How to Make Experimental Electrical Apparatus.

By T. G. J.

(*Continued from page 78, Vol. IV.*)

An Improved Wimshurst Machine.

FOR many months I have devoted my attention to the design and action of the Wimshurst machine, and have studied with interest the various forms described in the text-books and magazines devoted to the science. Up to the present, however, I have failed to find a design which fully came up to my own idea of an ideal Wimshurst—one which would be equally adaptive to scientific experiment and practical use. I therefore devoted my own energies to the design of a machine which would fill these requirements, and, after much forethought and experiment, succeeded in completing the machine which is here described and fully illustrated. I believe it is absolutely necessary that the scientist's electrical machine be somewhat portable, as there are many occasions on which it has to be taken from place to place—as, for instance, when lecturing, exhibiting, &c. We then find how inconvenient one of these machines is to take with us, the brittle plates, &c., preventing one from packing the apparatus sufficiently well to ensure its safety during transit. I have therefore kept the matter of portability in view throughout the entire construction, and designed the various parts accordingly.

The size of machine I selected—24-in. plates—is rather large, and all the parts are of first-class construction. The initial cost of making may somewhat exceed that of the machines usually described, but from experience I would urge all those who really can afford it, and who are about to construct an influence machine, to make all the parts according to instructions given. As a result, the maker will be in possession of a genuine first class influence machine worth a dozen makeshifts.

Apologising for this somewhat lengthy introduction, I shall now proceed with the practical part of my subject, and shall first describe the construction of the various parts, and then follow with instructions for putting the parts together.

The stand seen in Figs. 1 to 4 and in plan (Fig. 5) is of walnut, dovetailed at the corners, the top being secured to the frame by means of screws and corner-pieces from beneath. It will be as well to leave the boring of the holes in the top till further on. The standards (Fig. 7) are also walnut, and have two 9-16ths in. holes bored to receive the driving and plate spindles. One hole has its centre 3¼ ins. from the bottom of the standard, and the other 1½ ins. from the top. Both holes are bushed with 9 16ths-in. brass tubing, 1-16th in. in substance. The standard sockets (Fig. 8) are cast in brass to finish ⅛ in. thick—*b* has two projecting lugs at the bottom ends ½ in. thick, and *a* has one similar lug projecting from the centre. These lugs have 3-16ths in. holes bored near their ends to receive clamping bolts.

The driving apparatus consists of a 7-16ths in. silver steel spindle, 15⅞ ins. long, covered by the hard wood sheath (Fig. 9), which bears on its ends the wheels. The sheath is bored in the lathe previous to turning up, and fitted with the steel spindle. The spindle is then centred in the lathe, and the sheath turned up to shape and dimensions given. The wheels should be cut as nearly round as possible, and the 1¼-in. holes bored in their centre, and finally glued to the shoulders on the sheath. The spindle is then again centred in the lathe and the wheels turned up to shape.

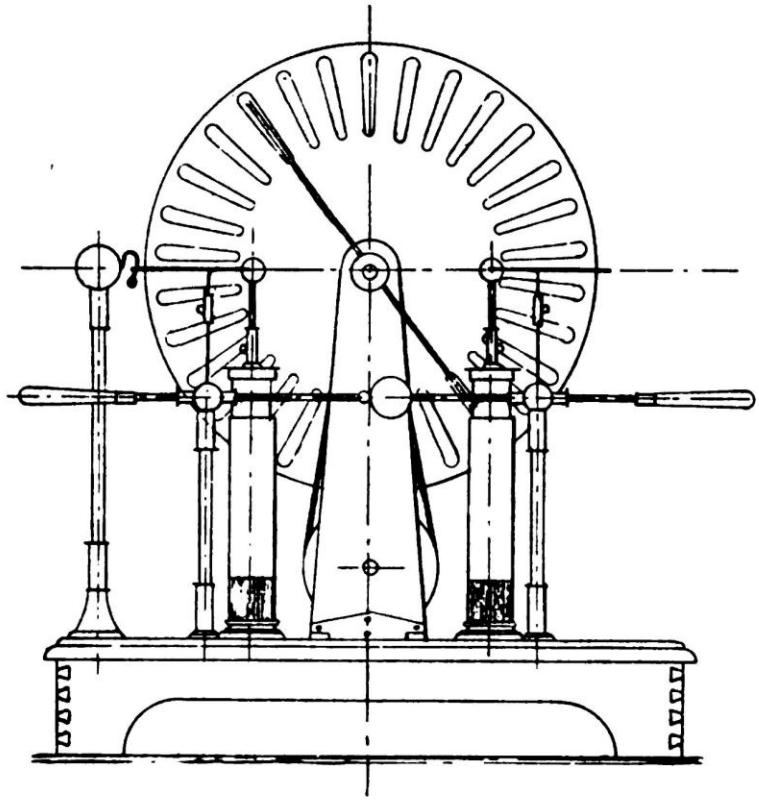

Fig. 1.—Front Elevation of Wimshurst Machine.
Scale: 1 in. = 1 ft.

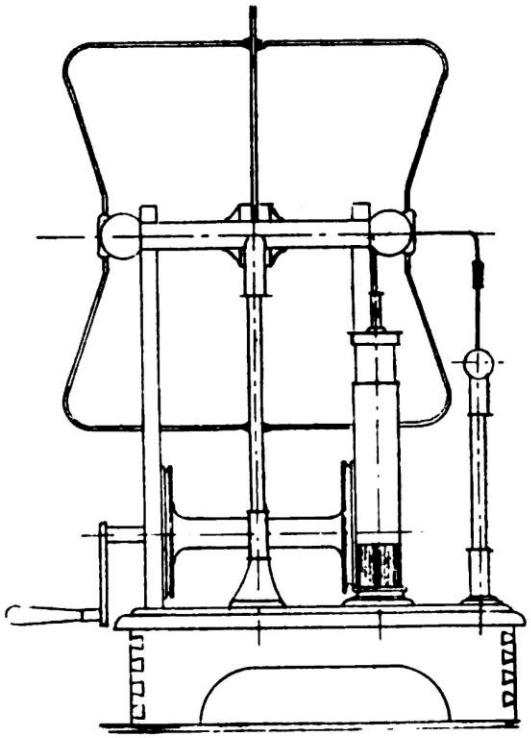

Fig. 2.—End Elevation of Wimshurst Machine (Left-hand End).

The pieces from which the plate bosses (Fig. 10) are to be turned up should have 9-16ths in. holes drilled in them, and then bushed with a piece of perfectly true brass tubing 9-16ths in. diameter, 1 16th in. in substance. Now run a 7-16ths in. drill through the hole in the brass bushing to ensure its being true. Place on a mandrel, and turn up the boss to shape. It should be observed that the bushing of the bosses should protrude 1-16th in. at either end of the boss. The plates are 24 ins. diameter, 16 oz. "patent plate" glass, with central hole ¾ in. diameter. This kind of glass may be obtained from most large glass merchants, and is the only sort that can be relied upon for truth in flatness. The ordinary sheet or window glass often recommended for this purpose is practically useless, as it is impossible to obtain a piece which is of equal thickness throughout, or which, when mounted on the bosses, will run perfectly true. As a consequence, we must keep our plates ⅛ in. or more apart, and thereby reduce the power of our machine considerably. I would advise the reader to have his plates drilled in the house where he buys them, as I believe glass is not a proper thing for novices to practise on. The plates, cut circular and bored, should be got for about 7s. 6d. the pair, and they can easily have their edges ground by rubbing them with an old emery disc, which may be had at any engineering works for the asking. Use plenty of water with the disc when grinding the plates.

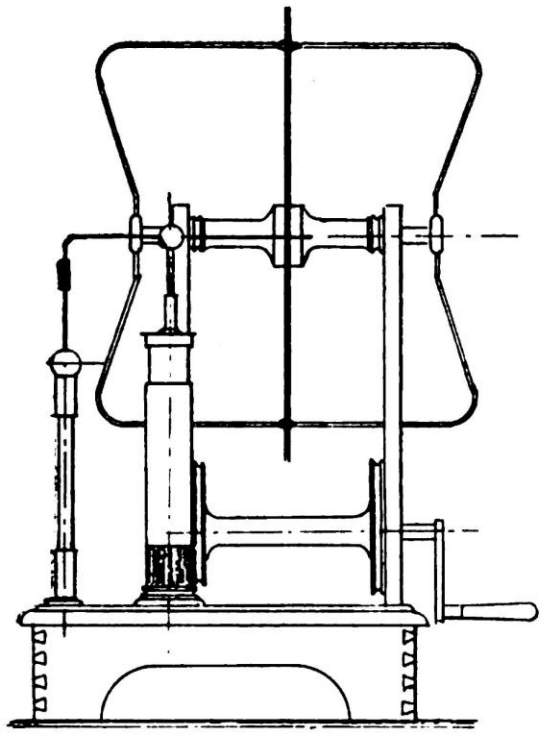

FIG. 3.—END ELEVATION (Right-hand End).
Scale: 1 in. = 1 ft.

The bosses are attached to the plates with Ellis's fish glue spread on thin flannel washers. Cut out two washers from thin flannel the same diameter as the large end of the bosses, and with central hole about 1 in. diameter. Well cover the side of the washer with the glue and press firmly down upon the face of the boss. Now smear some more glue over the dry side of the flannel washers, and allow them to dry for about ten minutes. They should now be pressed up to the plates and given a slight twist to ensure the glue spreading evenly over the entire surface of that part of the plates covered by the bosses. The plates should now be removed to a flat surface, and a book placed on the top of the boss so as to maintain a slight constant pressure until the glue sets, which will take about six hours. I would here warn the reader not to fasten his bosses to their plates without the flannel washers, as the plates would surely crack during rotation.

The next operation is to fit a 1-16th-in. ebonite washer to the inside face of one of the plates. This washer should be about 2 ins. diameter, with a central hole ¾ in. diameter, and is fixed to the plate with the glue mentioned above. The plates can now be varnished with good shellac varnish. As a half pint will be more than sufficient for all parts requiring this varnish, and as this quantity can be bought for about ninepence, I would advise the reader to buy his varnish from some of the makers, they being able to supply a much purer liquid than that made by oneself; and a great deal depends on the purity of this varnish, as the insulation increases with the purity. Warm the plates evenly all over, and apply the varnish with a broad camel-hair brush. Always draw the brush in the same direction, and do not go over the same place more than once.

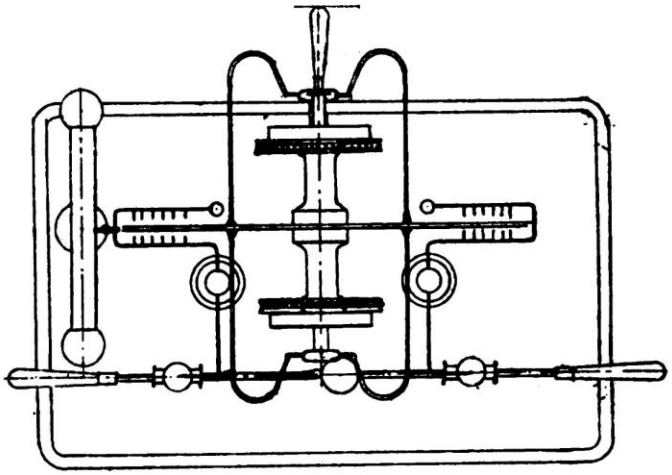

FIG. 4.—PLAN OF WIMSHURST MACHINE.
Scale: 1 in. = 1 foot.

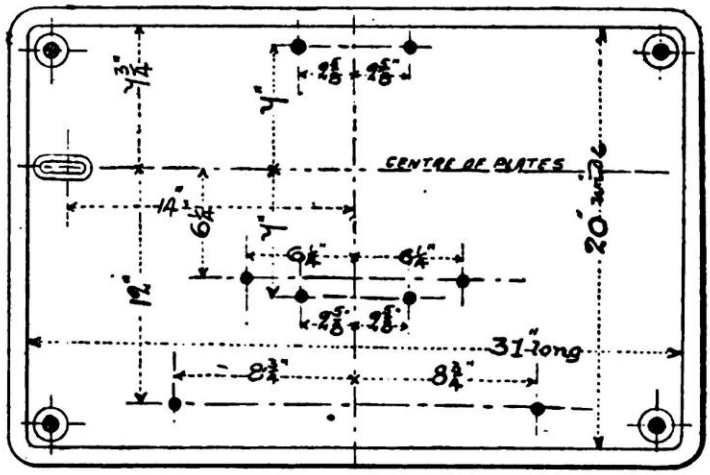

FIG. 5.—BASEBOARD. (1-12th Full Size.)

The sectors (Fig. 11), of which there are 32 on each plate, are of tinfoil, and are stuck to the plates with thick shellac varnish or thin glue. To fix these sectors

to the plates evenly, strike out a circle of 24 ins. diameter on a sheet of paper. From the same centre strike out another circle 22⅜ ins. diameter, and divide the circumference into 32 equal parts. From these points draw lines to the centre. Now place the plate on the paper, see that the edge of the plate lies evenly on the circumference of the 24-in. circle, and fix the sector over each of the lines drawn on the paper, the wide end of the sector just touching the circumference of the inside circle drawn on the paper. In this way the whole 32 sectors are placed evenly and equi-distant on the plates, and a clear margin ⅝ in. wide left between the top of sectors and edge of plates.

The driving bands are continuous round rubber rings, 8 ins. diameter, ¼ in. thick. These rings can be had to order only, and are obtainable at rubber stores for about 1s. 6d. the pair. These bands are preferable to leather, as no means of tightening is necessary, the stretch which must be given to them in order to bring them over

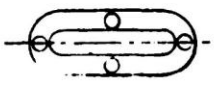

FIG. 6.—¼ Full Size.

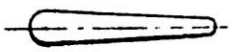

FIG. 11.—⅛ Full Size.

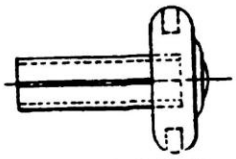

FIG. 13.—⅛ Full Size.

FIG. 14.—⅜ Full Size.

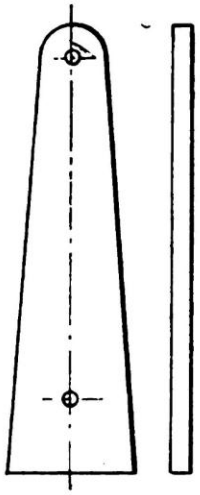

FIG. 7.—STANDARDS. (1/12 Full Size.)

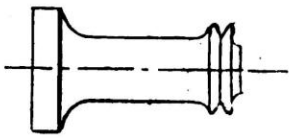

FIG. 10.—PLATE BOSSES. (⅛ Full Size.)

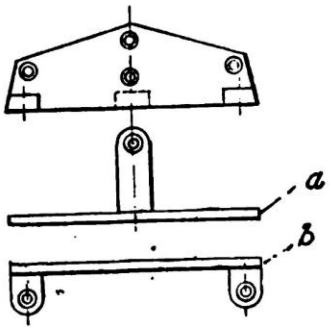

FIG. 8.—BRACKETS FOR STANDARDS. (⅛ Full Size.)

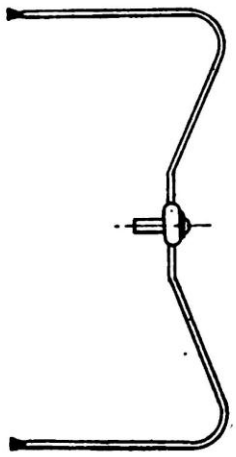

FIG. 12.—NEUTRALISING RODS.

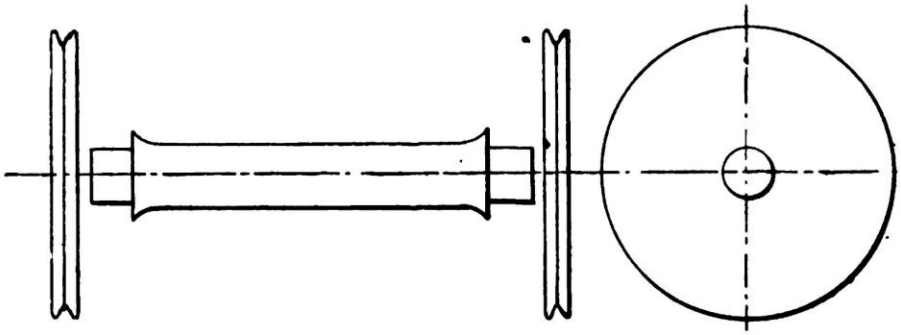

FIG. 9.—SHEATH AND DRIVING WHEELS. (⅛ Full Size.)

the bosses serving to maintain a constant hold on the wheels and bosses during use.

The neutralising rods (Fig. 12) are ¼ in. brass bent to shape and screwed into the holder (Fig. 13). The brushes (Fig. 14) are made from tinsel wire, and are secured in an ⅛-in. hole in the ends of the neutralising rods by means of a little wooden peg. The rod holder (Fig. 13) which has a saw-slit the full length of the barrel, is made from a casting and finished in the lathe. The hole in the barrel is 13-32nds in. in diameter, or 1-32nd in. less than the plate spindle. The saw-slit enables us to press the holder on to the projecting ends of the spindle, upon which it should have a firm grip.

(To be continued.)

How to Build a Model Caledonian Railway Express Locomotive, "Dunalastair No. 3."

(Continued from page 109.)

ON the accompanying Plate No. VIII, Figs. 48 and 49, show the general arrangement of the tender for the "Dunalastair" locomotive. To complete the underframing the springs and hangers must be made, and after the fitting of these, the tender may be tried on the rails. In the original spring there are some fifteen plates, and, as well known to most model engineers, to imitate this construction in miniature exactly to scale would result in having a spring much too strong for the weight of the tender, and one which would require hundredweights to deflect it to any appreciable extent. Fig. 50 shows an arrangement whereby the correct outward appearance of the spring may be preserved in conjunction with the required "liveliness." The "back plate"—the longest plate—of the spring should be annealed at the ends, and be either carefully and slowly bent to form the eyes to receive the pins of the hangers; or, perhaps a better method, have a piece of tube silver-soldered on to it. The ends of the back plate, and also the two plates above, must, before the spring is re-tempered, be forked to allow of the hanger to work freely. The number of plates adopted for the model is seven, cut to the proper length from ¼-in. clock spring, and to preserve the scale size of the spring, these must have packing pieces of brass plate, about ½ in. × ¼ in. × 1-16th in. thick, placed between each plate. The plates should be secured in the buckle

How to Make Experimental Electrical Apparatus.

By T. G. J.

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AN IMPROVED WIMSHURST MACHINE.

THE jars are 14 ins. high, 2½ ins. diameter, and mouth 2 ins. diameter. The tinfoil coating on the outside is 3 ins. deep, and the inside is filled with gunshot to the same height. The outside bottom of the jar should be entirely covered with the foil, and the coating of the sides overlap the bottom edge about ¼ in. All uncovered portions of the jar must be well varnished with good shellac varnish. The cover of the jar is a disc of boxwood ¼ in. thick, with rounded edge. To one side of this disc is glued, with fish glue, a new cork bung, which fits the jar mouth. Bore a ⅜ in. hole in the centre

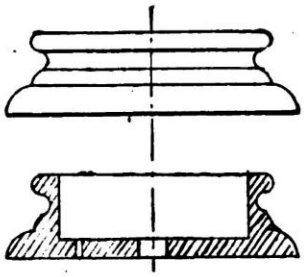

FIG. 15.—BASES FOR LEYDEN JARS. (⅛ Full Size.)

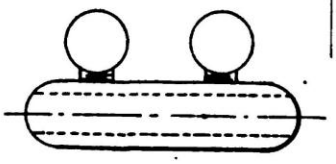

FIG. 18.—DOUBLE CONNECTOR. (⅜ Full Size.)

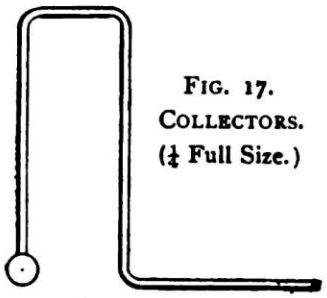

FIG. 17. COLLECTORS. (⅛ Full Size.)

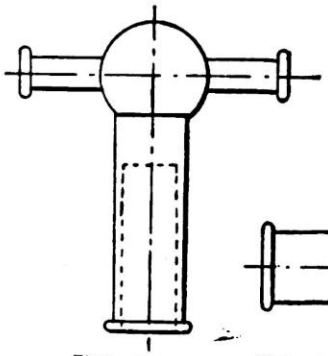

FIG. 20. ⅓ Full Size.

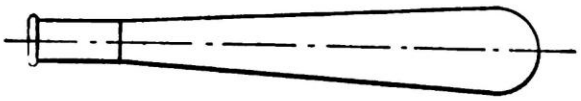

FIG. 21.—DISCHARGING HANDLES. (⅓ Full Size).

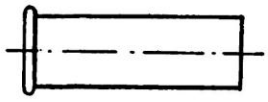

FIG. 23.—SOCKET FOR PRIME CONDUCTOR. (⅛ Full Size.)

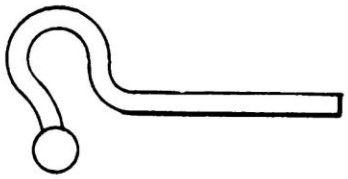

FIG. 25.—BRASS HOOK FOR PRIME CONDUCTOR.

of the wooden disc, and continue this through the bung with a cork borer. Bush the hole with a piece of ⅜ in. ebonite tubing, and allow this to protrude about 1 in. below the bottom of the bung.

To the top of the boxwood discs are screwed the rod

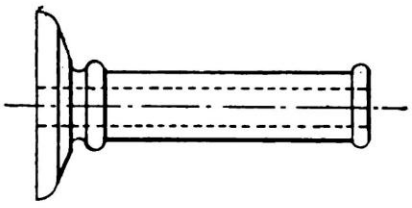

FIG. 16.—LEYDEN JAR ROD HOLDERS. (⅜ Full Size.)

holders (Fig. 16), with small round-head brass screws. This holder, which is made from a casting, must be well finished in the lathe, and have all edges, &c., carefully rounded. In the side will be seen a ball-head adjusting screw. If any difficulty is experienced in procuring these screws, they can be easily made by screwing a short piece of 3-32nds in. hard brass wire into a ¾ in. brass ball, and then running a thread on the piece of wire which projects. A corresponding hole will have to be drilled and tapped in the holder to take the adjusting screw. The jar rods are 12 ins. long, ¼ in. diameter, furnished with a 1½-in. ball on their upper ends, and 4 ins. of brass contact chain on their lower extremity. This chain is a light brass wire chain, made specially for the purpose of

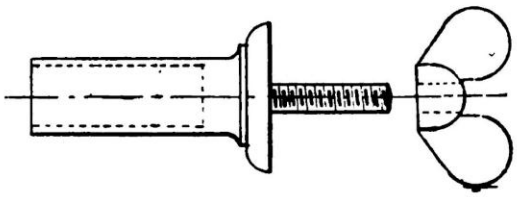

FIG. 19.—⅓ Full Size.

making contact with the interior coating of Leyden jars. The brass ball has a hole drilled through the centre and tapped to receive the collectors and connecting-rods.

The connecting-rods are 3-16ths in. brass, bent to shape shown in Figs. 1 to 4. The extremity of the rods have a thread run on them for a distance of ¾ in., to enable them to be screwed into the balls on the jar rods. The collectors are also 3-16ths in. brass rod, bent thrice at right angles (see Fig. 17). The parallel sides have four points fixed on their opposite faces. These points are 1 in. brass tacks, with their heads removed, and are screwed into the rods about ⅛ in. On the free end of the collector rod is screwed a ⅝ in. brass ball, and on the other end is run a screw thread for a distance of ⅝ in. The collectors are screwed into the opposite side of the jar rod balls to that into which we screwed the connecting-rods.

The jar bases (Fig. 15) are of walnut. The top is sunk ¾ in. to take the jars, and in the centre is bored a ⅜-in. hole to take a piece of ebonite tubing. Half way between the centre hole and the wall of the base is bored a ⅛-in. hole to take a small clamping bolt. This latter hole should be countersunk. A disc, 2½ ins. diameter, should now be cut from 1-32nd in. sheet brass. To the centre of this disc is soldered a piece of No. 20 copper wire, about 6 ins. long, bent on itself to form a narrow U 3 ins. long. It is the ends of the wire which are soldered to the brass disc, and when the solder has set the wire should be twisted to within ¼ in. of the bottom, thus leaving a small loop.

The discharging-rods' insulating supports are ¾ in. ebonite rod or tube 11⅛ ins. long, fitted with the brass fittings shown in Figs. 19 and 20. The bottom fitting (Fig. 19) has a piece projecting from underneath, upon

which is run a screw thread. A butterfly nut must fit this screw for clamping the supports to stand. The upper fitting (Fig. 20) has a hole ¼ in. diameter drilled all the way through the horizontal arm to take the discharging rods, and both upper and lower fittings have ¾ in. holes drilled in their barrels to admit the insulating-rods. These latter holes should be bored 2 ins. deep. In the top centre of the ball head on Fig. 20 is bored and tapped a hole, into which is screwed a 3-16ths in. connecting-rod about 4¼ ins. long, furnished at its upper extremity with the ball-screw double connector (Fig. 18). The discharging-rods are 12 ins. long, ¼ in. diameter.

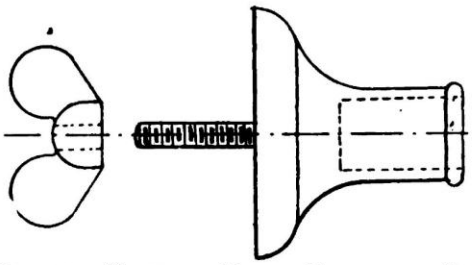

FIG. 22.—BASE FOR PRIME CONDUCTOR SUPPORT.

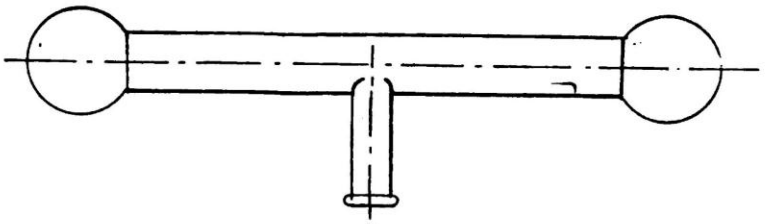

FIG. 24.—PRIME CONDUCTOR.

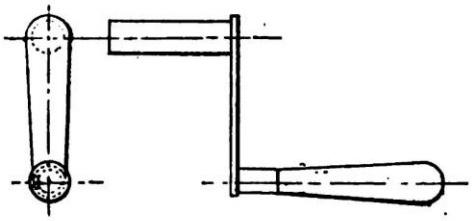

FIG. 26.- DRIVING CRANK. (1-6th Full Size.)

FIG. 27.—SOCKETS FOR COVER SUPPORTS. (⅛ Full Size.)

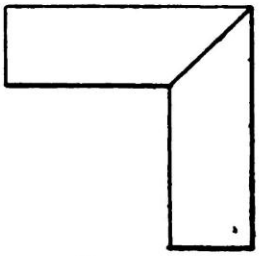

FIG. 29.—BRASS ELBOW. (⅜ Full Size.)

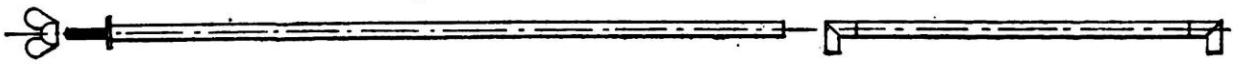

FIG. 28.—CORNER SUPPORTS FOR COVER. (1-12th Full Size.)

To one end is fixed the insulating handle (Fig. 21), and the other is fitted with a brass ball. The right-hand or *negative* rod has a 2-in. ball, and the left-hand or *positive* rod a ½ in. ball. These balls should be fixed to the rods by screwing, but must not be fitted until after the rods have been passed through the holders.

The insulating handles (Fig. 24) are walnut with ring-end ferrules, and must be soaked in melted paraffin wax for about twenty-four hours. They should then be held vertically by their ferrules and lifted quickly out of the liquid. Allow the thin film of wax to set, and, still holding vertically, again immerse in the paraffin and immediately remove. Repeat these operations about four times, permitting the wax to set after each removal from the liquid. A thin layer of wax will thus be formed uniformly over the entire surface of the handles, which will greatly increase their insulating properties, and, if done properly, at the same time improve their appearance.

The prime conductor (Fig. 23) is made from 12 ins. of 1⅜-in. brass tubing, into the ends of which are sweated the two 2⅜-in. brass balls seen in the figure. The plain bed knobs sold by ironmongers will cost much less than solid balls, and as the useless portion goes inside the brass tube, it will in no way interfere with the action of the machine, the electricity developed in statical machines flowing over the surface of the parts only. In the centre of the tube is screwed the socket (Fig. 23). If both the tubes be heated over a blowpipe or Bunsen burner, and a little solder allowed to flow over the screw thread, and the socket then screwed and sweated into the larger tube, greater strength will be obtained than by screwing the two together, very few threads being possible on the thickness of the larger tube. At right angles to the socket, and in the centre of the conductor, is screwed the 3-16ths in. brass grappling hook (Fig. 25). This hook is terminated with a ½-in. brass ball.

The finished conductor should now be mounted on the insulating pillar. This pillar is ebonite, ¾ in. diameter, 15 ins. long, and should be fastened in the socket with electrical cement, as should also the discharging-rod supports mentioned above. The bottom end of the support is fitted into the base (Fig. 22). This base, which is of walnut, has a ¾-in. hole bored in it 1½ ins. deep, to receive the support, and the hole then continued with a ¼-in. bit right through the bottom. Counter-sink this ¼-in. hole on the inside, and pass a ¼-in. bolt through

FIG. 30.—STRENGTHENING PIECES FOR COVER.

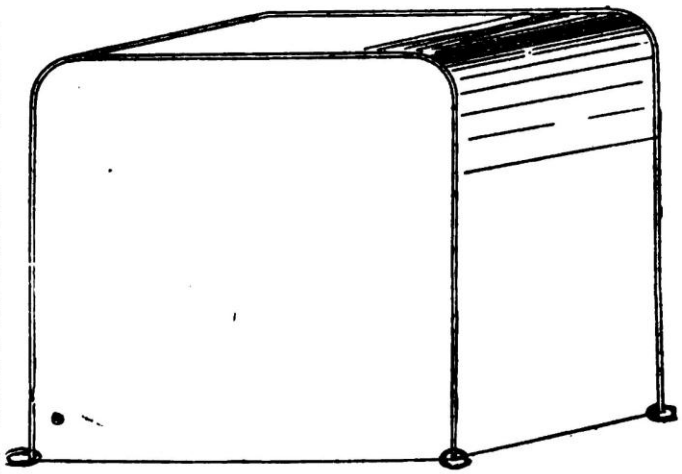

FIG. 31.—COVER FOR WIMSHURST MACHINE.

it. Before fixing the support, pass it through a collar (Fig. 23), keeping the ring end uppermost. Now cement the support into the base, and when the cement has set, allow a small quantity to melt round the support just where it enters the base. Press down the collar, give it a slight twist, and allow cement to set.

The cover of the machine is made from green baize, sewn together at the corners and all round the top. A seam about ⅜-in. wide should be left for binding with a braid same colour as the baize. Fig. 31 will give a good idea of the finished cover. As it is necessary that the cover should sit squarely over the machine, four supports will be necessary at the corners. These supports are shown in Fig. 28, and are ¼-in. walnut-rods, tapered to ⅜ in. at the top. These are fitted with brass sockets (Fig. 27) at their lower ends, to enable them to be clamped to the stand. The sockets are 1½-in. brass discs, 3 32nds in. thick, soldered to ¼-in. diameter brass tube 2 ins. long. In the centre of the disc is bored a ⅛ in. hole, and through this hole is passed a ⅛-in. bolt. The rods are then fastened in the sockets, and a small thumb nut provided to fit the ⅛ in. bolt.

If desired, the reader could also have the cross pieces shown in Fig. 30. These are walnut rods, fitted at their ends with brass elbows (Fig. 29), and can be pressed down upon the tops of the cover supports, and thus provide additional support for the cover at the ends.

The crank (Fig. 26) is made from a casting and screwed into the end of the driving spindle, which should have a thread run on both its projecting ends, so that the handle may be fixed on either end.

(To be concluded.)

The Society of Model Engineers.

THE following are the dates of the ensuing meetings, which have so far been arranged by the Committee:

Nov. 13.—Annual General Meeting for Election of Officers, Revision of Rules, etc.
Nov. 30.—Annual Conversazione.
Dec. 12.—Ordinary Meeting.

London.

The first indoor meeting of the Society was held at the Memorial Hall, on Monday, September 16th. The principal item of the evening was a paper by Mr. Percival Marshall, on the "Engineering Models at the Glasgow Exhibition," the second instalment of which appears in this issue.

The paper was illustrated by some fifty lantern slides, both of general and special interest to model engineers. A hearty vote of thanks was expressed by the members on the motion of Mr. Löwy, seconded by Mr. Dearden, Mr. Herbert Sanderson also speaking very favourably of Mr. Marshall's account of the Exhibition, and recounting his own adventures in Glasgow in an interesting manner. The services of the lanternist, Mr. Norman Gray, were acknowledged by the members.

Amongst the exhibits may be mentioned a model steam launch by Mr. Willis, a "Spicer" model engine by Mr. Wratten, and part of the castings and the working drawings of a model L.T. & S.R. latest type of ten-wheeled tank by Messrs. Martin & Co.

Provincial Branches.

Birmingham.—On September 12th the members of the Branch met at the White Horse Hotel, Congreve Street, at 7.30 p.m. Fourteen members and four visitors were present. In the absence of both chairman and vice-chairman Mr. A. B. Loach was persuaded to take the chair. The minutes of last meeting were read, and a slight account of the visits made during the summer was given. It was proposed that we open a subscription list to enable us to purchase our own lantern. This proposal was accepted, and a list opened, and well supported by members present. Will absent members please note? A discussion was started on the gauge of rails suitable for our branch, but was not settled. A number of catalogues have been obtained for the members. A vote of thanks to the Chairman closed the meeting at 9.30.—HERBERT G. FABB, Hon. Sec., 217, Aston Lane, Perry Barr, Birmingham.

Leeds.—A meeting o. this branch was held in St. Andrew's Church Schools, on Tuesday evening, Septem ber 17th, when there was a fair attendance of members. After the minutes of the previous meeting had been read, Mr. Wood produced a very neatly-made ¼ h. p. water motor, and Mr. F. Spells submitted a set of full-sized drawings—which were a credit to him—of a 1½ h.-p. petrol motor for a bicycle. Afterwards Mr. Broughton exhibited a steam engine indicator, and explained the working and how to use it, and submitted a number of diagrams from land and marine engines taken by himself, the meeting terminating at 10 p.m. —W. H. BROUGHTON, Hon. Secretary, 262, Carlton Terrace, York Road, Leeds.

Manchester.—The monthly meeting of this branch was held at the Marsden Café, on Monday, September 2nd, twelve members and one visitor being present, and Mr. Hays in the chair. There was little business to be done, and the following exhibits were the chief items of interest:—Mr. S. L. Thompstone exhibited a finished driving axle for a ¾-in. L. & S.W. express engine, with driving wheels and eccentrics in position. Also a complete set of castings and drawings for a ½-in. L. & Y. express engine No. 1,400, were exhibited by Messrs. Wm. Leather & Co., of Salford. The meeting closed at 9.15 p m., with votes of thanks to the chairman and to Messrs. Leather & Co. Next meeting, Monday, October 7th.—N. C. HIGGIN, Hon. Secretary, Monton Lodge, Monton, Manchester.

Rontgen Ray Work.

THE use of the Röntgen rays on the body sometimes gives rise to mortification of the skin, according to an article in the *Comptes Rendus*. When the tubes are driven by influence machines it does not happen, but when the activity is reduced, the presence of moisture and the necessity of an earth connection, may prove to be inconvenient. The difficulty, however, would appear to have been successfully met by one R. Demerliac, who has found that tubes worked by alternate currents of high frequency and high tension, never produce erythema, and that, on the contrary, the rays so obtained possess the curative properties recognised in electro-therapeutics since the experiments of d'Arsonval, Oudin, Dourner, and others. He therefore employs the Oudin resonator, which, with certain precautions, may be made to work *x*-Ray tubes. They light upon connecting them with the upper knob of the apparatus. A broad, concave cathode and a small anode or an annular anode are used. The cathode is joined to the resonator, and the anode may be left free or put to earth. The discharge is most effective when it proceeds in one direction only. A cathode valve should, indeed, be useful. The tubes may be brought quite close to the skin without risk, and thus any loss of penetrative power is effectually counteracted.

As the levers are formed of double strip, and are ⅛ in. apart, thickening washers must be provided at the ends of the brake rods engaging the levers, except where unnecessary on the front bogie. It will be noticed that as the rod connecting the lever to the crank brake on the shaft crosses the forward brake rod, the thickening washers can be arranged on alternate sides, when it will not be necessary to make any sets in these rods. Tightly-fitting collars may be fitted to the transverse rods to each side of brake rods to prevent their lateral movement. The brake rigging of the trailing bogie is the same as that shown for the leading wheels, and line diagram given in Fig. 48 (Plate VIII, September 1st) will make clear the one point of difference —the absence of the rod to the crank on brake-shaft. The brake rigging is not an exact replica to scale of that used on the real engine, but is necessarily modified because of the reduction in size, and although the modification prevents it being possible always to get exactly the same pressure of all the blocks upon the wheel, as the brake cannot be worked whilst the engine is running, this will be no serious fault; the blocks being of wood, the one worked to the hardest extent will wear the most, and the pressures will be more or less equalised.

Fig. 52 (Plate IX) gives an external elevation of the tender; the colours were given in detail in the July article. The drawing indicates the lining out and lettering of the tender, and shows the position of the handrails, steps, &c.

This drawing completes the whole of the series, and as the description of every item in the construction of the model would result in needlessly protracting the articles, it will, perhaps, be necessary to answer questions and give opinions of any proposed improvements in the adaption of this fine locomotive for a working model. There have been many ways open in making the inevitable alterations from real, but those which from actual model experience have seemed the best have been made. Nevertheless, readers may want their model to be made in some other way to suit their especial requirements, and unforeseen difficulties may arise, in both of which cases help and advice will be accorded to querists. Many readers may feel that their skill is not sufficiently great to warrant their attempting so complete a model, or the time at their disposal may be limited, and therefore it would be essential, if the engine is to be built, to know exactly where it may be simplified without detracting from the efficiency and appearance of the model to any serious extent.

The drawings given have been, in most cases, prepared so that to those used to mechanical drawings, so full a description would not have been required. Also, many of the details of construction given will be found very useful to readers not actually engaged in making a model of the "Dunalastair," as many of them are possible of application to other types of model locomotives of the same scales. If it is desired to make a model more correctly to scale, without regard to its efficiency as a working model, full working drawings can be found in *Engineering* of May 18th, 1900.

The North-Eastern Railway Company is constructing ten new engines, which will surpass in size and weight any other British locomotive ever built. This departure is to enable the company to dispense with the services of assistant-engines in the hauling of heavy trains on steep gradients. The locomotives are to be made with driving wheels 6 ft. 8 ins. in diameter. Exclusive of tender, they will weigh, when in working order, 67 tons 2 cwt., or 9 tons more than the engines designed by Mr. J. F. Aspinall, of the Lancashire and Yorkshire Railway Company.

How to Make Experimental Electrical Apparatus.

By T. G. J.

(*Concluded from page 175.*)

An Improved Wimshurst Machine.

THE actual making of the parts is now completed, but some advice on the finishing will be necessary. The bosses, jar bosses, jar bungs, and prime conductor base should all be soaked in molten paraffin wax for several hours previous to French polishing. Every brass part which takes an active part in the working of the machine should be deprived of all sharp edges, a nice round being given to every angle. A good point to bear in mind is to have neither roughness, scratches, sharp edges, or points on any working metal part but the collector points, and to have everyone of these latter covering some portion of the sector when brought opposite to it, taking care to have no points outside either end of the sectors. The brass must be brought up to the finest possible degree of finish, and then well polished. The polished surface is then treated in the following manner previous to lacquering. Make a pickle of from 5 to 10 parts of sulphuric acid to 100 parts of water. Into this bath the articles are placed till all grease, discolouration, oxidation, etc., is removed. They should now be strung on wires and dipped into a bath of nitric acid.

Care must be exercised in the selection of the nitric acid, as there are several qualities in the market. An acid of a pale straw yellow is preferable, and if a little sawdust is added it will help the acid. Before dipping the articles to be lacquered, the acid must be diluted with water. If one immersion does not make the brass bright enough, it will have to be thoroughly washed in clean running water, and again dipped in the acid bath. When they have been dipped, the parts are dried in hot sawdust. Iron must not be used for any purpose in any of the foregoing operations, as it discolours the brass.

The lacquering of the articles requires a little experience to do it properly. For this purpose an iron pan of any convenient size should be procured and supported on an iron support. Beneath the pan is placed a Bunsen burner. On the pan are placed the articles to be lacquered, and they are allowed to remain until they are at the heat of boiling-point. The lacquer is then spread over them with a flat camel-hair brush. This should be done lightly and evenly, so that the work may appear regular when finished. The heat of the articles drives off all moisture and evaporates the spirit contained in the lacquer. If the work is too hot, it will oxidise; if too cold it will appear streaky, and the lacquer will not set properly. The lacquer known as pale gold will give the best appearance to brass for scientific instruments. Green also gives a good finish, and is often used by instrument makers. There are a few of the brass fittings which may with advantage be bronzed (Figs. 16, 18, 20, 24). The discharging rods and balls and crank will all be improved by bronzing. Having dipped the articles into the nitric acid bath and well swilled them in water, they should be placed in the following mixture until they have assumed the desired tint. Take one part nitrate of tin, and add two parts chloride of gold dissolved in a little water and acid. After removing from the bath, wipe the articles with a clean linen rag. It should be observed that the articles should be polished with rottenstone previous to being immersed in the bronzing bath. Some experi-

ence will be necessary in order to lacquer or bronze satisfactorily, and I would advise the reader to test his skill on a few pieces of brass before taking in hand the more important articles belonging to the machine.

Every wooden part of the apparatus should be well French-polished with the exception of the boxwood discs on the jar covers, which should be coated with shellac varnish. Every part of the machine should be entirely finished before fitting to another part, and great care will require to be taken to prevent electrical cement flowing over any part of the brass work when fixing in the insulating pillars, &c., as this would require the brass to be scraped in order to remove it.

Having completed the parts, we shall proceed to fit them together. Let us begin by screwing the standards to their sockets. The plate having the two lugs is screwed to that side of the standard which will be away from the driving wheels, and the plate with the single central lug, to the side nearest to the driving wheels. The driving bands are now thrown loosely over the driving wheels, and the ends of the driving spindle passed through their holes in the standards. The standards are then bolted to the stand with brass bolts passing through the socket lugs, and screwed up with thumb-screws from underneath the stand. Take up the plate-spindle, and holding it in the top hole in one of the standards, pull up a driving band and place it over the spindle end. Next pass the spindle through the boss and plate, and, holding the other plate close up to the first, push the spindle along until it comes through at the other end of the boss. The second driving band is now pulled up, given a single twist, and lifted over the end of the boss. The spindle can now be passed through the hole in standard No. 2, and if two flats have been filed on those parts which lie inside the holes in standards, a round-head brass screw inserted from the top and screwed down upon the flats will keep the spindle from turning when the machine is in motion. The jar bases should now be clamped to the base by small bolts passing through the smallest holes in the base and stand. The larger central holes in the bases must correspond to the larger holes in the stand. Through these holes, which should be bushed with a piece of ebonite tubing, long enough to extend about 1 in. through hole in stand, passes the twisted wire soldered to the brass disc. A disc of ebonite, 1-32nd in. thick, inserted between the brass disc and the base, improves the insulation of the former. The two twisted wires should be connected by a guttapercha and double silk-covered copper wire. The ends of the wire should be bared of their covering for about 1½ ins., then passed through the small loop at the end of the twisted wires protruding through the top of the stand, then bent back on themselves and well twisted. Lap the bare portions of both wires with a piece of silk tape immersed in paraffin-wax.

The jars can now be fitted to their bases, but before doing so the collectors and connecting-rods should be screwed into the brass ball on the jar rods. The discharging-rod supports should now be fixed in position, and clamped with the thumb-screws. The rods themselves can then be passed through the holders, and the balls afterwards screwed to the ends. The free ends of the connecting-rods, which we screwed into the jar balls, should now be inserted in the upper end of the double connectors, on the top of each of the support connecting-rods. These rods are clamped in the connectors by means of the ball screws; the neutralising rods being screwed into their holders, are fitted to the projecting ends of the plate spindle. Let us imagine the plates to be the face of a clock, and let us stand facing the front, or that side of the plates nearest to the jars. The rods on this side of the face of our imaginary clock will point to XI and V, and that on the other side to I and VII.

In giving these directions, it has been assumed that the handle of the machine will be screwed to the end of the driving spindle at the front of the machine, and that the person using the handle is a right-handed person, and will turn the handle to the right in the direction of the hands of a clock. If, however, we desire to screw the handle to the back end of the driving spindle, the position of the neutralising rods will require to be reversed. Turning the handle to the left will also necessitate the reversal of the brushes, unless it is screwed into the back of the machine, in which case the position of the brushes will remain the same as that given above.

When the machine is in good working order the left-hand side of plates, collectors, and dischargers will be positively electrified, and those on the right-hand negatively electrified. If we reverse the direction of motion, and consequently the position of the brushes, the electrical condition of the machine will also be changed, positive electricity appearing at the right and negative at the left. Sometimes the machine reverses its condition in damp weather, and will not work properly. In order to set it aright, open the dischargers, turn the handle in the wrong direction; after a few seconds stop the machine and close the dischargers, and then turn the handle in the right direction. A Leyden jar is charged at the right hand side, when the handle is being turned to the left; and held against the collectors on the left, when the handle is turned to the right. This at once sets the machine in the proper condition; if not, the operation must be repeated.

By observing the collector points in the dark, we can always tell whether or not the machine is working properly, provided the plates be kept moving. If the positive collector points exhibit small points of light, and the negative points small brushes of light, we know all is well. If not, we must reverse in the way described above. The discharge rod on the positive side is fitted with the small ball, and that on the negative with the large one. When out of use the machine must not, under any circumstances, be left exposed. The cover should be placed over it immediately we finish using the machine, and rings finished in the corners of the cover will serve to keep it close down upon the stand if a small brass sneck be screwed to the underside of each of the four corners. These snecks, or catches, should be screwed in such a position that they do not appear in sight, except when pulled out to catch the cover rings.

A piece of good flannel, which is warmed before use, should be kept for wiping the insulating supports and brass working parts each time the machine is to be used. A piece of silk should also be provided for wiping the plates before use. A little feather duster will be found convenient for dusting down the apparatus; but if this is used, one should be kept for that purpose alone. These few precautions, taken each time we are about to use our machine, will more than repay the trouble.

A convenient form of bag for carrying the apparatus is one with a fall front, and inside shelves. Small wooden divisions and stops can be employed to keep the various parts in their own position on the shelves. The plates should be placed on separate shelves and be well packed. The prime conductor need only be fixed on the stand when actually required. It should be slid along the slot until the hook has a slight pull on the collector-rod, when the thumb-screw must be tightened up. It is on this prime conductor that all the interesting mechanical experiments described in the various text-books of electricity are performed. Fig. 6 (shown on page 151 in the October 1st issue) is a sheet-brass shield screwed over the slot cut in the top of stand to admit prime conductor. It should be sunk into the wood, so as to be flush with the surface. It is shown fixed in position to left of Fig. 5.