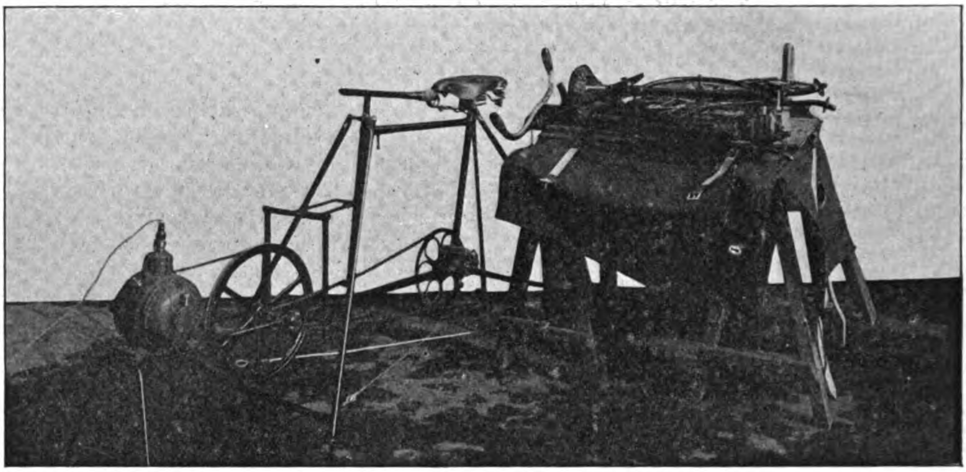


FIG. 2
Source of Power — Set Up and Ready for Transport

ner of a bicycle, and can easily be worked by one man. The arrangement is shown in Fig. 2. It is so constructed that it can be taken apart

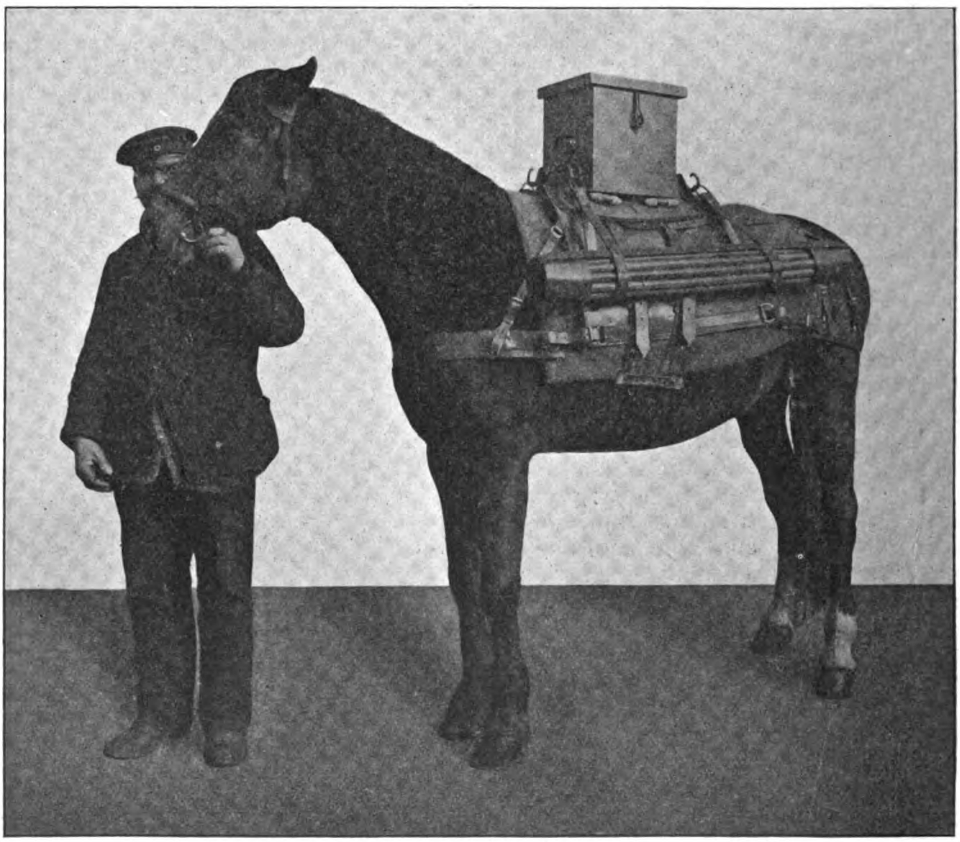


FIG. 5
Apparatus Packed for Transportation by Cavalry

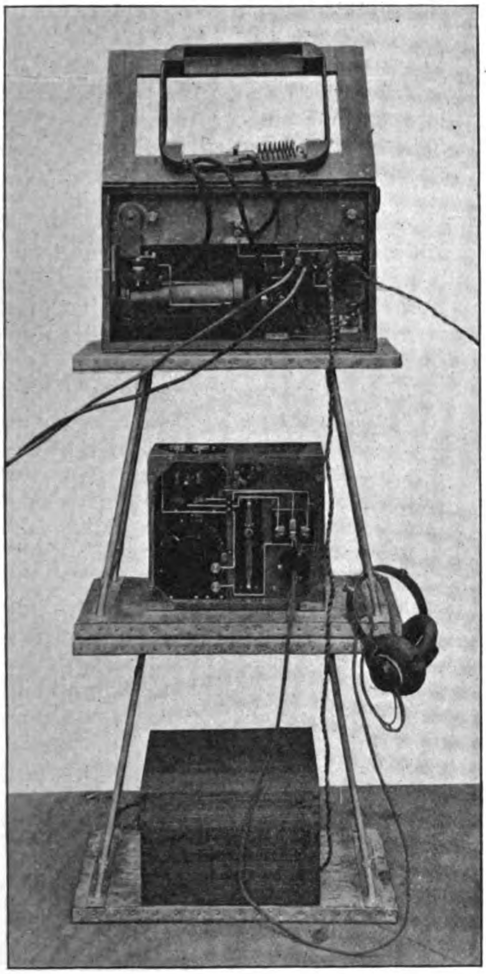


FIG. 3
Apparatus Set Up

into ten pieces and put together in five minutes.

Fig. 3 shows the apparatus constituting the transmitter, which can be all packed away in a metal-bound wooden box, provided with a leather case with a rain-proof cover. Fig. 4 shows this in working order. The open oscillation circuit is formed by the aerial net, the extension coil, the counterpoise net and the counterpoise coil; and the closed oscillation circuit consists of the spark gap, condenser, exciter, self-induction and correcting coil. The primary circuit consists of the dynamo, which is also provided with a pilot lamp, a plug switch, a Morse key, the primary of the induction coil and its trembler, which, of course, has a condenser, connected in parallel with the break. The length of wave sent is about 364 metres with an invariable coupling of eight per cent.

All the receiving apparatus is also collected in a wooden frame, which is enclosed in a leather case. The receiving system is composed of an aerial and lower capacity net with an extension coil and an inductively connected telephonic receiver.

The high-frequency oscillation circuit of the receiver consists of the plug, the receiving transformer, the variable series condenser, and the electrolytic detector, with constant parallel condenser. The local battery circuit contains three choking coils, the head telephone receiver, an adjustable resistance and the working battery. The conductors leading to the high frequency circuit are insulated with especial care. They are silver-plated in order to reduce the losses by damping to the greatest possible extent. With this apparatus it is possible to exclude waves of only five per cent. variation in length.

The weights of the various parts of the equipment are as follows: Mast, thirty kilograms; aerial net and accessories, fifty kilograms; transmitting apparatus, twenty kilograms; primary interrupter condenser, ten kilograms; receiving apparatus, ten kilograms; driving gear for dynamo, fifteen kilograms; dynamo, thirty kilograms; two stools, ten kilograms; tools, accessories and spare parts, twenty-five kilograms; giving a total of two hundred kilograms.

The portable station has a range of about fifty kilometres on the level, or about thirty kilometres in mountainous country. The apparatus for the transmitting and receiving station can, when not required for actual use, be packed together in a two-wheeled transport cart. The weight of the cart when loaded is about eight hundred and fifty kilograms. This cart is intended to transport the apparatus for the two stations up to the point where the officers in command have taken up their position and where telegraphic communication is desired.

Here the first station is built up, whilst the apparatus for the second advances with the troops.

If the equipment is to be used by cavalry it is loaded on to four horses, with pack saddles, as shown in Fig. 5. The weight carried by each horse does not exceed fifty kilograms. A staff of one officer, one non-commissioned officer and seven men is required, one non-commissioned officer and five men for erecting the mast, and two men to hold the horses. As soon as the station is completely erected (which can be done in twenty minutes) one man is sufficient to look after the transmitter and receiver and two are required to drive the pedal dynamo, working alternately. When the apparatus is used by infantry, or when, in consequence of the nature of the ground, the further transport of the equipment on the cart is not possible, the portable station can be arranged to be carried by eight men. For this purpose two carrying frames formed out of two bamboo parts, tied together with cords, are used, upon which the heavier parts are fastened.

Electric Music.—Announcement is again made that within a short time the long-promised electrical musical instrument, the telharmonic, is to be in full operation in New York. This is an instrument for the transmission of music from a central keyboard to the homes, hotéls, restaurants and public places of a city.

At a cost of more than $50,000 the central musical "plant" has been established at a convenient point in Manhattan. The instrument is virtually perfected, and in a short time it is expected the company will be ready to offer its musical wares to the public. At no great cost the householder, flat dweller or restaurant proprietor may have a telharmonic installed, connected by wire with the central instrument or instruments, and by simply pushing a button will be able to turn on the music. The instrument that will be placed in the homes is a small affair, and can easily be hidden by a grouping of flowers or potted plants. Four grades of music will be available—grand opera, pipe organ, orchestral or piano.

Tests thus far made show that the rich tones of the central instrument are preserved in transmission, and there is no marring of the music by the rasping sound of the phonograph. The inventor of the telharmonic and the capitalists who are backing him are confident that the instrument will not only have connections with thousands of homes, but will soon be used almost universally by the restaurant-keepers. —The Keystone.

Of recent years a good deal has been said about generating electricity at the pit's mouth, and transmitting it to various industrial centers. But it would be considerably cheaper to manufacture producer gas at the pit's mouth and transmit it through pipes to the industrial centers, there to use it for driving gas engines for generating electricity and also for heating purposes and furnace work. The questions of the distribution and transmission of power must not be confused. For the former it is agreed that there is no agent to compare with electricity; for the latter purpose it is suggested that it is more economical to employ producer-gas and piping than electricity and cables.

At Notodden, in Norway, atmospheric nitrogen is being used in the manufacture of artificial manure. Dynamos worked by water power produce an electric arc flame; air passed through this flame contains one per cent. of nitric oxide; and from this by certain chemical processes calcium nitrate is manufactured. Manuring experiments show that this salt is as good as Chili saltpetre on most soils, and better on sandy soils. The pioneer work of this process was done in England, but it is not possible to carry on the manufacturing process there for want of cheap power which is essential to make it a going concern. At Notodden a profit of 100 per cent. is being made.

Make every blow count except the one aimed at a fellow man.

Mechanical Drawing

WILLIAM C. TERRY

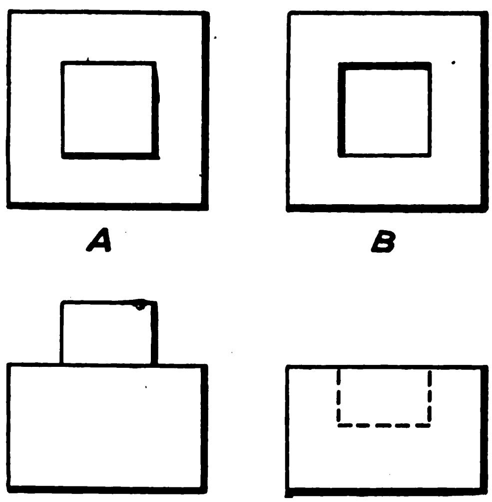


Fig. 1

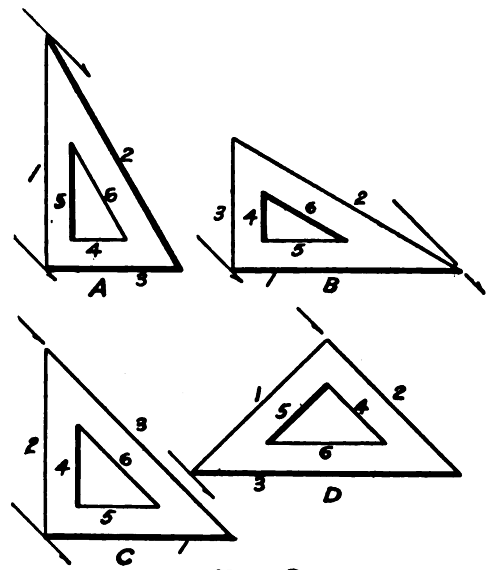


Fig. 2

Shade Lines.—To make a drawing apparently stand out from the paper, shade lines are sometimes used. These indicate raised and depressed portions of an object. They are all of the same width and are about three times as wide as the original lines.

Shade lines are always drawn outside the original lines of the figure. The light is always supposed to fall on the object in all views from the upper left hand corner of the paper on an angle of 45 degrees. The shade line begins and ends at its full width and does not slope at the ends except with circles. In Fig. 1, A shows a central raised portion and B a depressed interior portion.

Let us consider two triangles, 30x60 degrees and 45 degrees, made of material thick enough to cast shadows.

Placing the 30x60 degrees on the

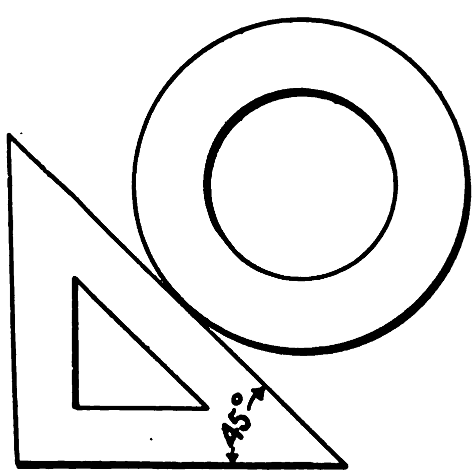


Fig. 3

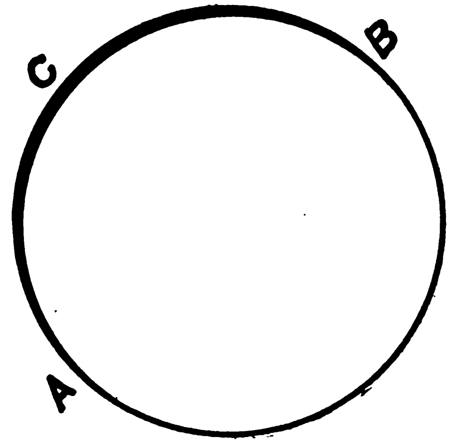


Fig. 4

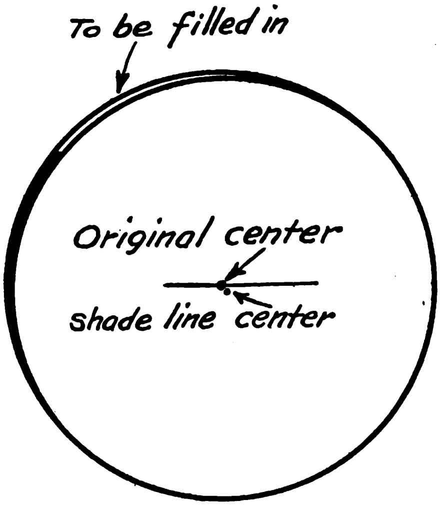


Fig. 5

shortest base, we have three shaded lines, 2, 3, and 5. (See a, Fig. 2.)

Referring to c and d, Fig. 2, we have one edge of the triangle on an angle of 45 degrees, and therefore not shaded. We can not get more than two shaded lines with one 45 degree triangle, and in c we have 1 and 4 shaded, and in d, 3 and 5. All the rays of light are considered parallel and all come from the upper left-hand corner at an angle of 45 degrees. The shadows begin as soon as the rays of light fail to strike the edges.

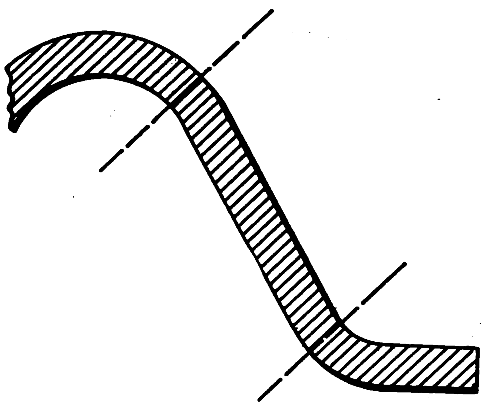


Fig. 6

The edges to have shade lines may generally be determined by the eye; but if an edge away from the source of light is nearly in a 45 degree direction, the question of the shade line may be determined by placing a 45 degree tri-

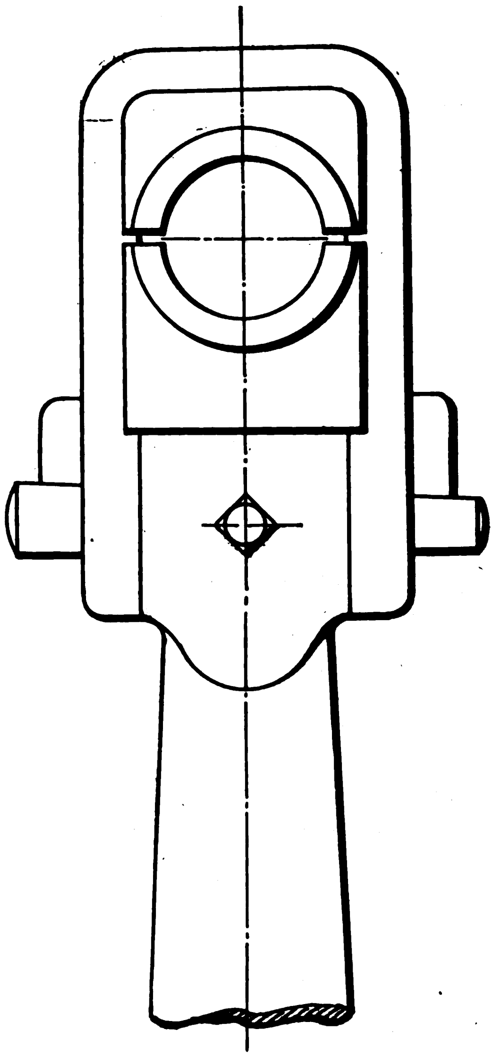


Fig. 9

angle in position on the T square. If the edge of the solid body farthest from the source of light is beyond the 45 degree point, so that the light does not shine along that edge, a shade line should be placed on the drawing. When circles are shaded, the method given above of determining the shaded portions by using the 45 degree triangles will be followed. The shade

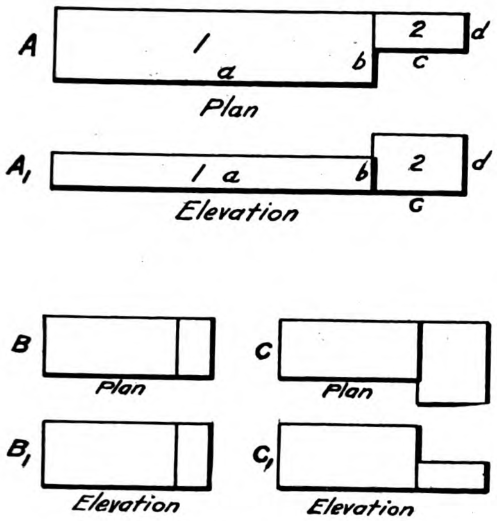


Fig. 7

lines begin at the points where the light fails to strike the edges. These points are determined by the 45 degree triangle placed on the T square and held just tangent to the arc. (See Fig. 3.)

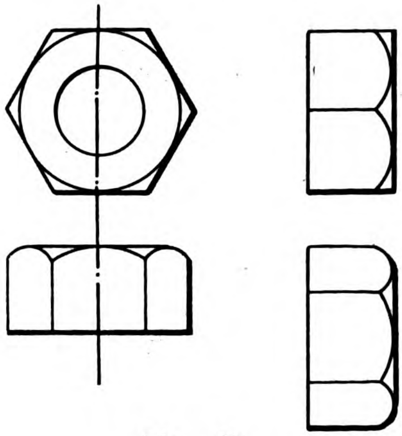


Fig. 8

For an interior, as the inner line of a washer, the opposite part of the arc is shaded; the points of beginning and ending are found as before.

In shading these circles, taper the shade line to nothing at a and b, Fig. 4, and make it the heaviest at c, the point of broadest shadow.

Placing the same triangle on the longer base, we again have three shad-

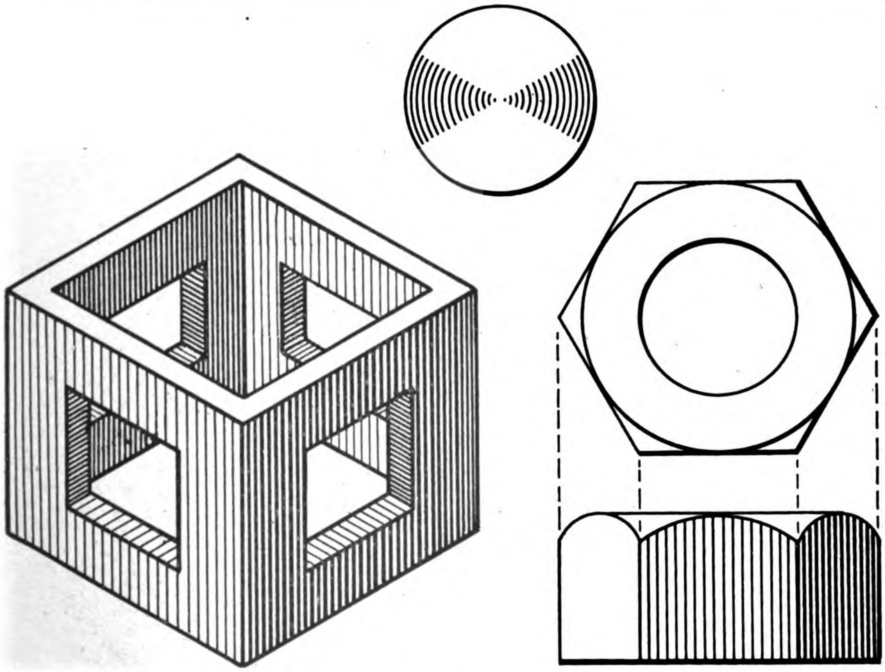


Fig. 10

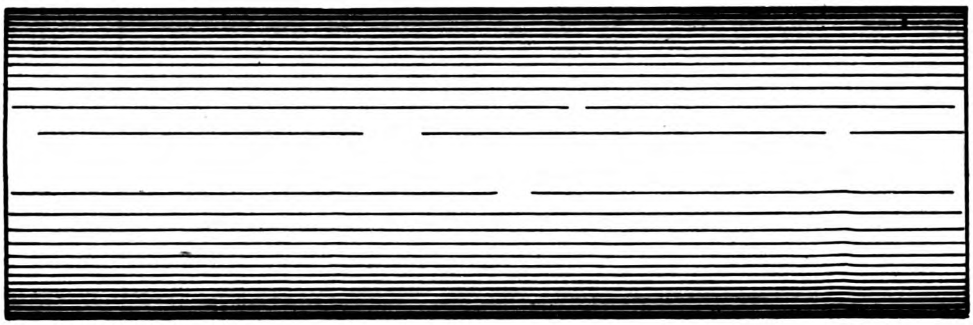


Fig. 11A

ed lines, 1, 4, and 6. The arrows indicate the direction of light.

There are several methods of shading circles, and the writer believes the best method is as follows: Make a new and distinct centre for the shade line (see Fig. 5). Great care must be taken in doing so. The heaviest part of the shade is about three times as heavy as the original line, as in the case of straight lines.

Figure 6 represents a curved surface in section with shade lines. Note that the shade lines cross the figure at the 45 degree points.

When surfaces of separate portions of the figures are touching and are at the same level, no shade lines are drawn. In A and A', Fig. 7, block 1 is wider and lower than block 2. In the top figure, or plan view when looking down on the blocks, the sides a, c and d are shaded in accordance with the general plan; the line b is shaded only where it is free from block 2, as its edge in contact with block 2 cannot cast a shadow. In the lower figure or elevation, when looking at the side of the blocks, a, c and d are shaded by the general plan, and b is shaded as it projects beyond the block 2.

The figures B, B' and C, C' will be self explanatory to the reader if he has grasped the principles of shading.

All shade lines should be of the same width. Make a sample line on the border or a piece of scrap paper, and often test the set of the pen with this sample line.

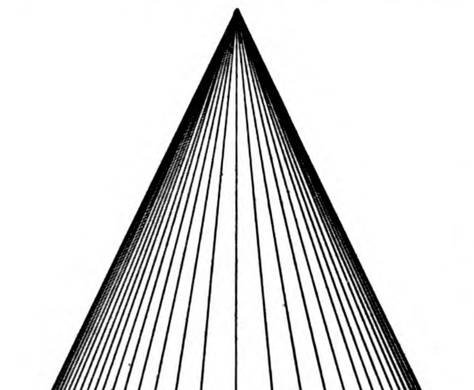


Fig. 11B

Fig. 11C

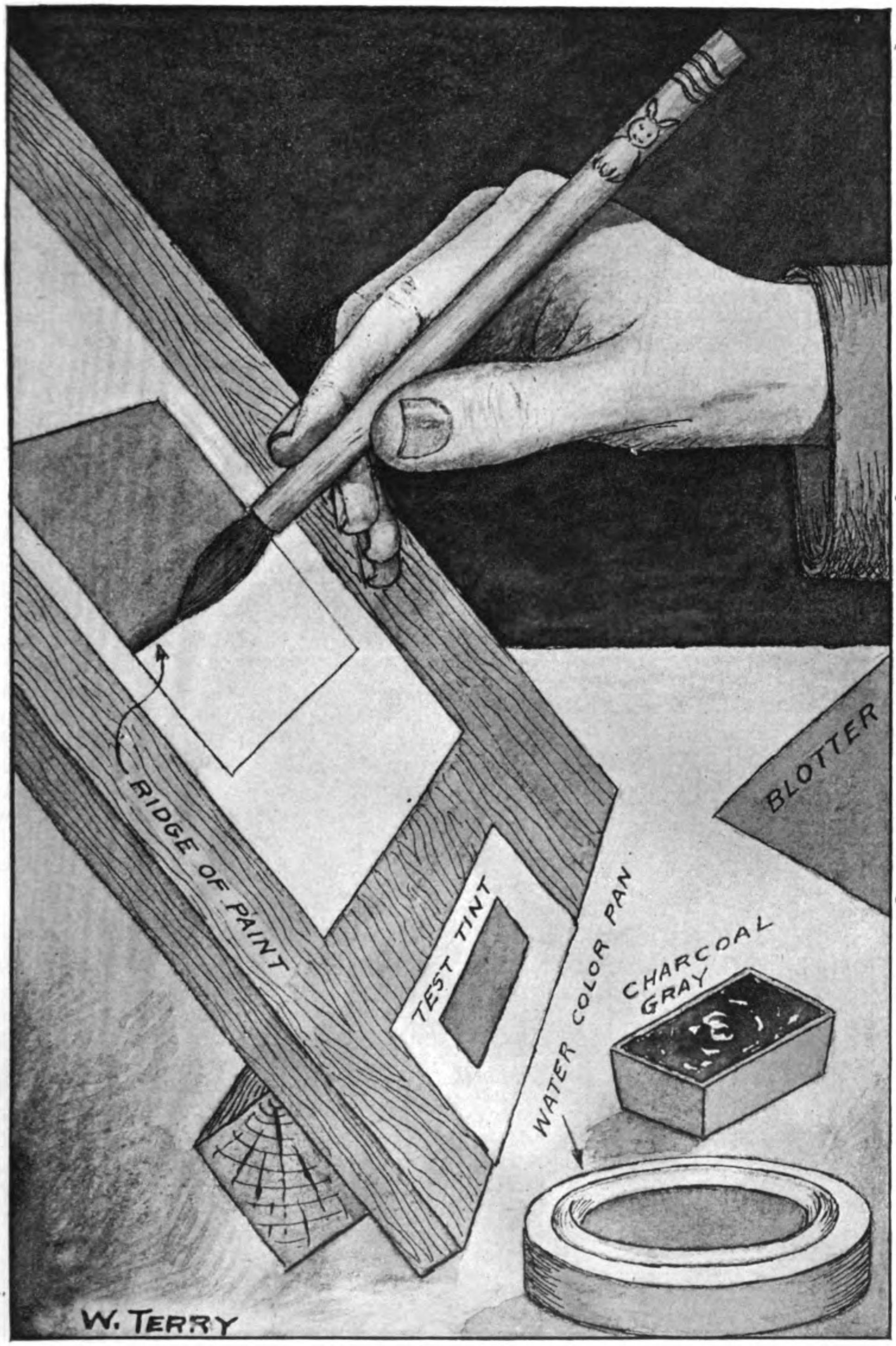

RIDGE OF PAINT
TEST TINT
WATER COLOR PAN
CHARCOAL GRAY
BLOTTER
W. TERRY

FIG. 12

Shade lines are not shown in the pencil drawings.

Dotted or broken lines are never shaded.

The best method of shading bolt heads is shown in Fig. 8.

In Fig. 9 are given a few examples of shade lines for the reader to reason out.

Line Shading and Tinting.—Line shading and tinting are used to some extent for ornamental drawings for catalogue and general engraving purposes. The light is supposed to come from the same point as under "Shade Lines"; that is, from the upper left hand corner of the drawing board.

Flat surfaces are shaded by a series of parallel lines like section lines, with the exception that they are generally drawn as horizontal or vertical lines. Contrasts are made by making light lines with wide spaces; and adjoining surfaces with heavier lines and narrower spaces. To line shade the end of a polished shaft, rod, etc., draw two sets of arcs from the normal centre covering about one-half of the surface with one-quarter of the area between each set. (See A, Fig. 10.)

In order to produce the rounded effect of the cylinder, lines or tints are graded from light effect to darker ones. Practically it is correct to shade a cylinder as shown in Fig. 11, A. The rounding effect is produced by a combination of varying the width of the lines and the distances apart—often three or four of the darkest lines at the darkest point of the shading are combined in one. It seems best to place the drawing so that the shade lines are drawn horizontally and work from the dark to the light by turning the drawing board. The line first drawn should be well chosen and in accordance with the size of the cylinder. This line will establish the width of the remaining lines. After the first line, the others are varied according to judgment. The combination of varying the width of the lines and the width of the spaces gives a good chance to produce a well rounded surface.

It will be found advisable to shade a cone by drawing the lines from the apex (See Fig. 11 b). Many lines are not begun at the apex, but a little below, to avoid a blot. When all the lines are drawn, and the ink is dry, fill in the light space with ink.

Fig. 11c shows a sphere shaded with a high light. The same method of arranging the lights and shadows of the line shading applies to the tinting.

Any water color may be used, but charcoal gray is considered the best for half-tone reproduction. The colors are sold in full and half pans. Three brushes are necessary; a large brush for washes, a smaller one for detail work (both camel's hair or sable), and a bristle brush (used for oil painting) which we will use for scrubbing. The

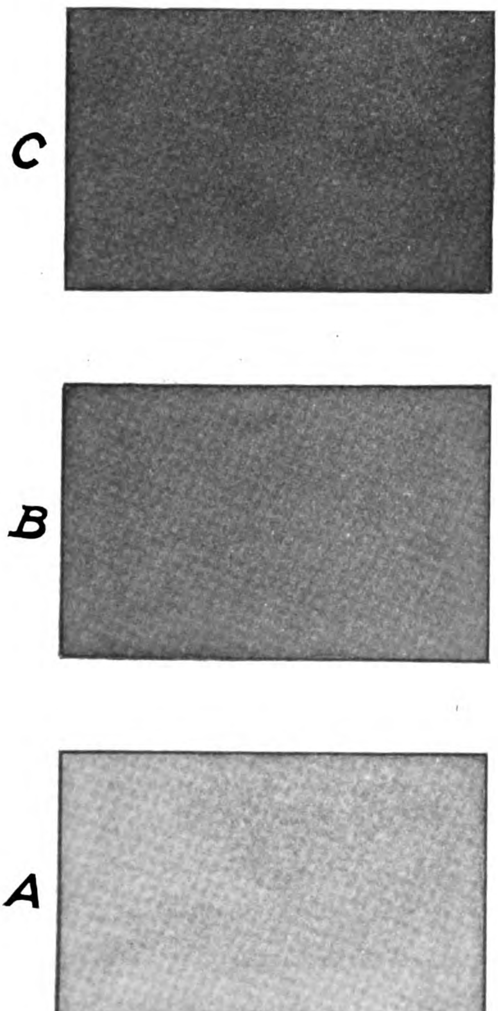


Fig. 13

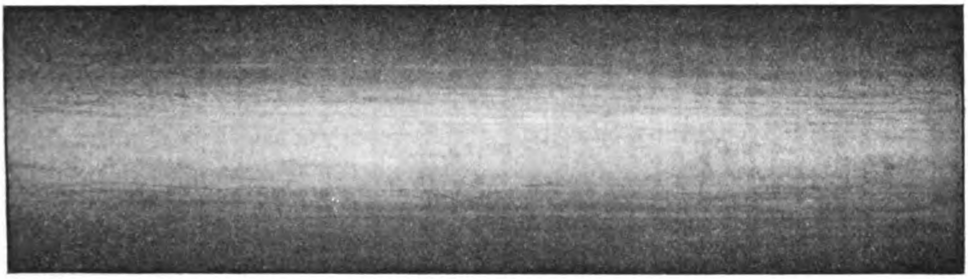


FIG. 14

paper must be stretched on the drawing board for tinting, and a good cold-pressed paper is quite necessary. The tinting is done after the black lines of the drawing are completed without shade lines. To lay a flat tint proceed as follows: Place eight or ten brushfuls of water in a clean saucer, or in the tray of a water-color pan. Then, with the brush add charcoal gray paint until you feel convinced that the tone is dark enough. Try it on a scrap of paper, remembering that an allowance must be made, owing to the fact that water colors always appear lighter when dry than when wet. The amount of allowance must be determined by experiments. Allow the trial tone to dry and beside it place a fresh stroke of the brush. By a few such comparisons you will be able to determine for yourself the necessary allowance for drying. When the half-tone has been obtained, proceed to lay

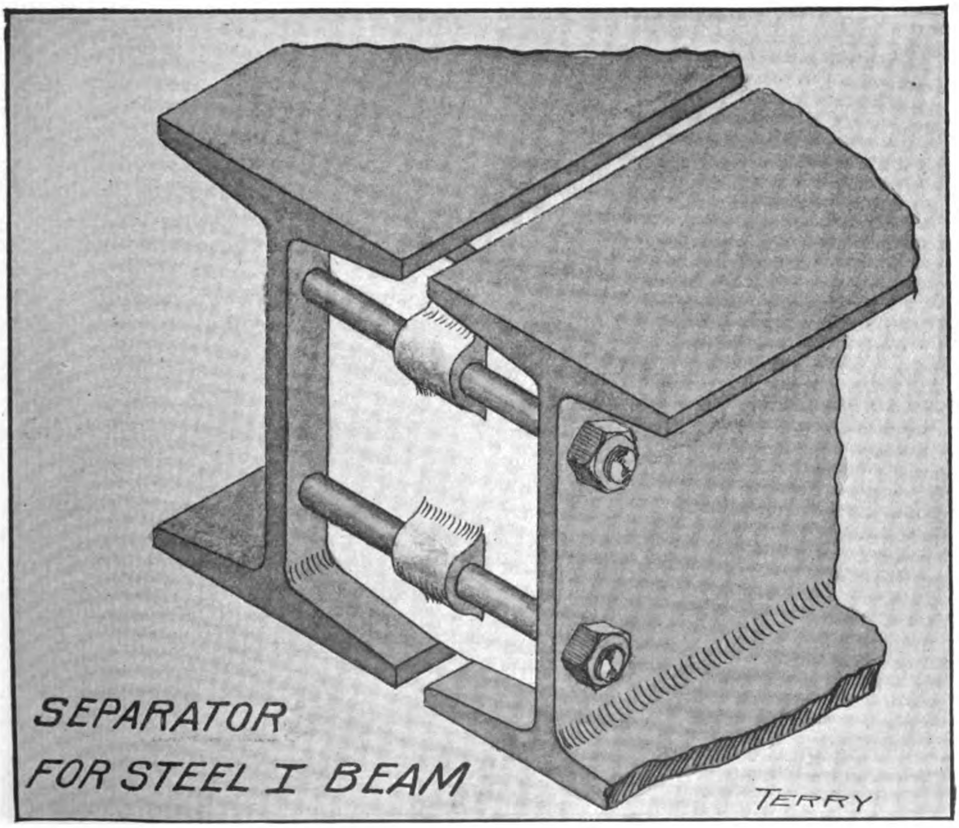


FIG. 15

the wash as shown in the accompanying illustration, Fig 12. With the paper inclined, fill the brush and draw it lightly across the top line, fitting the paint snugly against it. This should leave a little ridge of paint at the bottom of the stroke. The only care now is to keep this ridge of paint moving down the paper by repeating the operation. Keep the brush well filled, dip it with each new stroke, and fit the wash carefully against the side lines as you proceed; for you must not, under any circumstances, go back to repair damages. When the bottom has been reached, the ridge of paint must be removed with a blotter very carefully.

It is good practice to wet the surface to be tinted with clear water and a clean brush, before applying the tint. If the tint applied is not dark enough, it may be darkened by successive tintings; but never put on a second tint until the first one is dry to the touch. When using the brush along the boundary lines of the space, always keep the brush point towards the edge. Do not bear on the brush as this may cause marks to be made that will show under a light tint. For large surfaces lay on a light tint, turn the board around and repeat the operation. This does away with the danger of streaks. Fig. 13 shows a three-tone scale; the tint A is the result of one application of wash. At the same time, space B and C were tinted; and after waiting, B and C received a second coat, and later a final tint was added to space C.

There are two methods of producing graduated tints, the French and the American. The French we will not discuss, as the American is most used and takes less time, while the effect is equally good. This is called the method of shading by softened tints. For a surface that is flat and inclined at an angle to the paper, the method is as follows: Saturate the brush with the tint and remove most of it against the side of the water-color pan; lay a narrow line of the tint along the line of darkest shade; while this is still wet dip the point of the brush in clean water, which dilutes the color on the brush, and run the brush along the edge of tint previously applied; again weaken the tint and proceed as before. At the end we have a clean brush and no color.

When the surface is dry the operation can be repeated until the desired tone is obtained. In laying on graduated tints, the work must be done rapidly to prevent the color from drying before the blending is completed.

The scrubbing brush is used to soften spots or edges of color by first dipping in clear water, and used after the color is dry.

Fig. 15 shows a practical use in tinting for catalogue work.

That air which has been breathed has a higher electrical conductivity than normal air is shown by the recent experiments of I. R. Ashworth, says "Science Abstracts" (London). "The author determined the conductivity of the air in a lecture-room to hold 140 students, on a number of occasions both before and after the room had been used. In all cases the conductivity is greater immediately after the room has been used than immediately before, the difference being greater when there is no ventilation than when the ventilators have been working. A similar effect is observed in the case of a sleeping-room, the experiments being performed with electric charges of both kinds. Control experiments were carried out when the rooms had been unoccupied: in this case no change in conductivity occurred."

Man is a tool-using animal. He can use tools, can devise tools; with these, granite mountains melt into light dust before him: he kneads iron as if it were soft paste: seas are his smooth highway, winds and fire his unwearying steeds. Nowhere do you find him without tools; without tools he is nothing, with tools he is all.—Thomas Carlyle.

To copper iron castings, the articles must be made perfectly clean, and dipped in a solution of 1½ pounds copper sulphate in water to which 1 ounce sulphuric acid has been added. They are then washed and dried.

How to Build a Small Model Undertype Engine and Boiler

HENRY GREENLY

I.—General Arrangements

In inflicting readers with another design for a model compound horizontal undertype steam engine and boiler—to give the machine its full title—the writer has, in making the usual apologies for an offence of this sort, to plead extenuating circumstances. The previous design was published in "The Model Engineer" for January, 1903, since which time "The Model Engineer" has had many new readers; furthermore, the present drawings are for an engine of much smaller size and simpler construction. The latter is an important difference. Whereas many model engineers would find it impossible, from sheer lack of sufficient tools and a large enough lathe, to say nothing of the first cost of materials, to build up the more powerful engine, the model now illustrated is one which any reader possessing a 2½ in. centre single-geared lathe should be able to manage without difficulty. Whilst retaining the compound principle, the mechanism of the model is much simplified. The boiler is of the standard water-tube type, with all joints brazed, and is, therefore, one which is much less trouble to build, and less costly, besides being more efficient than a flue-tube boiler, especially when the only available means of firing is by a plain alcohol lamp.

Readers may be interested to know, also, that the writer is putting forward the design as one which, of all small model engines and boilers, he would prefer for his own use. To this end he is showing his good faith in ordering one to be built by one of the well-known model engineering firms, and hopes in the near future to be able to submit some practical tests with the finished engine.

Let us consider the "raison d'etre" of the design. It is almost an axiom that you cannot expect to drive a dynamo and get any current worth having from an engine fired by a denatured alcohol lamp of ordinary dimensions. But the point is not one which has absolutely been settled, and it is the writer's desire to produce an engine that, given the very best workmanship in both boiler and machinery, will drive a small dynamo and produce enough electricity to charge a small 4-volt cell. It is, he admits, expecting a good deal from both engine and boiler; but there is no reason, if the best can be obtained from the steam, and frictional losses and electrical are reduced to a minimum, why the object should not be accomplished. We do not say that, reckoning the cost of fuel, it will be an economical method of charging an accumulator; but, considering the interesting hours to be obtained by making and using the proposed machinery, most readers would prefer it to using primary batteries for the same purpose.

The first question to settle is — To

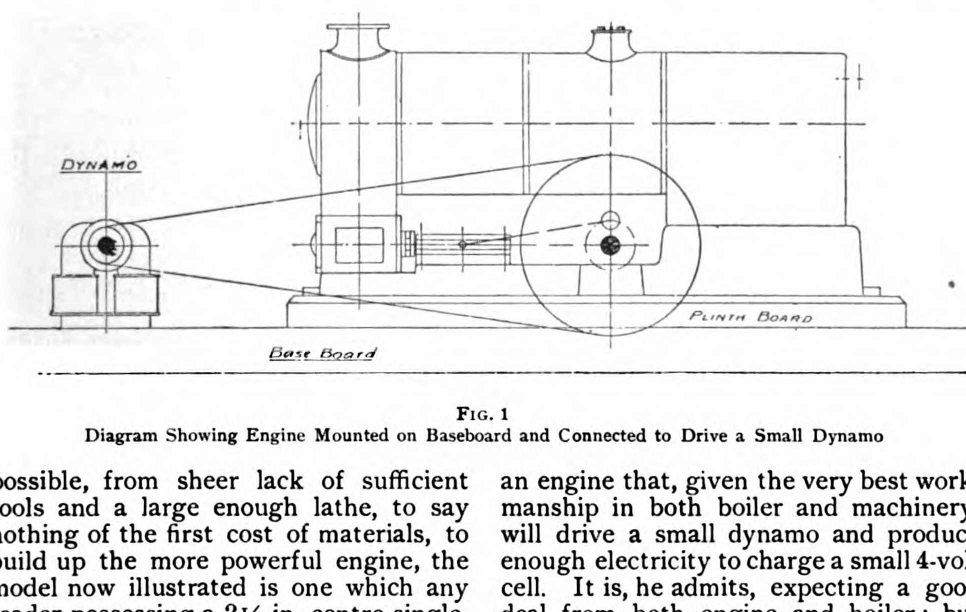


Fig. 1
Diagram Showing Engine Mounted on Baseboard and Connected to Drive a Small Dynamo

charge a 4-volt cell, what electrical energy is required? Reckoning on a maximum charging rate of ¾ amp., the total watts, allowing for a higher E.M.F. than that of the cells, equals, we will say,

$$5 \text{ volts} \times \tfrac{3}{4} \text{ amp.} = 3\tfrac{3}{4} \text{ watts.}$$

Now, as 746 watts is equivalent to 1 h.p., then

$$3\tfrac{3}{4} \text{ watts} = \frac{3\frac{3}{4}}{746} \text{ h.p.} = \text{say,}$$

$$\frac{3.75}{750} = \frac{375}{75000} = \frac{1}{200} \text{ h.p.}$$

This is, of course, the theoretical horse-power required at the dynamo; but we must not forget that a small dynamo is a very inefficient machine, and that there will be transmission losses, losses by friction in both dynamo and engine, to say nothing of the inefficiency of the whole steam plant as a thermal engine.

But we will proceed to get at the indicated horse-power of the engine. The cut-off is provided in both cylinders; and, therefore, we need not consider the effects of expansion in each cylinder individually. The boiler is shown on the general arrangement as pressed to 80 lbs. per sq. in.; but while this is the predetermined blowing-off point, it does not mean that the boiler will maintain this pressure when the engine is working at full load and speed.

The indicated horse power of the engine will be the sum of indicated horse-power of both cylinders — that is,

I.H.P. of the H.P.C. + I.H.P. of L.P.C. = Total I.H.P.

The cylinder ratio is ·3 to ·75*, which are respectively the *areas* of the H.P. and L.P. cylinders. This means that, according to Boyle's law, under which

$$\text{Pressure} \times \text{Volume} = \text{a Constant Quantity,}$$
$$P \times V = C,$$

if we have a pressure of 50 lbs. in the H.P. cylinder when it is exhausted into the L.P. cylinder, the pressure will fall in inverse proportion to the new volume. In dealing with pressure, we must always reckon the atmospheric pressure in addition to the gauge pressure; therefore we get 50 + 15 = 65 as the absolute pressure.

* The L.P. cylinder should be bored a bare inch diameter; therefore, we may take the area at ·75 sq. in. instead of ·7854 sq. in., which is the exact area of an inch diameter piston.

The new pressure (that in the L.P. cylinder) may be found as follows: —

As H.P. cyl. press, × H.P. cyl. vol. = const. quantity, then, 75 × 3 = 225.

Therefore, as we know the constant quantity is 225, and the new volume

$$\text{as} \quad P \times V = C,$$
$$\text{then} \quad P = \frac{C}{V}$$

In the case in point —

$$\underset{\text{(the L.P. cylinder pressure)}}{P} = \frac{225}{V \text{ (the L.P.C. vol.)}}$$

$$P = \frac{225,}{7.5}$$

L.P. cylinder pressure = 30 lbs.

To prove the correctness of this, we multiply the two (the H.P. cylinder and the L.P. cylinder) pressures by the volumes, and we should get the constant quantity the same in each case —

As P × V = 225, then
H.P. cylinder 75 × 3· = 225,
L.P. cylinder 30 × 7·5 = 225.

Now we can proceed to estimate the horse-power developed in each cylinder.

We all know that: —

Average pressure × length of stroke (feet) × area of piston (inches) × number of strokes divided by 33,000 equals I.H.P.

Now, the average pressure in the H.P. cylinder is the pressure driving it forward, minus the pressure which is locked up between it and the L.P. piston. These pressures by virtue of the different volumes of the H.P. and L.P. cylinders, we found were 75 lbs. by 30 lbs. respectively. The effective pressure is, therefore, 75 − 30 = 45 lbs. We must, however, make some modification in this estimate, due to practical considerations. There is always a loss in the transmission of energy, and, therefore, we must reckon that the back-pressure in the H.P. cylinder will be always slightly higher than the forward-pressure in the L.P. cylinder, due to wire-drawing or throttling. We will, therefore, estimate the mean forward-pressure in the H.P. cylinder on the assumption that the back pressure is 37 lbs.

75 (forward) −37 (back pressure) = 38 effective pressure in moving the H.P. piston. The indicated horse power will

then equal at 400 revolutions per minute (400 × 2 strokes per minute): —

$$\frac{P.L.A.N.}{33{,}000} = I.H.P.$$

$$\frac{38 \times 1\frac{1}{4} \times \cdot 3 \times 400 \times 2}{12 \quad 33{,}000} = \frac{1}{35}\ I.H.P.$$

This brings us to the L.P. cylinder. The forward pressure here will be practically the same as that calculated, say 29 lbs. instead of 30 lbs. absolute, and if subtracted from this (29 lbs.) the pressure of the atmosphere plus, say, 3 lbs. back pressure, due to the nozzled exhaust, we get $29 - (15 + 3) = 29 - 18 = 11$ lbs. effective pressure on the L.P. cylinder. This gives

$$\frac{P.L.A.N.}{33{,}000} = I.H.P.$$

$$\frac{11 \times 1\frac{1}{4} \times \cdot 75 \times 400 \times 2}{12 \times 33{,}000} = \frac{1}{48}\ I.H.P.$$

The respective horse powers of $\frac{1}{35}$ and $\frac{1}{48}$ would appear bad to show cylinder proportions, but the writer has allowed for slight leakages of H.P. steam into the L.P. cylinder. These leakages will have the effect of reducing the mean forward pressure in the H.P. cylinder and increasing that in the L.P. cylinder, so that where they occur they more than equalize the work of each cylinder.* However, the total work theoretically to be obtained will be

$$\frac{1}{35}\ (\text{H.P.C. I.H.P.}) + \frac{1}{48}\ (\text{L.P.C. I.H.P.})$$

$$= \text{roughly}\ \frac{1}{20}\ \text{I.H.P. total.}$$

Now this is no less than ten times more than the energy delivered to the accumulator, so we can afford to part with nine-tenths of the power in electrical, mechanical, and heat losses. This would appear to be a big margin, but the writer would warn the builder that it is not so. Great care will have to be taken in every part of the plant to enable the remaining

$$\frac{1}{10}\ \text{of}\ \frac{1}{20} = \frac{1}{200}\ \text{h.p.}$$

to be rendered available.

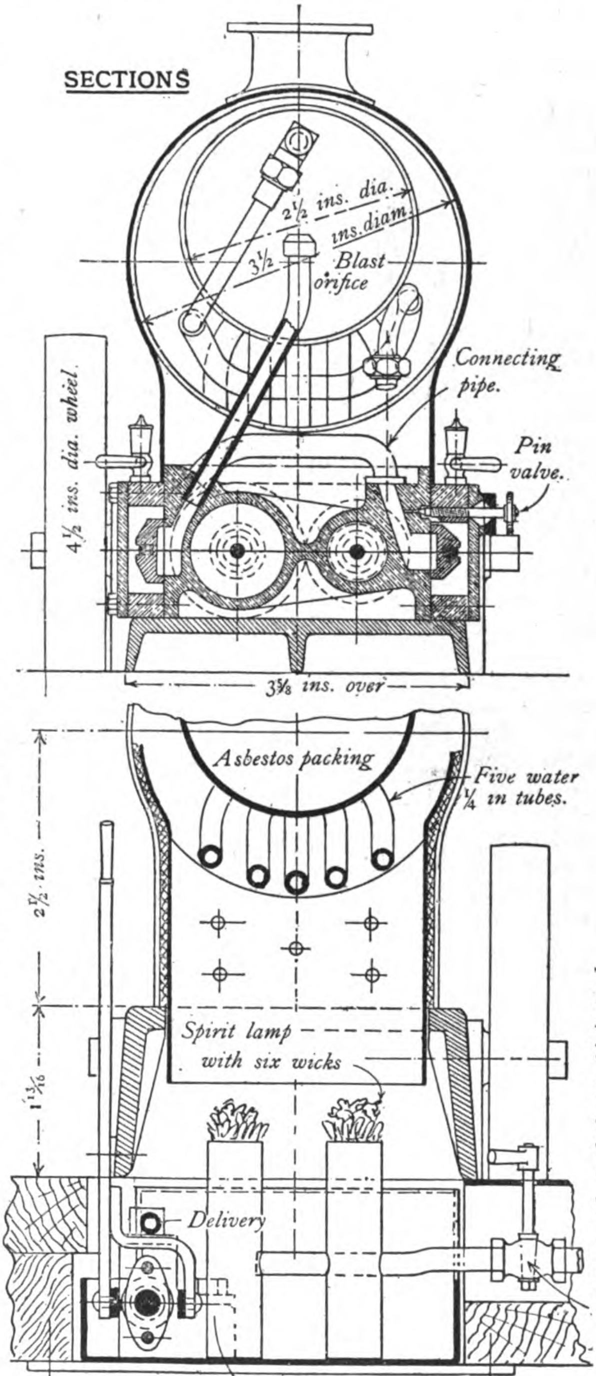


FIG. 1A
Design for Engine and Boiler, Half Full Size

*In addition, a greater degree of efficiency than estimated in the boiler will result in a higher pressure being maintained. The effect of this will be to equalize the work of both cylinders, as a reconsideration of the figures on the basis of say 75 lbs. boiler pressure will show.

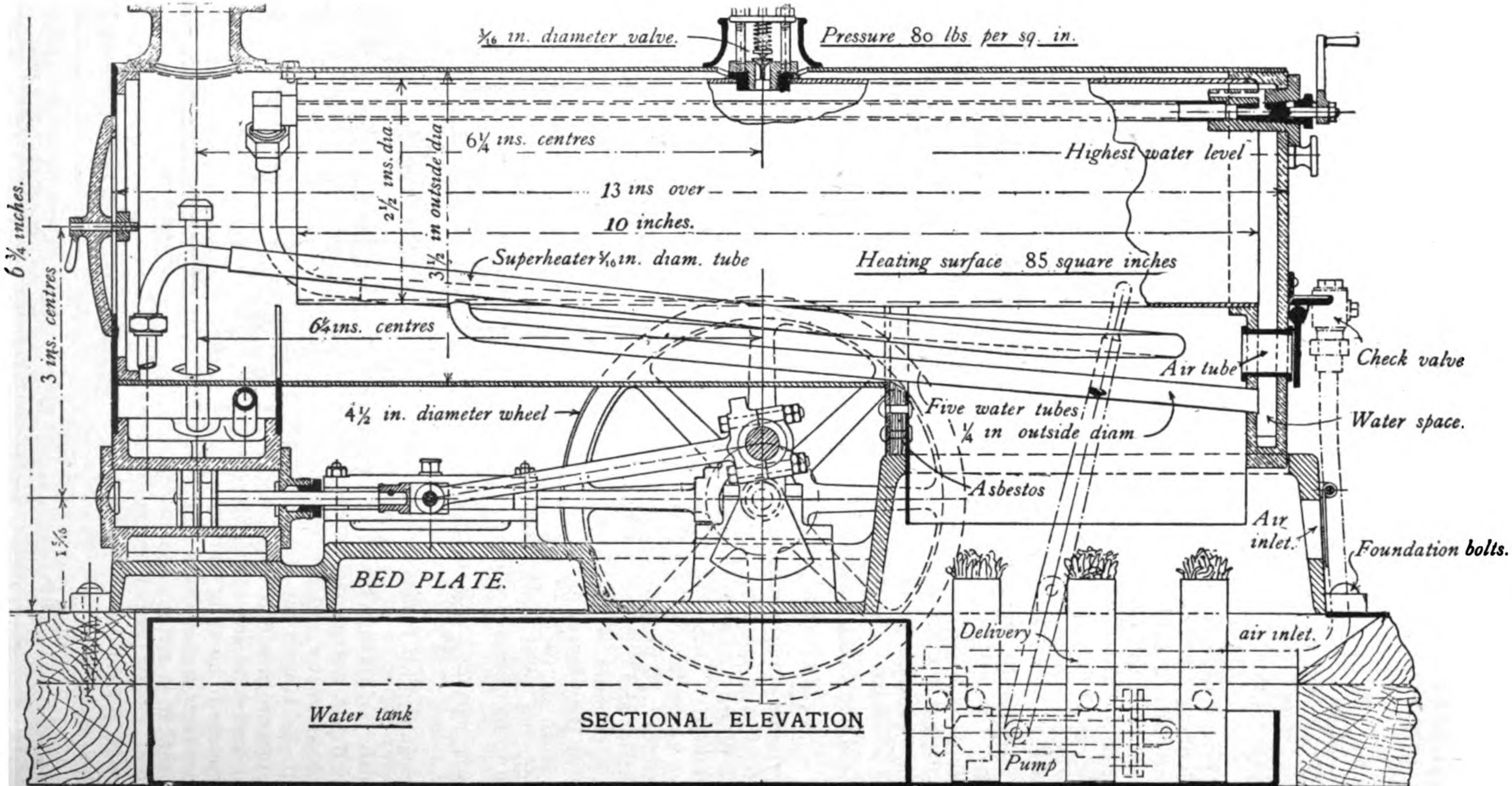


Fig. 1b. Design for Engine and Boiler, Half Full Size

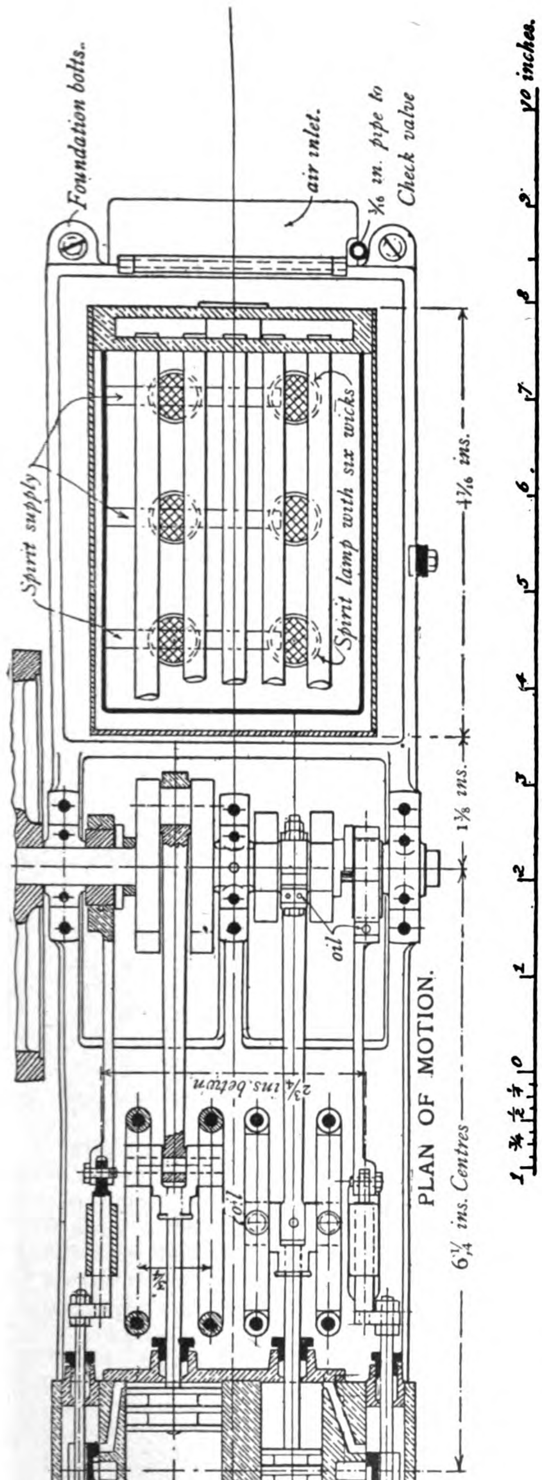


FIG. 1C. Design for Engine and Boiler, Half Full Size

But what about the boiler and its evaporative power? With one charge of water — that is, with no cold water going in to make up the water used by the engine — the boiler should evaporate about 1 cub. in. per minute. The evaporation with a steady feed would not be more than ⅞ in. per minute. Therefore at 400 rev. per minute the pressure maintained will average about 65 lbs. at the stop valve, which, in practice, the writer has found can be maintained under load with a single-cylinder ⅝ × 1¼ engine supplied with a similar boiler.

To obtain such results a very high standard of workmanship is necessary; but to render to some degree nugatory the losses due to the use of H.P. steam — which, by the way, is so advantageous in a small engine — the compound principle has been adopted. In spite of good workmanship and fitting, it is found that, however well they are packed, steam does get past the pistons of small engines, especially where the piston is too small to be provided with really satisfactory metallic rings. Valves also leak at the faces, and in a H.P. simple engine all such steam goes to waste. The high boiler pressure is needed to take advantage of compounding, and to prevent leakages in the boiler — which may be imperceptible, but are there all the same, — the number of joints and fittings should be reduced to a minimum, and what there are should be most carefully made and packed.

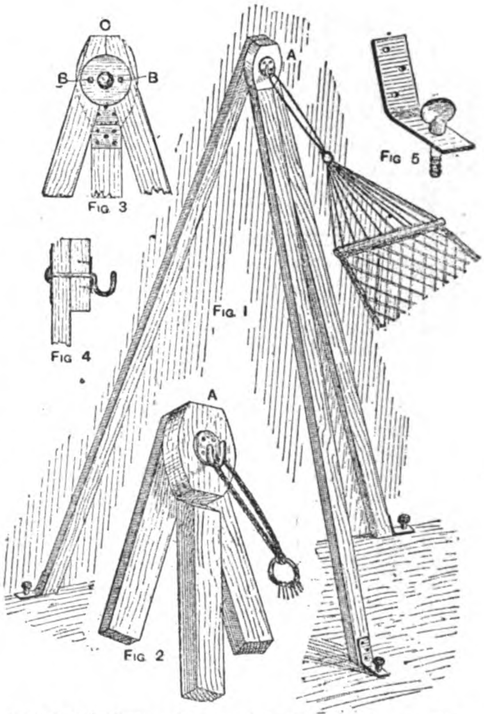
If two ⅝ × 1¼ cylinders had been adopted, the pressure maintained would have fallen in proportion, and although leakages in the boiler would thereby be reduced, the total losses, due to piston and slide valve leakages, clearance spaces, would most likely more than balance those of the H.P. boiler and compound cylinders of the present design.

The use of one H.P. cylinder of ⅝ in. bore and 1¼ in. stroke will render priming less prevalent, as a much smaller volume of steam has to rise from the surface of the water, which is an important point in the design of model steam engines.

So much for the theoretical considerations. As will be seen by the general arrangement (drawings herewith), the engine is built up on a cast-iron bedplate. This rests on a wooden plinth, which may be painted to represent the cement or brickwork used in the original to face the foundations. The whole may then be put upon another board, which may extend beyond the engine and be used to support the dynamo, pump or apparatus to be driven by a belt from the flywheel of the engine, as shown in the diagram (Fig. 1) herewith. Underneath the base may be placed the feed-water tank and pump. A feature of the cylinders is the starting valve, which also may be used to assist the L.P. cylinder should the pressure in the boiler be too low to provide an efficient blast, or should any extra work be momentarily required from the engine. To enable the motion to be reversed, slip eccentrics are advised — that is, if engine efficiency is the principal thing desired.

Every part of the model will be detailed by full size drawings (where possible), as in the case of the writer's designs for the *M.E.* steam and electric locomotives, and, therefore, builders of the model need only refer to the large drawing for main dimensions and for information with regard to the general dispositions of the various parts of the engine — The Model Engineer.

(To be Continued.)



Support for Fixing Hammock in Room. Fig. 1.—View of Tripod Supporting One End of Net. Fig. 2.—Head of Tripod. Fig. 3.—Back of Head of Tripod. Fig. 4.—Vertical Section at C (Fig. 3) showing Shank of Hook Riveted to Back Plate. Fig. 5.—Bracket Iron and Thumbscrew.

A Simple Hammock Support

The accompanying illustrations show a simple portable arrangement which can be used for supporting a hammock between the two walls of a room, when hooks cannot be firmly fixed in the walls.

At the top of a tripod a hook is fixed, over which the hammock cord is looped. A tripod is formed of three pieces of wood, two against the wall being 2 in. by 1 in., and that which forms the strut is 2 in. by 1¼ in. A block of hard wood 1¼ in. thick is shaped as shown at A (Figs. 1 and 2). The wall pieces are splayed at the top and fixed with a screw through each into the block, as indicated at B (Fig. 3). The screws first pass through a thin circular iron plate, as shown. The principal use of the iron plate is to secure the shank end of the hook, which is riveted to the back of the plate, as clearly indicated in the section (Fig. 4); this will prevent the hook drawing out. The strut is splayed at the top end, as shown in Figs. 1 and 2, and fixed to the block with a strong back flap hinge and screws, as shown in Fig. 3. The bottom ends of the leg are cut to fit the floor as shown, and when in use, the feet are secured in position with brackets and thumbscrews (see Fig. 5), the latter screwing into nuts fixed in the floor.

A suitable height for the supports would be about 4 ft. 6 in. to the hooks, and ash is the most suitable wood to use. Of course, two of these tripods are necessary, one for each end of the hammock. When not in use, the thumbscrews can be released and the tripods folded up, and thus they will only occupy a minimum of space.—Work.

A cement that will resist white heat may be made of pulverized fire clay. 4 parts; plumbago, 1 part; iron filings or borings free from oxide, 2 parts; peroxide of manganese, 1 part; borax, ½ part. Mix these to a thick paste and use immediately. Heat up gradually when first using.

Design for a Simple Model Electric Locomotive

S. M. THOMPSON

The accompanying drawings and following description will illustrate a 2-in. gauge electric engine, which I have just completed, and which will pull a very heavy train satisfactorily, taking a current of about 2 amps. at 10 volts.

The engine, which is composed largely of sheet zinc, is meant to represent one of the engines used on the District Railway. The principal dimensions are as follows:

Length of engine: Over buffer beams, 12 ins.; over buffers, 13 ins. Width of engine, 3½ ins. Height (rails to roof), 6½ ins. Wheels (8): Diameter on tread, 1¼ ins. Gearing: Pinion of motor, ⅝ in.; spur wheel, 3⅛ ins.

The bogie trucks were each cut out of a single piece of sheet zinc No. 20 S.W.G. thick, the two sides or hornplates, with the grooves for the axle blocks, being bent over at right angles. The axle blocks were made of 3-16ths in. sheet brass, with saw cuts on the vertical opposite ends which slide up and down the above-mentioned grooves; and all blocks, except those of the driving wheel axles, have springs fitted above them. The wheels I bought, and they are of cast iron, 1¼ ins. diameter on the tread. They are all loose on their spindles, and are kept at the proper gauge by distance tubes, except in the case of the driving wheels, which are a tight fit and sweated on to their spindle. The driving is done by means of two bevel wheels, as shown, and a pinion and spur wheel, which latter were taken from an old medical electric machine.

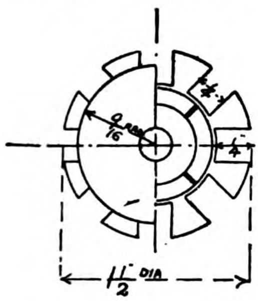


FIG. 6.

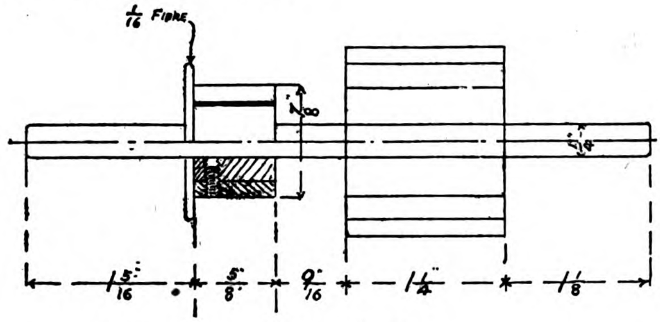


FIG. 7.

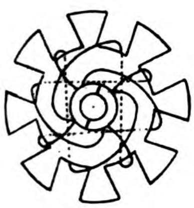


FIG. 8.

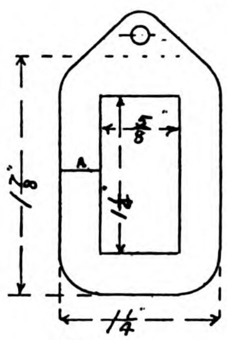


FIG. 9.

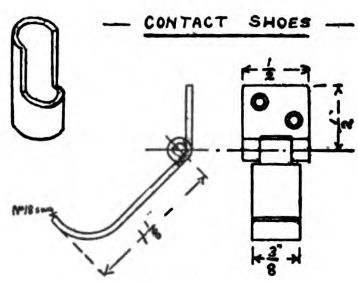


FIG. 10.

Details of Motor for Small Electric Locomotive

The floor of the engine I made of 5-16ths in. teak. The bearing for the spindle of the spur wheel forms the trunnion for one bogie, and the other is simply a screw put in from underneath.

The sides and ends of the engine casing were cut out of sheet zinc in one piece, the joint being at one end of the car. There are two windows at each end, and a sliding door and two windows at each side. The roof was also cut out in one piece and bent at the dotted lines (see Fig. 5).

The moter is series-wound, the magnets being made of thin Swedish iron stamp-

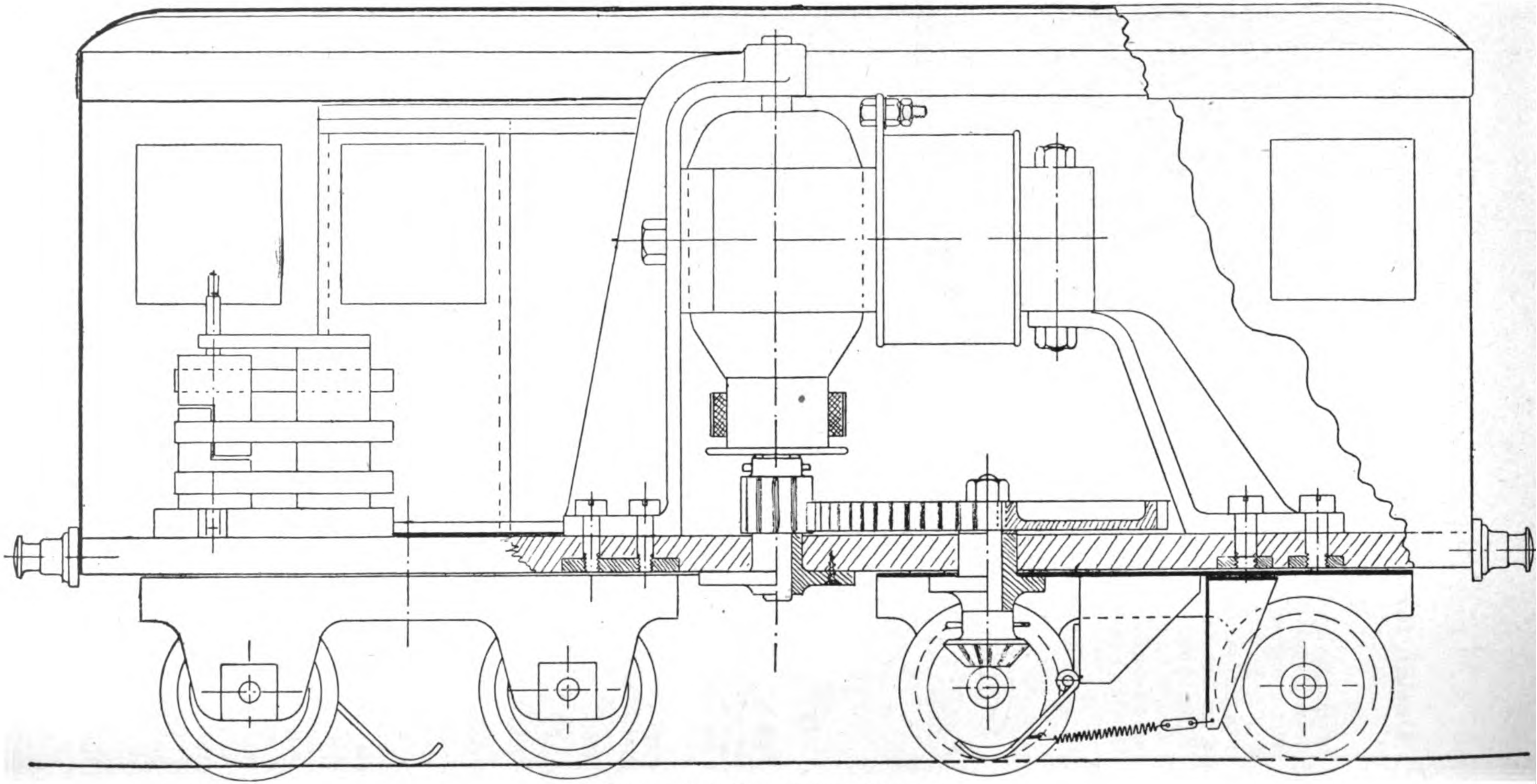


FIG. 1.—PART LONGITUDINAL SECTION.

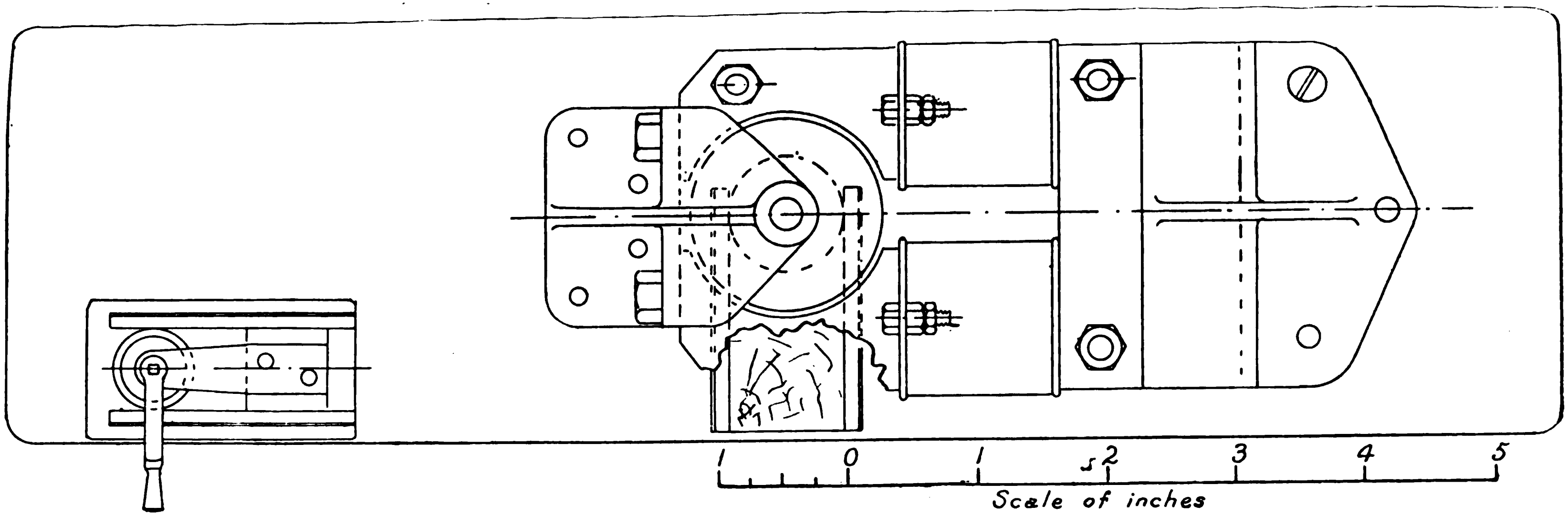


FIG. 3.—PLAN SHOWING ARRANGEMENT OF MOTOR AND REVERSER.

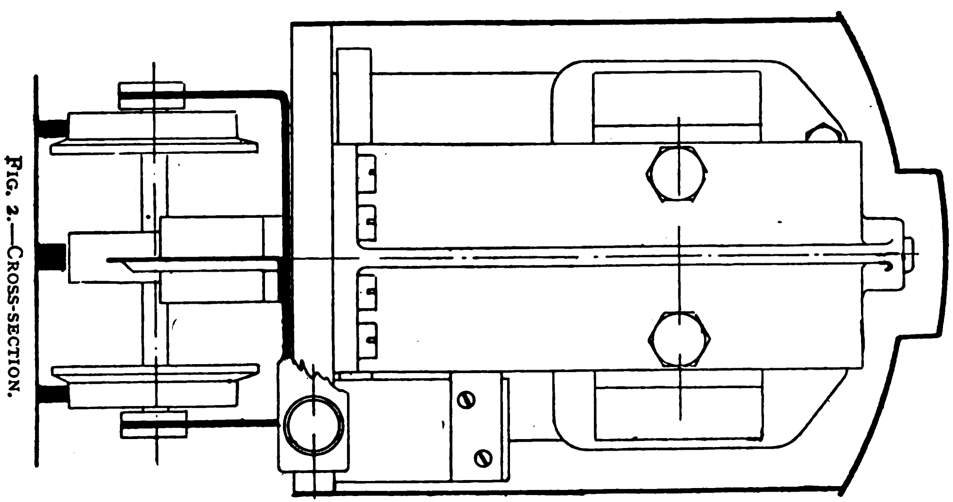


FIG. 2.—CROSS-SECTION.

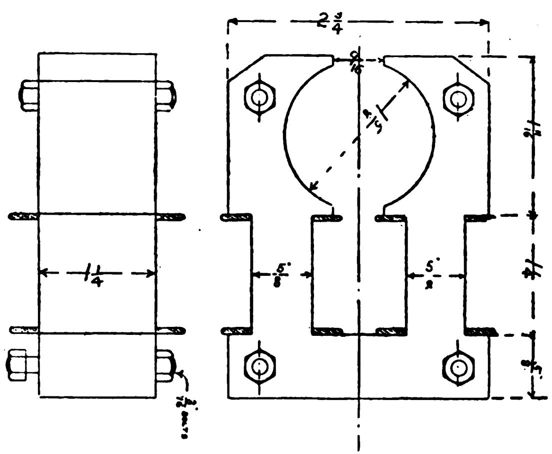


FIG. 4.—DETAILS OF ELECTROMOTOR.

DESIGN FOR A MODEL ELECTRIC LOCOMOTIVE.

ings bolted up between two outside stampings ⅛ in. thick, and the tunnel bored out to 1⅝ ins. diameter. Vulcanized fibre flanges were made and cut across at A (see Fig. 9) to enable them to be slipped on to the magnet limbs before winding was begun, the spaces between these flanges being insulated with tape and varnished with shellac varnish. The magnet winding consists of 26 yds. of No. 18 S.W.G. D.C.C. copper wire, which was wound on by hand and well coated with shellac varnish It is best to test this winding for leakage before varnishing.

The armature was also made of thin iron stampings assembled on the shaft, with a coat of shellac varnish between each stamping. It is 1½ ins. diameter by 1¼ ins. long, with eight slots. The stampings I clamped tight together whilst the varnish was wet, and put a taper pin through the spindle at each end to hold them in this position.

The commutator was made of brass tube ⅞ in. outside diameter by ⅝ in. long by ⅛ in. thick, which was fitted tight on to a turned fibre bush and scribed off, for division with four segments, each division being fastened to the fibre with two ⅛ in. screws. When all these screws were fixed the tube was sawed through at the four lines, thus making four segments. These four saw cuts I filled with mica strips driven in with shellac varnish, and when ready the commutator was keyed to the shaft, turned up, and faced at ends. Four small holes were drilled in the segments at the end, near the armature, to receive the ends of its winding. The armature was then carefully insulated with silk and shellac, and wound with No. 24 S.W.G. D.C.C. wire until the slots were filled (see Fig. 8). The reversing switch was placed in the engine so that the handle projects through one of the windows, and was made as follows: Two pieces of brass tube were cut (see Fig. 3), and driven on to a turned piece of fibre, and which can be rotated by the handle above mentioned. Four copper gauze brushes with flat springs behind them press on this tube—one each side at the centre of its length, one at the top on the left, and one at the bottom on the right. The connecting wires are simply soldered to the ends of these brushes. The contact shoes for collecting the current from the middle rail are made of sheet copper hinged and bent as shown on the drawing, two of them being provided, to enable the engine to run over points and crossings without shutting off the current, as would happen if only one contact shoe were fitted. These shoes are drawn down to the live rail by coiled brass springs, and are connected together electrically. The motor brushes are made of folded copper gauze with flat springs on the outside, screwed to a block of hard wood of the same width as the diameter of the commutator. This block of wood was screwed to the engine base from underneath.

A main switch was also provided in the engine, so that the current can be cut out of the engine when other engines are being run. The starting resistance was not placed in the engine, as it is more convenient to start the engine without going near it, but was put in the supply circuit, viz., between the accumulator and the live rail.

The engine was painted red, and provided with buffers, couplings, and head lights, which latter are worked by a small accumulator carried in the train. The electrical connections of the engine were made as shown in Fig. 11.

For locating punctures in inner tubes a sure method adopted by some is to blow into the tube a small quantity of fine powder of a pronounced color; almost any of the harmless dyes will do. When the tube is inflated the puncture can be quickly located, however small it is, by passing a damp rag along the surface. The powder having been blown through the puncture by the pumping process, will make a stain on the rag.

Inspection of an electric motor has sometimes exhibited the fact that, because of its own bad condition, it has required a percentage—a percentage far too large—of its rated horse power in current merely to run itself without load. Any such condition should be corrected promptly if electric power is to be employed as economically as it should be and may be. Examination in time often saves many times the cost of nine stitches.

The Construction and Management of Gasoline Engines

XII. Operation

CARL H. CLARK

Before attempting to start a gasoline engine one should become thoroughly familiar with all the piping and valves, and also the oiling and ignition systems. If the engine has not been used for some time before, it is well to test the ignition system to make sure that the contacts are not corroded and that the circuit is complete. In the case of the make and break spark this is done by closing the switch and turning the fly wheel until the points are brought together inside the cylinder; the wire is then disconnected from the insulated electrode and snapped across it so as to make and break the contact; a series of sparks should follow. If no spark shows, all contacts should be gone over and cleaned, including those of the sparking gear inside the cylinder; the circuit should be overhauled until a spark can be obtained in this way. In a jump spark installation the spark plug should be removed and laid upon some bright part of the engine with the secondary wire still attached. The engine is now turned over until contact is made by the timer, when the buzz of the vibrator on the coil should be heard, and the spark be seen to pass between the points of the spark plug. If the buzz of the vibrator cannot be heard it shows a fault in the primary circuit. If, however, the vibrator does buzz, but yet the spark does not appear, it shows that something is wrong in the secondary circuit.

The gasoline supply should then be examined to make sure there is a clear flow to the engine without obstruction. The tank also should be sounded to be sure of having a sufficient supply.

Oil and grease cups should then be filled, and a small amount fed from each one.

The switch in the ignition circuit may now be closed and a small amount of gasoline be turned on. The engine is now turned over by hand in the direction in which it is to run, using the crank or handle as the case may be. After a few trials the engine will probably explode a charge and continue to turn. The carburetter is then adjusted for air and gasoline supplies until the engine turns at the greatest speed; oil cups should then be opened, allowing the oil to feed. If, in the case of a two-cycle engine, it does not start after a few turns, the gasoline should be shut off and the compression cock opened. It is probable that several charges of gasoline have been taken into the base without being exploded, making the mixture too rich, and, as it is termed, "flooding" the engine. This over-supply may be due to two causes, either from too great a supply passing from the carburetter, or the failure of the ignition system to explode the charge. This flooding may be gotten rid of by turning the engine over with the supply turned off, and the compression cock open. If the failure has been due to too great a supply, an explosion will be obtained after a few turns, and the engine may continue to run until the charges in the base are exhausted. The supply should then be cut down and another trial made. In the four-cycle type this trouble is, of course, avoided as the charges are forced out of the cylinder mechanically. All that is necessary then, is to turn the engine under varying conditions of gasoline and air supply, until it finally starts, always making sure that the ignition system is working properly.

In turning the engine by hand great care must be taken that the sparking gear is so set that the ignition cannot take place until the piston reaches the top of its stroke. If the spark is advanced so that ignition can take place on the up stroke, the piston will be driven violently downward, in the wrong direction, giving a "back kick" which is likely to do damage.

Starting the engine is often made easier by "priming" it, that is by putting a small amount of gasoline directly into the cylinder through the compression cock. In some engines special priming cocks may even be provided for this purpose.

If the engine runs for a short time

and finally stops, with a muffled explosion in the base, it is a sign of a weak mixture, and the gasoline supply should be increased. If, on the other hand, the engine labors, slows down, and finally stops, it shows a too rich mixture and the supply should be cut down. The best mixture can be found only by experiment. It is needless to say that as little gasoline as possible should be used. A judicious regulation of the air supply will often allow the gasoline supply to be cut down.

Two cycle engines of the two port type, especially in the case of large engines, may best be started in the following manner. The spark is advanced to a point somewhat beyond the usual running point and so that the spark will take place on the up stroke when the engine is turned in the opposite direction to which it runs. The fly wheel is then turned so that the piston is at the bottom of the stroke. It is then rocked backwards and forwards a few times, thus sucking in a charge, mixing it in the base and charging the cylinder. The flywheel is then brought up quickly in the reverse direction to that in which it runs until the spark explodes the charge in the cylinder. It is then quickly released and the engine starts off. The spark is then restored to the running position. This is a very easy way of starting a two-cycle engine; it cannot, however, be used on a three-port engine, as no admission to the base takes place until the piston is at the top of its stroke so that the three-port engine must be started by pulling it over the center.

In starting any engine with a crank great care should be taken to hold the handle loosely in the hand, so that it may be quickly released in case the engine should start quickly or "kick back." Frequent accidents happen from disregarding this precaution, sprained wrists, and even broken arms resulting.

As soon as the engine has fairly started, the gasoline supply should be so regulated that the engine runs steadily with the smallest consumption of fuel. After running for a short time the fuel consumption may change somewhat, owing to the engine becoming warmed up, and the carburetter being cooled off by the evaporation. The oil supply should be regulated to just below the point where smoke would issue from the muffler. Blue smoke passing out through the exhaust is usually a sign that too much oil is being fed, which, instead of being used in the engine is carried out through the exhaust and wasted. In the case of the two cycle engine, oil must be put in the crank case at frequent intervals, as from this point the main working parts of the engine are oiled. The cylinder oil cup should be adjusted to give from three to five drops per minute according to the circumstances. The exterior parts, such as eccentric and pump bearings, are of course oiled with an oil can at intervals. In the case of a new engine, oil should be used rather liberally at first, while the parts are wearing down to a good bearing surface. Some powdered graphite fed in with the oil greatly assists in forming a good bearing surface, especially in the cylinder, as it fills up the pores of the soft cast iron and forms a sort of skin on the surface.

As soon as the engine has started it should be ascertained that the cooling water pump is working properly. Any failure of the water circulation will cause the overheating of the cylinder and possible damage.

While it is not possible to take up in detail all of the causes of failure of a gasoline engine to run, a few of the most usual may be considered.

One of the most frequent causes is the failure of the electric current, which of course prevents the formation of the spark and explosion of the charge. It may be due to corroded contacts or to weak batteries. All contacts on switches, etc., should be kept bright and in good condition. In the case of weak batteries the engine will run for a short time and then stop, after missing a few explosions.

As batteries regain their strength somewhat after a short interval, the engine may be again started and run for a short time. The only remedy is to fit new batteries. It should not be attempted to use batteries more than one season, as there is a probability of their giving out at an inconvenient time. Broken wires are also a fruitful source of trouble, especially if the wire be broken and the insulation remain intact. Wires are most apt to break where they are joined on to binding posts. This may be largely avoided by turning a small coil in the wire where it joins the post; this gives some elasticity to the wire.

Ignition trouble may often be traced to dirty plugs or sparking points. If too much oil is used in the cylinder, it will carbonize on the plugs and prevent the sparking. The remedy is to clean the plugs or points and to use less oil in the cylinder.

All parts of the engine should be kept clean and bright and not allowed to become coated with rust. A large amount of trouble may be caused by an accumulation of grease and dirt on the working parts of the engine.

The flow of gasoline to the carburetter may sometimes become obstructed, which will cause the engine to slow down and finally stop. The small needle valve in the carburetter is liable to become stopped by a piece of scale or dirt, which may be easily removed. Care should be taken in filling the tank to see that no dirt is carried in. Gasoline should be strained, either through fine wire gauze or chamois skin. In sounding the tank a clean stick should be used. Trouble has been caused by the lack of an air vent in the top of the gasoline tank. The flow of the gasoline from the tank creates a partial vacuum in the tank so that the flow is reduced and finally stopped. This may be remedied by drilling a small hole in the cap in some position where neither dirt nor water can enter. One should always make sure, before starting on a run, that there is sufficient gasoline on hand to complete it.

There are occasional troubles with the valves of four cycle engines, they may sometimes stick in place, or may become leaky from wear, thus spoiling the compression and reducing the power. These troubles are easily recognized and are easily remedied by regrinding the defective valve.

When a reversing clutch is fitted it should be given some attention. The barrel should be plentifully supplied with oil, so that the gears run practically in an oil bath. The frictions should be so adjusted that they take hold firmly at the proper time, as slipping of the frictions not only causes a loss of power, but wears out the clutch.

It is not expected that these few hints should cover all possibilities of trouble. With a full understanding of the principles, however, one should be able to easily master the starting and running of the engine, and after some practice should be able in the case of trouble, to quickly decide upon and remedy the cause.

Wireless Telegraph Distances

VICTOR H. LAUGHTER

In looking through the Questions and Answers columns of the Electrician and Mechanic I find that one of the most repeated questions is, "How far will a wireless station work using a certain size coil?" or "What size coil is necessary to telegraph a certain distance?" I want to say at the beginning, that no one, no matter how well versed in wireless telegraphy could answer such a question without being thoroughly familiar with the conditions under which the set was to work. For instance, we have to consider what type of receiver is to be used, the height of the aerial wire, strength of coil, and whether set is to be used across water or land.

The distance to which a wireless telegraph set will work also varies in different parts of the country. Where the region is subject to fogs and dampness, a stronger set will be required to work a certain distance, than if the atmosphere is clear and dry, as a fog or damp atmosphere will quickly dampen out or kill the waves. It is a well known fact that wireless transmission is a great deal more successful over water than land. This is probably due to the fact that no intervening trees, windmills, smoke stacks, etc., are between the two sets, all of which serve to kill out the wave strength to a certain degree. On water a better ground connection can also be secured, as it is merely necessary to tie weights to a piece of wire netting and throw it overboard, to get the large area of ground connection which is desired.

I have found that a very good ground on land can be made by soldering the ground wire to a large copper or tin sheet and burying to a distance of about six feet, or deep enough so that the plate will make contact with permanently damp earth.

A wireless station will work farther at night than in the day time. Some authorities claim that the reason for this is that the atmosphere at night is more constant and is not subject to such changes of condition as in the day time. I saw a statement in a technical paper some time ago that a wireless telegraph set would not work at sunset or sunrise. I have never noticed any difference, probably because my transmitter had a large surplus of energy; but of this I will leave the amateur to form his own opinion.

A word now in regard to the distance at which a wireless set will work. Let us assume that the experimenter wishes to work his set to a friend's house one-quarter mile away, and has a one inch spark coil fitted with spark balls, etc., and that the country over which the wireless set is to work is fairly open, with very few trees. In this case the spark coil would work a coherer at the receiving station, or it would work a detector made according to directions given in the March issue of this paper one-half a mile, provided that the aerial was about 35 or 40 feet in height, and the net-work was used at the receiving station.

While of course one might use this same set for a greater distance than given here, this could not be depended on, as the working of the coherer or the indication in the telephone receiver would not be reliable.

If the set is required for say 100 miles across water, a spark coil capable of giving energy equivalent to a fifteen-inch spark would be required. We say "equivalent," because in wireless telegraphy a coil that gives spark strength and not spark length is desired; that is brought about by winding the secondary with large heavy wire rather than fine small wire. The height of the aerial in this case should be about 150 feet. By increasing the height of the aerial we may reduce the size of coil to be used; but I prefer a coil of fully this size, as I do not believe one any smaller will give satisfaction.

To work this same distance across land (100 miles) it would probably be necessary to use an oil transformer with a battery of Leyden jars. I have been informed by one amateur, however, that he is successfully telegraphing this distance with a fifteen-inch spark coil. While this experimenter might be able to accomplish the feat, another might fail; for, as mentioned in the first part of this article, one would have to consider the conditions under which the set was to be worked.

I will now give a table showing the distance to which a wireless set will work (it being understood that the writer has drawn up this table from experiments and what other amateurs have accomplished.) Under favorable conditions the distances given in this table can be relied on.

Spark Length of Coil	Height of Aerial	Distance	
		Coherer	Liquid Detector
½ inch	35 feet	⅛ mile	¼ to ½ mile
1 "	40 to 45 feet	¼ "	¼ to ¾ "
2 "	50 feet	2½ to 3½ miles	5 to 10 miles
*4 "	75 "	10 miles	10 to 20 "
6 "	100 "	15 "	15 to 30 "
10 "	150 "	50 "	50 to 75 "
15 "	180 "	60 to 75 miles	75 to 100 "

*From the 4-inch coil down it is supposed that one is using a tuned sending and receiving set.

The Perils of a Lineman

GEORGE RICE

[We print the following article, which shows a certain sense of humor, as a rather interesting bit of personal experience. The illustrations are by the author, and fit in well with the character of the sketch, though we do not hold them up as models to be imitated.—Eds.]

Linemen, like gas meter readers, are often mistaken for book agents, burglars, tramps, etc., and treated accordingly. One of the most exciting experiences which I had was with a German who could not understand what I said, and who mistook me for a second-story thief, while I mistook him for a lunatic. The lines of wires ran along some poles beside the building where the German lived. It was necessary for me to ascend a tree and clear the wire and then get on a slanting roof near the window of the German. In order to get a hold on the roof, I slipped the upper sash of the window down, intending to open it and use the window sill as a seat while I repaired some of the wiring. The German thought I was a robber. He grappled with me with great earnestness. I decided that I had opened the window of a caged crazy man and operated accordingly. I sought to soothe him for a moment, but quickly came to the conclusion that I would have to use a little physical strength. He began to get the best of me. He

was gradually hauling me through the window in a most undignified manner for a lineman. Finally, we both fell on the floor inside just as some people came into the room to help catch the thief. They sat upon me. The fact that I had my climbing equipment on did not matter because they remarked that this was part of the game of thievery on the part of the second-story worker. A policeman was sent for and the gallant German turned me over to him with a dramatic flourish. Of course the police officer understood the situation at once. The German nearly collapsed when his friends gave him the laugh. He was too ashamed to apologize to me. Shortly after, however, he sent me a case of beer with a card.

Another time I had occasion to get up near the margin of the roof of a building where some inexperienced linemen had secured a line in an imperfect way. The superintendent wanted the wire removed. I secured a good long ladder and went up the same to the position. It was very early in the morning, before some of the folks were up, and while the light was still dull. A ghostly form came to one of the upper windows, quietly raised the sash, and without a word shoved the top of my ladder out and off. I went down fifteen feet with a thud. Fortunately the sod below was like a cushion and I did not get damaged physically. My feelings were much affected however. The quiet man in white simply closed the window and evidently went back to his couch. I sat on the sod and waited. Then I put the ladder up at a good distance from the window and by reaching far over, managed to get my work done. All this while the man in the room was quiet. I finished the job and left. I learned afterwards that I had operated in the district where petty thievery was prevalent, and that thieves had often ascended to the second stories by means of ladders. The quiet citizen, no doubt, was accustomed to having thieves climb to his window with a ladder. He could not afford to lose his sleep by dallying very long with an intruder. Therefore he considered his duty completed when he pushed the ladder out and heard me fall.

The most exciting events of this nature arise when one or more women think you are a thief. I once entered, to make a wire connection with a switch, a house where a maiden lady was lying on a couch. She was bundled up in pillows and shawls of great beauty. I did not see her. I could not resist the temptation to stop a moment as I passed by, to admire the beautiful designs on the fluffy pillows. The elderly maiden awoke just then, and saw this lineman, with his soiled clothes, hair disordered by the winds, hat gone, hands blackened, and tools sticking out of his belt just like a real bank-breaker. The lady uttered a good strong shriek and fled. I endeavored to explain, but she did not hear a word. I could hear steps below and mumbling of voices. A crowd of relatives was accumulating at the door below. I could hear each coax the other to come up and tackle the daring burglar with his arsenal. I could not overcome the desire to have some fun. I heard two or three manly voices and the spirit of fun got the best of me. I began giving orders to imaginary accomplices in a voice so that the excited crowd below could hear. I ordered the searching of certain apartments above. Each order was followed by a howl from below. I could hear them speak of police. A boy who was sent for a policeman came back with the pleasing intelligence for the party that no such person was available. I kept the thing going about ten minutes. Then I heard them whisper that a policeman was coming. I put on the last stroke and sent the mob further down by threatening to shoot them with my monkey wrench. Then I heard the policeman coming. I sprang to the switchboard. I commenced to coolly adjust a fuse, just as if nothing had happened. Cautiously the policeman came up, followed by the husband, the sons and the women. They found an electrician quietly attending to his business. The police officer laughed. The people tried to

explain about the rumpus, but he would not believe that I had been anything but a nice, quiet little electrician, attending strictly to business.

Another adventure I had was when climbing a pole near a house. There are some people who have little wealth in their house, and they protect it with loaded weapons. I have always been a little shy of these loaded guns. One day I was nearly up a pole, to do some repair work on it, when a window in close proximity softly opened a few inches and the cold, shining barrel of a gun projected out. I could not make out any form of a man. I could see or hear no one. There was only that terrible gun barrel, which seemed ready to speak out at any moment. I will acknowledge that I was scared. I read my past life over several times in those few moments and wished I had omitted a few things which had been recorded against me. I wanted to speak out, but my voice seemed stilled. Mechanically I raised my hand and struck the barrel with a blow. The gun did not go off as I had expected. But the window went up, and the surprised face of a jolly Irishman appeared, and his lips parted sufficiently to do some explaining. "I am doing the pointing and aiming drill," he said. Then he explained that he had joined the local militia, and that it was a part of the instruction for recruits to "point and aim." He was mad because my head got between him and his target beyond. But we talked awhile and became good friends before I had finished the job and descended to the ground.

Sometimes I think that I will have to wear armor. It is safer. There are not only people who mistake you for a burglar, but there are people who do not want you around.

I always think of the woman who preferred to have her walls and ceilings soiled, rather than go to the trouble of getting the rooms ready for a rewhitening. It is so in the electrical business to some extent. If you get at a telephone and test up while someone is sleeping in the house you may get cursed out. Yet the telephone must be fixed now and then. So it is with the wiring. The wires must be inspected and repaired. Many people think that the system can be maintained year after year without any attention. Then when you give your attention to the job, you may be taken for a thief and get a thump on the head for your trouble. Nevertheless, I like the business and would not quit it for such a little thing as being mistaken for a thief. I have not even taken a cigar lately. Sometimes I take a match. Sometimes the servant girl gives me a lemonade. I like the cook who passes out a piece of the boss's pie. The boss does not lose anything, for I am more attentive to the needs of the wires and electrical appliances of his house.

Electric Flash Lamp for Photographers

L. E. PHILLIPS

Following is a description with drawings of an electrically operated flash lamp for taking flash-light pictures. This lamp has the battery included in the box, and the reflector and lighter can be taken down, packed in the box with the battery, which is then locked and is carried by a leather handle on the lid, which is similar to the one on a camera.

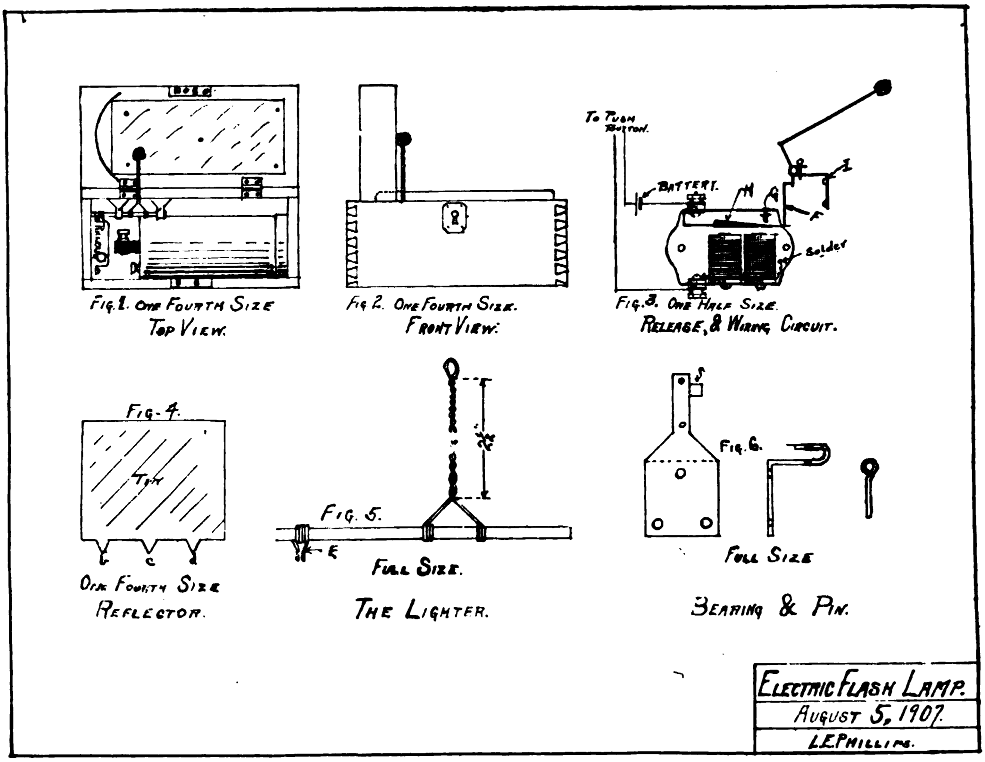
The box is made of ⅜ in. oak, with dove-tailed corners. The dimensions can be taken from the drawing, which is one-fourth size in Figs. 1 and 2. (Note.—The author's drawing has been reduced to half-size in reproduction.—Eds.) After the box is completed, it would be better to assemble the parts and then remove again before finishing. In this way, all the marks used to assemble the parts can be sandpapered off and leave a much neater job.

After the box has been well sandpapered, put on filler; when almost dry rub off surplus and put on a coat of shellac, and in a few minutes it will be dry enough to put on a coat of good varnish. In about twenty-four hours it will be dry enough to rub down with powdered pumice stone and water. If you have been careful with your work you will have a very presentable box.

The pan that holds the flash powder is of tin with the edges turned up about ¼ in. I used the lid of a box that "Nabisco Wafers" come in. The pan is fastened to the lid of the box with small screws, so that it will fit inside of the box when closed.

The reflector is made of a piece of bright tin to shapes of drawing, Fig. 4, and four times the size. The projections b, c, d, are to fasten the reflector in place on the back of lid; to accommodate these are three slots on a circle with a 2¼ in. radius, the centre being 2¾ in. from the end of lid and half way between each side.

The bearings for the lighter are made of 1-16 in. or 1-32 in. brass, cut and bent to shape shown in drawing, with two 1-16 in. holes for the pin that holds rod in place. One of the bearings has a ⅛ in. lug, A, in Fig. 6 to keep rod sliding endwise, the end of the box keeping it from sliding the other way. The bearing is fastened to the box with round-headed screws. The pin is made of No. 18 or 20 spring brass wire, to shape shown in drawing.



The lighter is made of ⅛ in. stock, three inches long. The stop, E, Fig. 5, is made by wrapping three or four turns of spring brass wire around the rod and soldering it, leaving about ¼ in. on each end, which rests against the extended part of the release, F, Fig. 3. The loop that holds the asbestos cotton is also made of spring brass wire. A loop is left in one end to hold the asbestos, the rest is twisted for about 2½ in. and the ends are twisted around the rod and soldered. This can be adjusted, when in place, so when the electricity is turned on it will fall in the pan where the flash powder is supposed to be.

The releasing attachment, Fig. 3, was made of an "Echo" buzzer. The end of the wire that goes to the contact, G, back of the armature, H, and causes it to vibrate, is soldered to the frame of the buzzer. By doing this the armature will stay against the magnets as long as the electricity is turned on. A piece about 3 in. long of a spring of an old alarm clock is needed but has to be annealed. Heat the spring to a cherry red and let cool slowly in ashes. It is bent to the shape shown in the drawing at F, one end is fastened to the armature, H, the location of the different parts can be taken from the drawing. The bearings are shown at I, and the lighter is fastened to the rod that the bearings hold.

The drawing, Fig. 3, is shown looking at the left hand end of the box; Fig. 1, from the inside. The circuit is also shown in Fig. 3 and a two-conductor flexible cord is used with a pear push on one end and the other ends are fastened on the inside of the box, and, when packed away the pear push button and cord are put along beside the battery.

If anything in this description is not clear, I will be pleased to answer any questions in regard to same. A letter addressed to me sent to the Sampson Publishing Company, with postage, will reach me.

A little electric light at the foot of your cellar stairs with a switch at the top may save many a stumble—perhaps a life.

How to Make an Armchair with Adjustable Back

BY W. H.

In the accompanying illustrations, Fig. 1 shows a novel arm chair with adjustable back. The back, which can be adjusted to different angles by a simple arrangement, is hinged to the seat rail. The arms are extended at the back, and notched on the top surface to support the ½ in. brass rod which keeps the back at the angle required.

The construction is simple, as there are no angle joints or shaped pieces usually met with in chair-work. Oak would be a suitable wood for the construction.

Commence with the two sides (Fig. 2). Plane up the legs straight, and square them to 1½ in. by 1½ in. They are shaped at the foot as shown, and the two front legs are reduced to 1 in. at the front above the seat rail. Mark the positions of the rails and stretchers, and mortise. The seat rails are 2¼ in. wide by 1¼ in. thick. They are rebated about ⅛ in. deep to receive the cover of the seat, showing 1 in. finished rails when the seat is upholstered. All the seat rails are set back ⅛ in. from the face of the legs.

The stretchers should be 1¼ in. wide by ⅝ in. thick, and should be mortised into the middle of the legs. The arms should be 2 ft. 7 in. long by 3 in. wide by 1¼ in. thick. Fig. 3 gives a plan of the arms, showing them shaped and reduced to 2 in. wide at the back. A series of notches 1½ in. apart are cut on the surface to receive the ½ in. brass rod which supports the back. The arms

Armchair with Adjustable Back. Fig. 1.—Arm chair Complete. Fig. 2.—Side. Fig. 3.—Plan of Framework. Fig. 4.—Back. Fig. 5.—Method of Hingeing Back to Seat Rail.

FIG 1

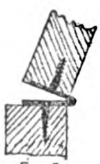


FIG 5

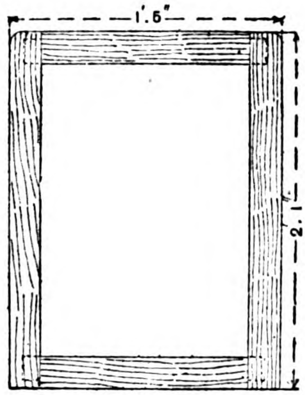
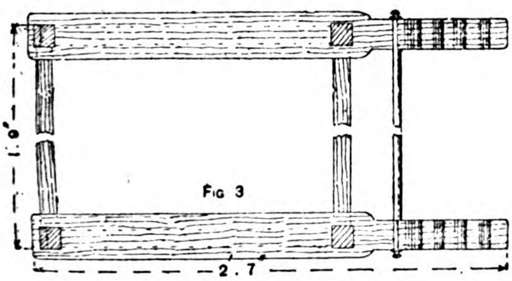


FIG 4



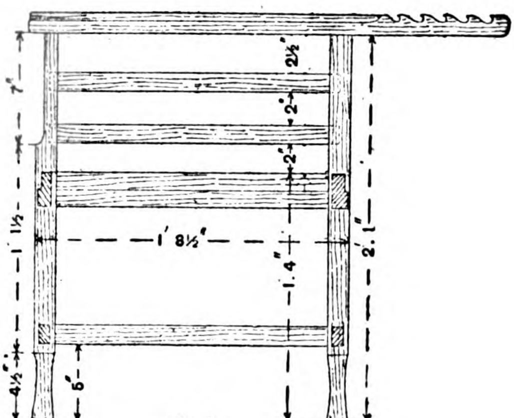


FIG 2

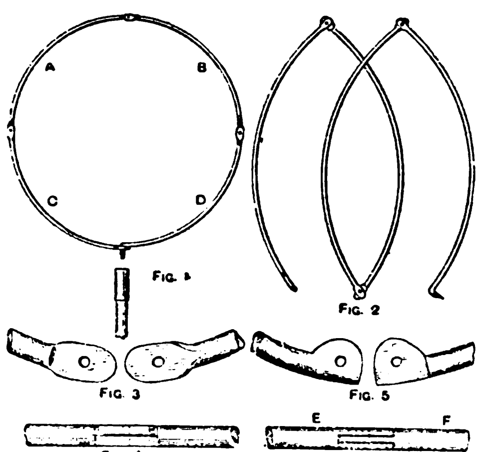
should have a shallow rebate to take the edge of the stuffing, showing ¾ in. on the bottom edge. The legs are mortised through the arms and wedged.

The back (Fig. 4), is entirely stuffed over. It can be made of birch or any other hard wood, and consists of a frame mortised and tenoned together, the stiles and rail of which are 2 in. wide by 1 in. thick. Fig. 5 shows how it is hinged to the top end of the seat rail with a pair of 2½ in. brass butt hinges.

Full instructions on stuffing the chair can be obtained from "Upholstery," price 50 cents, from our publishers.—Work.

Ring for an Angler's Landing Net

To make a ring of 15-in. diameter, procure about 4 ft. 2 in. of steel or iron wire (steel for preference), the gauge of which should be about No. 4 or No. 5 B.W.G. Cut this into four, and bend each piece into the quadrant of a circle; the two pieces A and B should be 1 ft.,



Making an Angler's Landing Net.

C 1 ft. 1¼ in., and D 1 ft. ¾ in. long. Both ends of A and B and one end of C and D should be hammered out and filed as shown in Fig. 3, and a shoulder set to half the thickness to make the joint come flush (see Fig. 4). The shoulders on the piece A are set both on one side, and on B on opposite sides. Then drill the holes for the rivet, which should be of iron wire. The wire for the rivet is now driven in, and should project slightly for riveting. The end C is hammered out 2 in. long and ⅛ in. thick, and should then be bent round a piece of wire of the same gauge, to form a ring. The end of D should be turned down at right angles at 1 in. from the end, and a thread tapped to fit the thread in the ferrule that is fixed on the end of the handle.

When the net is not required for use, the ring is unscrewed from the handle, folded as in Fig. 2, and the net wound round.

Another way is to make the ring with a box rule joint as shown in Figs. 5 and 6. In this joint the end E should be knocked up before forging into shape, and then slotted with a file. The other end F is set down on both sides, and then forged to shape. This end is then fitted into E and riveted, the rivets being filed off flush. If the joint is made properly it should be quite rigid when the ring is opened out.—Work.

Forward Truck for a Small Timber Cart

BY R. H. L.

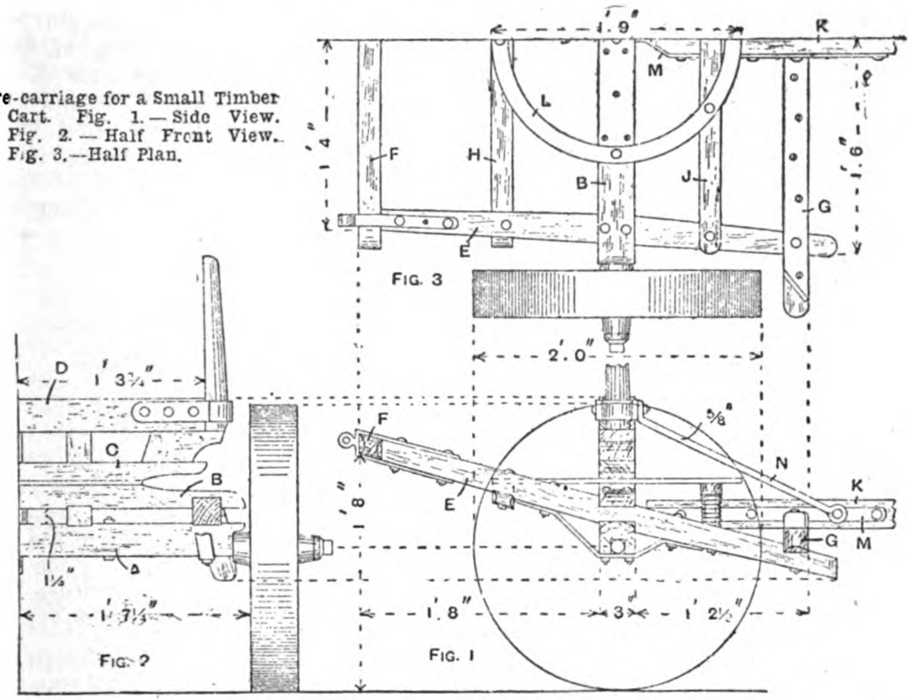
Fig. 1 is a side view of the forward truck carriage for a small timber cart suitable for a pony. Fig. 2 is a half front view without the splinter bar and the front part of the guides, and Fig. 3 is a half plan without the upper part of the carriage.

The timber should either be of English oak or ash of the following dimensions when finished:

Axle bed A, 2¾ in. deep by 3 in. wide; lower bolster B, 2¼ in. deep by 3 in. wide; upper bolster C, 1½ in. deep by 3 in. wide; top bolster D, 2¾ in. deep by 3 in. wide; guides or hounds E, 2¼ in. deep by 2¾ in. wide at centre, tapering to 1¾ in. by 1¾ in. at the ends; splinter bar F, 1¾ in. deep by 2 in. wide; sway bar G, 2 in. by 2 in.; front horn bar H, 2¼ in. deep by 1¾ in. wide; back horn bar J, 1 in. deep by 1¾ in. wide, strengthened with a 1¾ in. by 3/16 in. plate underneath; perch or reach K, 2½ in. by 2½ in.; wheel-plate L, 1 ft. 9 in. diameter by 1½ in. by ⅜ in.; axle arms, 1¼ in. diameter at collar. These sizes are suitable for a cart to carry from 10 cwt. to 12 cwt.

The wheel-plate is let into the lower bolster ¼ in., so that its upper face will

Fore-carriage for a Small Timber Cart. Fig. 1.—Side View. Fig. 2.—Half Front View. Fig. 3.—Half Plan.



be level with the top of the 1/8 in. transom plate, which is fixed along the top of the bolster. The upper transom plate is fixed underneath the upper bolster, and extends just over the outer edges of the wheel-plate. The king-bolt on which the fore-carriage turns is 5/8 in. in diameter, and goes through all the bolsters and the axle bed. The back horn bar rests on a turned wood pedestal at each end fixed on the top of the guides. The sway bar is protected on the top with a wearing plate, which is turned up at the ends to arrest the fore-carriage when turning and prevent the wheels from striking the perch. An iron plate is also fixed underneath the perch to take the wear from the sway bar. The perch is connected to the fore-carriage by the plate M, which has an eye at the front end for the king-bolt to pass through between the axle bed and the lower bolster. The upper part of the forecarriage is kept at right angles with the perch by two 5/8 in. round iron braces N, with an eye at each end to take a bolt through the perch, and one of the bolts near each end of the top bolster, as shown at Fig. 1.—Work.

"European medical experts," says Telephony (Chicago), "have exploded the theory that the continual use of the telephone is injurious to the sense of hearing. On the contrary, celebrated physicians say, the daily use of the telephone sharpens that faculty and increases its alertness, proving thereby a positive help. The question whether the long use of the telephone was injurious to the ear has been the subject of an exhaustive investigation by Professor de Blegvard in the laryngological clinic in Copenhagen. The examination of 371 'hello' girls led to the belief that continual telephone work did not damage the hearing. On the contrary, some of the subjects declared their hearing was materially improved owing to the practice. Professor Blegvard concludes that the naturally healthy and normal ear will not be harmed by telephone work—accidents of lighting, short circuit, etc., excepted—and advises those contemplating the work to submit themselves to an expert examination. He advises that persons inclined to nervous trouble or congestion of the blood, and suffering from headaches, should not enter the calling."

Some of the great Captains of Industry are only pirates in disguise.

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EDITORIALS

We want subscriptions to keep on coming in rapidly even if the price of the magazine has been advanced. It is twice as good and twice as big and extremely good value for the money. This is the time of year when everybody is deciding what magazines they will take next year. Just show your October and November numbers to your friends who are interested and get them to subscribe. You will find it easy and profitable, for we will allow you to keep a commission of 20 cents or select a 25-cent book on any new subscription at $1.00 which you send in, *but not on your own*. If you want to canvass among people you do not know, write us and we will send you a letter of credentials, so that people may know you are authorized to solicit subscriptions. No premiums can be offered on subscriptions when a commission is taken.

While we had expected many subscriptions to come in on our special offer which expired October 15, and had an edition of 13,000 copies printed, we were so overwhelmed by the rush of orders during the early part of October, and re-orders from newsdealers, that we were obliged to have the magazine reprinted after the forms had been broken up. This was extremely gratifying to us, although so costly as to be unprofitable.

In order to stimulate interest among our readers interested in woodworking, we offer a prize of five dollars for the best article on the construction of a piece of furniture, illustrated by satisfactory drawings fit for reproduction, received by December 1st. The sole condition is that the article and drawings shall be good enough to use. Unsuccessful articles which may be published will be paid for at space rates. Each article must be marked " For Furniture Competition," and be accompanied by stamps sufficient for its return.

Some of our readers who are interested in photography have suggested that we offer prizes for good photographs and reproduce the best in our pages. As this plan is adopted by many of the photographic magazines, and seems to be pleasing to readers, we are willing to make the experiment, at first in a modest way. We therefore offer a prize of one dollar for the best picture sent in by a reader before December 1. Any reader, whether a subscriber or not, may send in prints, as many as he likes. Title, name and address must be written on the back of each print, which may be mounted or unmounted. The best print will be reproduced in the magazine. Unsuccessful prints will be returned if sufficient postage is enclosed when they are sent. Pictures will be criticised by the editor if requested, and any photographic questions will be answered in the magazine. If the idea proves popular, the prizes will be given from month to month, and perhaps increased in number and amount.

If you have made something which would interest our readers, let us hear from you; we want articles on how to do things. If there is something you would like to see written up, tell us that; it may help both sides.

A story is told of the famous dictionary maker, Noah Webster, which will bear repeating. The learned man went into the kitchen one day, ostensibly to give some directions to the cook. His wife, opening the door suddenly a little later, caught him in the act of kissing the maid, who was very pretty. Throwing up her hands, she exclaimed: "Why, Noah Webster, I am surprised!"

Even at this critical juncture the ruling passion of the great lexicographer asserted itself, and instead of defending himself, he merely said: "You are mistaken in your term, my dear. You are astonished, I am the one who is surprised."

As Webster was so devoted to his science it is little wonder that the great dictionary he prepared has so long kept its reputation. Revised again and again, it is today known as Webster's International Dictionary, and is used wherever the English language is spoken. The acknowledged standard of English orthography and pronunciation, we most cordially commend it to our readers who may need a dictionary.

When you need electrical goods or any kind of tools, write to our advertisers and tell them you saw the goods advertised in our magazine.

Books are necessary to education; we can supply them. Order from us any book you need. If you are going to subscribe to magazines, send us your list and we will give you club prices.

Those having to notify us of change of location, will please be sure to state the previous as well as the new address.

Draughtsman's Center.—A brass thumb-tack with a centerpunch hole in the center of the top will prove valuable when the center of several concentric circles becomes so worn and enlarged that future work will be inaccurate. The thumb-tack may then be placed in the worn center and the compass used from the hole in the top.

In England, where municipally conducted electric lighting plants are so many, the whole electrical industry —the production of the many appliances and devices with which electricity is employed — is languishing. It has been estimated that some $250,000,000 represented the American production of these electrical appliances and devices during last year. This enormous output kept many pairs of working hands busy and must have gone far to increase the satisfaction with which the American workingman should regard his conditions and his opportunities.

A Balloon Railroad.—There has recently been invented and put into operation in the mountains near Salzburg, Germany, a balloon, which is fastened to a slide running along a single steel rail. The rail is fastened to the side of a steep mountain, which ordinary railroads could not climb, except through deep cuts and tunnels. The balloon floats about thirty-five feet above the ground, and a heavy steel cable connects it with the rail. The conductor can, at will, make the balloon slide up and down the side of the mountain. For going up the motive power is furnished by hydrogen gas, while the descent is caused by pressure of water, which is poured into a large tank at the upper end of the road, and which serves as a ballast. Suspended from the balloon is a circular car with accommodation for ten passengers. The cable goes from the bottom of the balloon through the centre of the car to a regulator of speed, which is controlled by the conductor.

Experiments upon a number of men have shown that a man five feet high and weighing 126 pounds will lift on an average 156 pounds through a vertical distance of 8 inches or 217 pounds through a height of 1.2 inches. Others 6.1 feet high and weighing 183 pounds could lift the 156 pounds to a height of 13 inches or 217 pounds to a height of 6 inches. Other men 6 feet 3 inches high and weighing 188 pounds could lift 156 pounds to a height of 16 inches or 217 pounds to a height of 9 inches. By a great variety of experiments it was shown that the average human strength is equivalent to raising 30 pounds through a distance of 2½ feet in one second.

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 letter, and only three questions may be sent in at one time.** No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for the 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. Neither do we guarantee that the answers will be satisfactory for any special use or purpose required.

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.

Gravity Battery

386. G. H., Danbury, Conn., asks (1) Through what resistance should a gravity battery of 24 cells be left working, when not in use? (2) What will be the resistance of a coil, wound in two layers, of No. 18 German silver wire, on a cylinder 14" long, and 2" in diameter, successive turns being 1/8" apart? Also, if wound on a cylinder 3-1/2" in diameter?

Ans. (1) A standard 16 c.p. 110-volt incandescent lamp would answer, but the two solutions might keep separate, and better economize the zinc, if you put two such lamps in series. (2) About 15 ohms and 25 ohms respectively.

Toy Motor on Alternating Currents

387. P. D. T., West Pittston, Pa., asks if a "Little Hustler" motor will run on alternating currents?

Ans. A few lamps would be needed in the circuit, else the voltage would be too high for the motor. With this precaution the machine ought to run, but there will be considerable sparking at the brushes, and the solid iron of armature will get very hot, endangering the insulation on the wire. You can see that when energy is thus expended in heat, the efficiency of the motor must be very low.

Medical Coil

388. W. M., Oxford, Mass., asks (1) What is the matter with his small medical induction coil? The battery seems to be strong enough, but the operation of the interrupter has been precarious, and now it fails altogether. (2) How is plain soda made, such as is served from drug stores?

Ans. (1) We suspect that the platinum contacts—if indeed the apparatus ever had any,—have been burned out. Examine them, and if necessary, renew them. You can provide home made ones, by taking the platinum leading-in wires from an incandescent lamp. If you can find a burned out one of the sort used in streets, the platinum will be large enough to flatten and make a presentable plate, while without any change in shape, another piece can be soldered into the end of adjusting screw. (2) The soda exists in history only. The real stuff is merely carbonic dioxide gas dissolved in, or as more often stated, absorbed in water under pressure. Marble dust and sulphuric acid are brought together, and the gas liberated is made to pass through water, under its own pressure, and charging it. Strong vessels are needed to withstand the pressure, and occasionally one of them bursts.

389. J. B. F., Shiloh, N.C., asks (1) If porous cups for batteries can be made from common brick clay? (2) What is the principle of operation of the "Essex" hot air engine? (3) Where can a wood-turning lathe for amateur work be obtained?

Ans. (1) No, you should have the quality of clay used for making crockery. (2) The same air is used, over and over, being passed from the cooling chamber back to the one over the fire; the air, being there expanded, pushes out the piston. One stroke has to be wasted in making the necessary transfer through the ducts, hence to get an impulse at every stroke, the engine has to be duplex. (3) Our regular advertisers of wood working machinery can supply you, or you might put a note in our "want" column.

Steam Engines. Cone Pulleys

390. R. D. McN., Sycamore, Ill., asks (1) Can a well-balanced, small slide-valve steam engine be run at a speed of 1200 rev. per min.? (2) How can the proper diameter of a set of cone pulleys be determined? (3) What is the construction of a simple differential gear for automobiles?

Ans. (1) Yes, but you do not give us a very clear idea as to how small an engine you mean. At such a speed, and with a high steam pressure as is used on automobiles, a comparatively small size of engine can develop a surprisingly large amount of power. (2) Make the sum of the respective diameters a constant; then from experiment, correct the sizes, as needed. (3) We feel sure that a description in words alone would not be very clear, so we will have to ask you to wait until some extended article appears in our other columns.

Electric "Thriller"

391. C. K., Joplin, Mo., has a little magneto machine known in trade under the above name, and wishes to change it into a generator for igniting the charge in a gasoline engine, or for lighting a small lamp. Is the machine large enough?

Ans. No, it is too small, and in addition the permanent magnet is only of cast iron, and weaker than one of steel of the same size would be.

Size of Wire

392. M. T., West Unity, O., asks what is the size of sample of wire sent?

Ans. No. 31, B. & S. gage.

Agate Grinding

393. D. R. G, Newport, Ore., asks (1) Is there a book that treats of agate grinding? (2) Where can carborundum wheels and other tools for such grinding be obtained? (3) Can brass castings be used in place of iron for cylinder and piston of a gasoline engine?

Ans. (1) The Gem Cutter's Craft, by Leopold Claremont, price 15s, Geo. Bell and Sons, publishers, London. We can get it for you. (2) The Carborundum Company, Niagara Falls, N.Y., or from any large hardware dealer. (3) No, the metal would be too soft, and could not be kept well lubricated.

Armature Testing

394. A. N. O., Madison, Wis, asks how a winder can test form-wound drum armature coils, in place, on the core, for short-circuits, before reaching the regular testing-room?

Ans. We do not know. As you except the testing room, and yet realize that tests of some sort are necessary, we do not know what to substitute. The regular methods are to measure the resistance from segment to segment and to apply the heat test by means of the special transformer. To be valid, such tests must be rigorous, and any makeshift devices would not be conclusive.

"Perrett" Dynamo

395. R. P. C., Tampa, Fla., asks (1) How to wind an 11-coil "Perrett" dynamo? (2) How can the field magnet of a dynamo be sufficiently magnetized to enable it to start generating? Must the antenna of a wireless telegraph line be high enough to overtop surrounding structures? (4) What size of coil would be needed to send messages for a distance of 15 city blocks?

Ans. (1) This is probably a plating dynamo, wound with a single layer of wire. As we know nothing about the size of machine, we cannot direct you how to rewind it. Better write to the manufacturers, The Electron Co., Springfield, Mass., stating the number on end of shaft. (2) Most of the Perrett machines were made with sheet iron field magnets, therefore they held only a small quantity of residual magnetism. For use as generators, such a construction should include cast iron end-plates, as their hardness will contribute to the retentive qualities needed. For motors, of course this necessity does not hold. If your machine will not hold enough magnetism from one day to the next, you might try to slip some bars of hardened steel, or even old files, in through the empty spaces within the field coils. (3) No, not necessarily, and for your short distance, we would suggest horizontal antennæ, composed of several parallel wires. (4) We cannot stipulate the size of coil,—let some of our advertisers do that.

Overworked Motor

396. C. C. S., Burlingame, Kan., has the parts for a dynamo, the armature being slotted, $3\frac{1}{2}''$ in diameter, $3''$ in axial length, and with 24 commutator segments. It is desired to wind the machine for an output of 30 volts, and 25 amperes,—therefore of one horse power capacity, —with speed not to exceed 1900 rev., but 1600 rev. would be preferable. Field coils are wound with 500 turns of No. 14 wire; armature was once wound with two No. 14 wires in parallel, and it seemed to give satisfaction, but repetitions of that winding fail to allow the desired current. What will be the proper size to use?

Ans. According to ordinary allowances, the original winding should suffice to carry 30 amperes, but with the space occupied with that size, we do not see how you can get as high as 25 volts. In general, at the low speed you specify, we should estimate the machine as of about one-half a horse power. If you will send us a sketch of the machine, particularly stating the dimensions of the field magnet, we can advise you more exactly.

Amateur Lighting Plant

397. H. P., Oakland, Cal., wants to light a few lamps in his house evenings, using a 1 h.p. gasoline engine and small dynamo. He asks (1) Should the lamps be for 110 volts, or for 50? The distance to transmit the current will not be over 100 feet. (2) Will a field rheostat, voltmeter and ammeter be necessary? (3) Should the engine be of the 2-cycle or of the 4-cycle type?

Ans. (1) Without the equalizing effects of a storage battery, you will find the operation of the lamps intolerable. Better use storage batteries to be charged during the day, and then enjoy your evening without having to make frequent trips to the engine house. Best of all, if you wish steady lights at minimum cost and annoyance, get the service from the regular lighting company. (2) Without a storage battery the ammeter will not particularly be needed, but the other two are indispensable. (3) The 4-cycle is easier to start, is more reliable in running, takes less fuel, and keeps a more uniform speed than the other sort. Of course it costs more, as for the same power, it weighs twice as much, and has more mechanism.

Non-Sparking Electromagnets

398. T. W. H., —— —— asks how electromagnets can be wound so as to eliminate the spark when circuit is broken? He describes a spool that has an auxiliary winding of No. 22 wire wound along with No. 30, but the latter is merely short-circuited on itself. What is the object? (3) What is the "differential" winding? It is claimed to operate sparklessly.

Ans. (1 and 2) Your description of the peculiar winding is an answer to the first question. The short circuited winding neutralizes the self-induction of the other winding; self-induction is the source of all such sparking at break of circuit. Bare wire would answer just as well for this extra winding, or it is often sufficient to make the spools, both neck and flanges, of brass. It is an old method, being employed with success on early arc dynamos, and railroad motors. In the latter case, the spools were made of single brass castings. (3) The differential winding is principally employed in duplex and quadruplex telegraphy, where the sparking is eliminated by the employment of condensers.

Toy Dynamo

399. E. P., Brooklyn, N.Y., asks if a "Little Hustler" motor can be changed into a generator? (2) What sizes are two samples of wire?

Ans. Probably not. The entire output of armature may be insufficient to energize the field. Try separately exciting the field from batteries. (2) Nos. 18 and 36.

Induction Motor

400. W. C. H., Kingston, R.I., sends a sketch of a small machine, resembling a fan motor for alternating currents, and asks if the idea is correct for induction motor? (2) What should be the output of a generator to light 60 16 c.p. lamps and drive two 5 h.p. motors, voltage to 110?

Ans. (1) The sketch is not very clear, but in the main, the idea is correct. Make the field cores shorter, and have the armature nearly twice the diameter you have shown. Clearance should be not over 1/64". The motor will not be self starting. (2) 9 k.w. would just do the work, but some leeway for overloads should always be allowed, and a 10 or 12 k.w. generator be employed.

Hot Commutator

401. ——— asks (1) Why the brushes and commutator of a 2 k.w. 110-volt dynamo get so hot? The machine was calculated for a speed of 1100 rev., but it takes 1400 to give the desired voltage. What is the cause of the error? (3) What is the best electrician's pocketbook? (4) What does Collin's "Manual of Wireless Telegraphy" cost?

Ans. (1) Perhaps the commutator is too small. You should not have more than 25 amperes per square inch of carbon contact. If you have only two brushes on your 4-pole machine, with series wound armature, you can help matters by putting on brushes in the other two possible places,—connecting opposite ones together. Perhaps you have too great pressure, or the holders are not of good design. You must realize, that at best, carbon brushes run pretty hot,—often too hot to touch. (2) Perhaps the iron you used was not of the permeability figured upon, or you have used a larger air gap. We do not understand why you selected a duplex series winding, for a single one with just as many slots as segments,—say 65 of each, would have offered some advantages. (3) Price of Sloane's "Handy Book," bound in leather, $3.50. (4) 25c.

Multi-Cylinder Gasoline Engines

402. A. R., Almont, Mich., asks (1) Are 4-cycle engines ever made with more than a single cylinder? (2) What would be the power of a sing e one, with cylinder 2¾"x3"? (3) Are such engines ever made reversible?

Ans. (1) Yes, this is the common arrangement for large boats and for the highest priced automobiles. Four cylinders are often used, and sometimes as many as six. (2) Between ½ and 1 h.p. (3) We have heard of this being done on some European boats of considerable size, but for the usual sort of craft, it is simpler to put the reversing mechanism elsewhere.

Electrical Engineering Education

403. E. H. F., Council Bluffs, Ia., asks (1) Is there any school at which he could learn electrical engineering? (2) What is the salary of an average electrical engineer? (3) Which would be the more useful for amateur experimenting, a dynamo for 6 volts and 6 amperes, or for 18 volts and 2 amperes?

Ans. (1) Yes, for home study, the "correspondence" schools are very helpful, but if you have the opportunity, go to your State University. (2) About $1500 per year. (3) The latter.

Engineering Outlook

404. H. P., Providence, R.I., asks (1) Which of the engineering professions seems the most desirable? (2) What is the work of an electrical engineer? (3) What is the rule for finding the gear of a bicycle?

Ans. (1) Unless you have very strong inclinations, we would not advise you to enter any of them. The competition, now enhanced by the excellent courses of instruction in the schools in this country, to say nothing of the influx of highly practical men from abroad, is such as to make a candidate realize that nothing short of the very best endeavors will bring success. (2) The designing of dynamos, motors, and kindred apparatus, the conduct of tests, the devising and formulating of new plans, the laying out and installation of lighting and power transmissions, and the management of enterprises. Also, now selling agents for the manufacturing concerns, and the canvassers for new customers are found to be competent engineers. (3) Divide the number of teeth in the large gear by the number in the small one, and multiply this quotient by the diameter of the driving wheel, in inches. The result is the equivalent diameter of an ungeared wheel for the same speed.

Ignition for Gasoline Engine

405. L. E., Warren, Mass., asks if a 4-cylinder, 4-cycle gasoline engine should be equipped with four separate jump-spark coils, or will a single one suffice.

Ans. It is customary to use but one. Of course there is four times as much drain on the batteries, but it would be inconvenient to carry four different sets.

Telegraph Relay

406. E. R., Ripley, O., asks (1) What should be the winding of a 150-ohm telegraph relay? (2) How many dry cells would be needed to operate a line one mile long with such relays? (4) Where can a person obtain a small quantity of German silver wire for contacts of telegraph instruments?

Ans. (1) Standard 150-ohm relays are wound with 30 layers of No. 30 B. & S. gauge, silk covered wire, 144 turns per layer, on each spool,—8,640 turns in all. (2) If you make the line wire of No. 14 B. W. G., XBB galvanized iron, it will have a resistance of about 50 ohms; we do not know the conductivity of the earth in your vicinity, but the resistance would ordinarily be less than that of the wire. If this is the case, you should need not more than 10 cells at each end. Instead of using relays as you propose, it would be common, for such a short line, to use 20-ohm sounders, and no relays at all. For such sounders you would use 14 layers, 67 turns per layer, on each spool, of No. 25 B. & S. silk-covered wire. Do not use double cotton-covered wire for telegraph instruments,—the insulation occupies too much space. Single cotton-covering will answer, but still this cannot be gotten into the same space as silk, and dampness affects it more. Almost any large hardware dealer ought to keep it, surely a manufacturing jeweller. Do not be misled into thinking that German silver is proper for contacts; platinum alone should be used. Perhaps you can get some of this metal from the base of a "street" system incandescent lamp. A five-cent piece would be better material than what you propose.

Storage Battery Plates

407. F. P. H., Baltimore, Md., asks (1) Do both positive and negative plates of a storage battery need to be placed in a solution of chloride of lime to convert them into peroxide of lead? (2) What is a practical method of lubricating the cylinder of a 1/8 h.p. steam engine? (3) Will a photographer's hydrometer do to measure the specific gravity of a storage battery solution? The graduations are from 0 to 80.

Ans. (1) We have never known such a forming solution to be used. A hot and very dilute solution of nitric acid is often used to roughen the plates. (2) A "squirt" cup at the top of cylinder is about all that is needed. Such small engines are not used constantly, and a movement of the hand lever, once in a while, is quite effective. (3) It will answer, if you can once compare its readings with some known instrument. Yours seems to be special, for Baumé's scale extends from 0 to 73, and Beck's from 0 to 85; we suspect that yours follows the graduations of the former, but carried far enough to enable it to be used for testing concentrated sulphuric acid. When batteries are fully charged, a density of 24 Baumé should be shown.

Magneto Generator

408. S. J. M., Highwood, N.J., asks (1) If in making a direct current generator out of a 5-bar or 6-bar generator, would it be proper to use the same size of wire as described for the 4-bar machine in the March, 1907, issue? (2) Is there sufficient space on such generators for the commutator? (3) What house in New York city keeps telephone supplies?

Ans. (1) Yes, you will simply get a higher voltage. (2) No, the space is rather small. (3) There are too many to be mentioned in these columns. Consult the business directory, under the head of electrical supplies.

Magneto Motor

409. L. P., Ponce, P.R., asks (1) Can a common telephone magneto generator be fitted with a two-part commutator, as described in the March, 1907, issue, and used as a motor for developing 1/6 h.p.? Battery supply would be at 12 volts. (2) If left as originally made, would such a machine run as a motor on alternating currents?

Ans. (1) It will run as a motor, but it is too small to develop as much power as you ask for. You might get 1/16 h.p. (2) Yes, it would run as a synchronous motor. Before closing the switch, you would need to turn the crank at such a rate as to give the correct number of alternations. In this particular case, the scheme is impracticable, for, imagining that your supply is from a 60-cycle circuit, the armature would have to be turned at 3,600 rev. per min., and before this speed was reached, the wire would probably fly off. The bearings, too, are not designed for such a speed. It makes a very interesting experiment to show that the machine will run, in a comfortable manner, on a special circuit supplied at, say 10 or 15 cycles, and not over 50 volts.

Lilliputian Dynamo

410. J. H. P., Belmont, Mass., sends a sketch of a little dynamo, of the upright Thompson-Houston style, and asks (1) What should be the winding of armature and shunt field to allow an output of 4 or 8 volts? Armature core is smooth, 1½" in dia., and 1½" in length, divided into 6 sections. Field bore is 1¾" in dia. (2) Would a slotted armature be better?

Ans. (1) No. 23 wire on armature, No. 25 on field,—all you can get on; the two voltages can be obtained from a single armature winding, by connecting the two field spools in series or in parallel with each other, as needed, and then adjusting the speed. (2) The slotted armature should allow about twice the output of the other.

Second Hand Printing Press

411. N. S., Asbury Park, N.Y., asks (1) Where can he get a second hand printing press? (2) Can a No. 1 "Standard" motor be used on a 110-volt circuit? (3) How many lamps in series with each other are needed to cut a 110-volt circuit to one of half that pressure?

Ans. (1) For an amateur press, we would suggest that you try our exchange columns. Also M. R. Landis, Richland, Pa., who is a dealer in all such supplies and fairly near you. A New York directory would also give you addresses. (2) No, it is not safe to put any of the so-called "battery motors" on ordinary lighting circuits. (3) Dependent entirely on how much current you desire. In case you wish to run the battery motor by this means, you should have several lamps, not in series with each other, but in parallel.

Frictional Electricity

412. M.K., Passaic, N J., states that in the oilcloth factory where he is employed, there is considerable annoyance, and even danger from fire, by reason of the production of frictional electricity. He asks if this can be avoided, say by the proper use of condensers?

Ans. Condensers would not be applicable,—they would make matters worse rather than better, for they would increase the violence of the shocks. You can stretch rods or wires across the belts, or other moving strips, that produce the electricity, and have a lot of fine wires dangling all the way across, so that their lower ends will be close to, or actually drag on the belts. Have the supporting wires attached to gas or water pipes, or to some other well grounded part of the building. The static charges will then readily pass to ground without having to go through a man or some inflammable vapor.

Battery Charging

413. M.H.T., Dowagiac, Mich., wishes to charge a few storage cells from a 110 volt circuit, and asks (1) for directions for winding a

small motor-generator set that will fit the conditions. He has two small machines with single coil field magnet; armature is 2½" in dia., and 2¼" long; one field is wound with No. 14 wire, and it is desired to wind the other for the 110 volts. (2) Will a field rheostat be necessary.

Ans. (1) We think the machines are much too small for the proposed purpose. They would have a capacity of not over 1/16 h.p., and a slight overload, of which you might not be aware, would quickly burn out the motor. As for the generator, a shunt field would be imperative, but the size you have already put on is large enough for series winding. It would be much more practical to use the lighting current, direct, with some incandescent lamps in circuit to give the required control. Of course the lamps would be in parallel with each other, as is customary for such circuits, but the group will be in series with the batteries. (2) Yes, in the shunt field circuit.

Battery Plates

414. R.G.L., Jewell, O., asks (1) What is the more practical form of storage battery plates, the "Warwick," or the style described the May and June, 1907, issues? (2) How many calls are needed to light a 50-volt lamp?

Ans. (1) Both are good, but the former is rather more economical of material for the sizes specified. (2) Allowing for the minimum voltage of cells that may be met, you should have not less than 30.

Armature Winding

415. J.C., Tampa, Fla., asks (1) How to connect the ends of a drum armature winding to the commutator? Latter has 12 segments, and one of the six coils is already in place. (2) Field is wound with No. 23 d.c.c. wire. What would be the proper size to put on armature to give the best results? (3) A "Manhattan" fan motor, with permanent-magnet field, used as a generator, will, when driven at a low speed, give good sparks. At a very high speed, it will light a 110-volt lamp, but will not ring a bell that a single dry cell rings loudly. What is the reason?

Ans. (1) You have shown considerable courage to start the winding before clearly seeing the outcome; that, under these conditions, you should now have to stop is not surprising. There are two general methods for winding a smooth core armature to fit a 2-pole field; one involves the cutting of the wire after each coil is in place, and successive coils cross each at right angles. Some confusion of ends exists and a beginner can easily make mistakes in connecting them. The other is not quite so symmetrical, but does not involve cutting the wire until the last coil is wound; loops are left out for commutator connections, with no possibility of confusion. A very clear drawing and description of this winding was given Chapter II, of the Electrical Engineering series,— August, 1906, page 40. (2) No. 20. (3) The wire on the armature is so fine that at best only a fraction of an ampere passes. The bell may demand an ampere or more. There is the additional factor besides the ohmic resistance of the circuit, that the dynamo current is pulsating, and the self-induction of the coils on the bell creates a counter electromotive force.

Book Reviews

POWER STATIONS AND POWER TRANSMISSION, by George C. Shaad, E. E. Chicago, American School of Correspondence, 1907. Price, $1.00.

The author of this manual is Assistant Professor of Electrical Engineering in the Massachusetts Institute of Technology, and it follows as a matter of course that the book is an adequate presentation of its subject. Something more than a complete knowledge of a technical subject, however, is necessary for its presentation in such form as to be useful and attractive to those who desire to learn. The author of the present book has the pedagogical qualifications necessary for the production of an instruction book, and therefore the book fulfills its purpose in every sense. No more mathematics are introduced than are absolutely essential for the presentation of the subject, and the algebra involved does not extend beyond simple equations and a few trigonometrical formulæ.

SELF PROPELLED VEHICLES, a Practical Treatise on the Theory, Construction, Operation, Care and Management of all forms of Automobiles, by James E. Homans, A. M. Profusely illustrated. New York, Theo. Audel & Co., 1907. Price, $2.00.

This volume of about 600 pages is an essentially practical book, which covers almost any point which the owner or operator of an automobile might desire to know. It covers the whole construction of all forms of motor propelled vehicles, with minute details and fully mechanical knowledge. There seems to be no point that might arise which is not covered satisfactorily. The book should be in the hands of every owner or intending purchaser of an automobile.

HINTS TO INVENTORS, by Robert Grimshaw. Boston, Inventor Pub. Co., 1907. Price, $1.25.

This excellently produced little book is a revised edition of a small manual published in 1892 by the author. It purports to tell, as the result of long series of correspondence with manufacturers, what are the crying needs in many lines of mechanical work. It undoubtedly enumerates thousands of things which would be desirable if invented, but the great majority of them are either impossible of production or of little value if produced. However, as indicating fields for the use of ingenuity, the book may serve a useful purpose.

OILSTONES: How to Select and Use Them, is the title of an attractive little pamphlet published by the Pike Mfg. Co., of Pike, N.H. It is of interest to every user of tools, and gives many facts of great value in regard to grinding and abrasive materials. A copy will be sent to any reader who will send a 2-cent stamp for it.

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