The Wireless Constructor's Encyclopædia

A Complete Guide, in alphabetical order, to the Construction, Operation, Repair, and Overhaul of all types of Wireless Receivers and Components. Containing a special section on Television

WITH 490 ILLUSTRATIONS

BY

F. J. CAMM

Editor of
"Practical Wireless"

LONDON
GEORGE NEWNES, LIMITED
SOUTHAMPTON STREET, STRAND, W.C.2

arrows (right and left portions of the diagram).

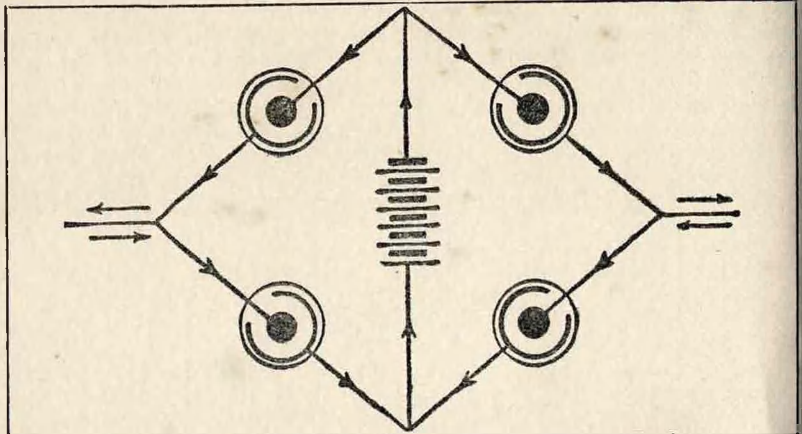


Fig. 13.—Usual method of obtaining full-wave rectification with chemical Rectifier.

It is not absolutely necessary to use ammonium phosphate as the electrolyte, which needs to be neutralised occasionally by the addition of a weak ammonia solution. Magnesium in ammonium fluoride solution and ammonium carbonate are sometimes used; but ammonium phosphate gives best all-round results. Similarly, carbon or steel is sometimes used in place of lead.

The Mercury-arc Rectifier. Another cheap and fairly efficient method of charging accumulators is the mercury arc, which automatically converts A.C. into D.C. It consists of an electric lamp containing mercury vapour, which, when the A.C. current is passed through it, becomes incandescent. The two anodes (Fig. 14) are connected to the A.C. supply, and the cathode (sometimes spelt kathode) to the direct-current part of the circuit. A starting electrode is included to form an arc by means of which the rectifier is started. With this type of mercury-arc rectifier (there are many other types) an induction coil is necessary, and it must be connected across the A.C. source of supply. The connection

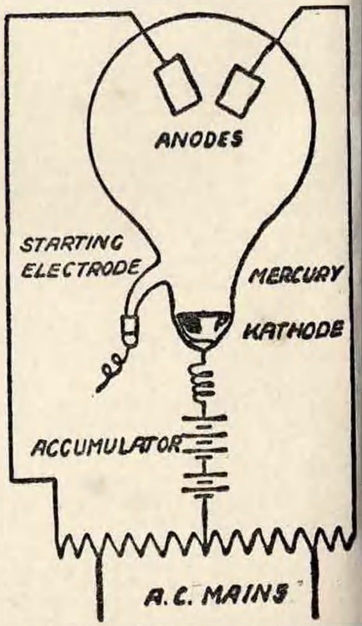


Fig. 14.—Circuit of mercury-vapour Rectifier.

from this inductance to the battery is the negative side of the D.C. portion of the circuit, and the connection from the cathode of the mercury-vapour rectifier is the positive side.

Such a rectifier will give a 30-ampere direct current at between 80 and 100 volts. Other rectifiers of this type can, of course, be obtained with larger and smaller outputs. They are simple to operate, but their life is comparatively short [illegible].

The Tungar A.C. Rectifier. The Tungar rectifier is a convenient rectifying unit supplied for alternating current charging, and its components consist of a transformer, a rectifying bulb, and a reactance. These parts are suitably cased to form a compact unit, and it can be recommended as a thoroughly reliable outfit.

The bulb resembles a wireless valve, and its purpose is to permit current to flow only in one direction. The filament is of tungsten, and the anode is of graphite. When a current passes through the filament, therefore, there is a flow of electrons between it (the cathode) and the anode, in exactly the same way as in a wireless valve. The valve action is obtained by means of the heated filaments and the inert gas, known as argon, with which the bulb is filled. This valve action also precludes the possibility of the battery discharging back. This Tungar rectifier makes use of only half of the A.C. wave, although full-wave rectifiers of the same make are available. They all operate on voltages of from 250 volts down to 100 volts, with outputs varying from ·25 ampere up to 60 amperes. Fig. 15 shows a circuit diagram of a typical Tungar rectifier.

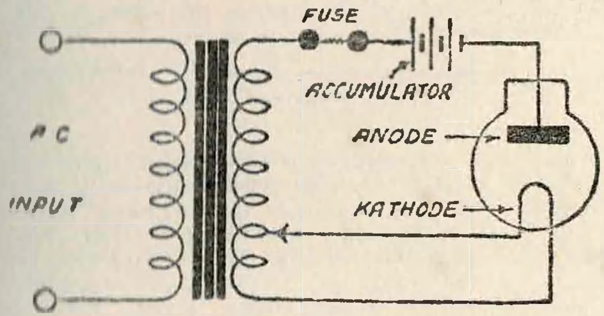


Fig. 15.—Circuit of Tungar type of Rectifier.

Metal Rectifiers. This type of rectifier, although not so efficient as those already described, is none the less quite reliable, and has the advantage of being trouble free. Its principle is, briefly, this: a piece of copper (pure) when in contact with a certain oxide allows current to flow more easily in one direction than another. Lead, being soft, permits of a great degree of contact, and is therefore used as one of the elements. A number of these elements are mounted concentrically on a non-conducting tube, the elements consisting of a lead disc, a copper washer, and some form of cooling disc. These units in any number may be suitably connected in series or parallel according to input and output requirements. A circuit diagram of a typical commercial metal rectifier is given in Fig. 16.

All the parts, enabling the amateur to construct his own metal rectifiers, are available quite cheaply from most electrical stores. Whilst such a system of rectification is chiefly of value in districts remote from towns, and has the great advantage

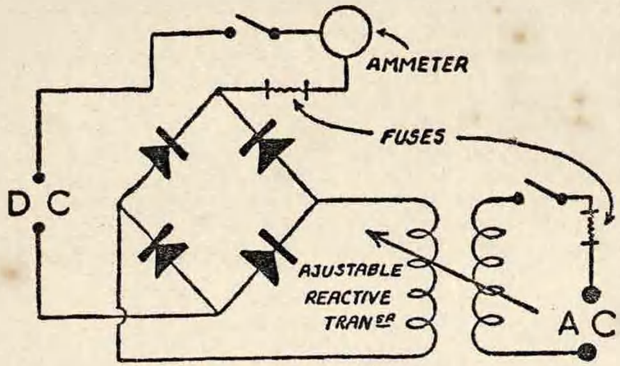


Fig. 16.—Circuit of metal Rectifier.

of simplicity, it is naturally a slow method of charging. Complete metal rectifiers, which are sometimes referred to as copper-copper-oxide or all-metal rectifiers, are made by the B.T.H. Co. and others.

Transforming Alternating Current. Unlike direct current, alternating-current voltage can be transformed to higher or lower potentials without the use of rotary converters. This means that a simple piece of apparatus can be used in place of the resistance, the advantage being that the excess voltage need not be dissipated and, therefore, wasted. Transformers can be purchased quite cheaply, and they are obtainable for all voltages of supply and with any output voltage.

The Charging Rate. The charging current should be limited to the correct rate in amperes, as specified on the makers' instruction label. Those accumulators, having approximately the same charging rate, should be grouped together in series and connected to the pair of charging leads which will supply the requisite current. If the exact charging rate for one particular accumulator cannot be obtained, remember that it is always advisable to charge below rather than above the given rate. For example, an accumulator to be charged at 2 amperes should be placed on the 1-ampere circuit rather than on the 5-ampere circuit.

Filler plugs may be left in during charge, but it is as well to make sure that the vent hole in the plug is not stopped up, otherwise the gases generated in the cell will not be able to escape. These gases, by the way, are highly inflammable, and the charging-room should be well ventilated in order to facilitate their dispersal. Never bring a flame or spark—such as a match or lighted cigarette—near the accumulators during or shortly after charge.

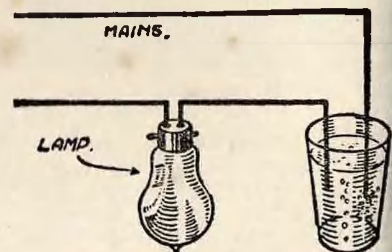


Fig. 17.—Dissolve a teaspoonful of salt in a glass of water and dip the ends of the charging wires in the solution. Bubbles of gas will form on the negative wire. (See also Figs. 26 and 27.)

Avoid high temperatures when charging, as these tend to increase the chemical activity of the plates and the electrolyte, and help to shorten the life of an accumulator. The temperature should never exceed 110° Fahrenheit (100° F. for cells in celluloid containers).

Cleanliness is another very important factor in accumulator management. Dirt and dampness on an accumulator permit the current to leak away, in addition to attracting and holding small quantities of acid. This is liable to cause corrosion and [illegible] of wooden crates, etc.

It is also advisable to use rubber in place of leather for carrying handles of accumulator crates.

Neutralising Spilled Electrolyte. If electrolyte is spilled, it should be immediately treated with a neutralising solution, such as sodium carbonate (soda) and water, or ammonia and water. Either of these liquids is excellent for checking the effects of acid on clothing. Benches, trays, and other fittings which have become acid-soaked should be treated with a solution of ½ lb. of soda to 1 gallon of water, and then allowed to dry thoroughly before coating with acid-proof paint.

Polarity of the Mains: First Method. Connect the positive pole of a direct-current voltmeter to the (supposed) positive main, and allow a wire from the negative terminal of the meter to momentarily touch the (supposed) negative main. If correctly connected, the hand of the meter will swing in the proper direction. If reversed, the hand will tend to swing backwards. Make sure that the connection is broken immediately, for a reversed connection might bend the hand of the meter.

Second Method. Dip the ends of the two wires into a glass containing a weak solution of salt and water. Bubbles of colourless gas will be formed on the negative wire. Be sure that the wires are not allowed to touch, and it is advisable to connect a lamp of "mains" voltage in series with the wire to avoid the danger of short circuits (see Fig. 17).

Fig. 18.—[illegible] cell ready [illegible]

Fig. 19.—State of cell when charged.

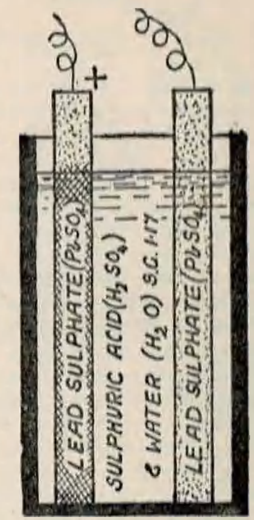


Fig. 20.—State of cell when discharged. Note the acid becomes weaker, having been used up in forming lead sulphate.

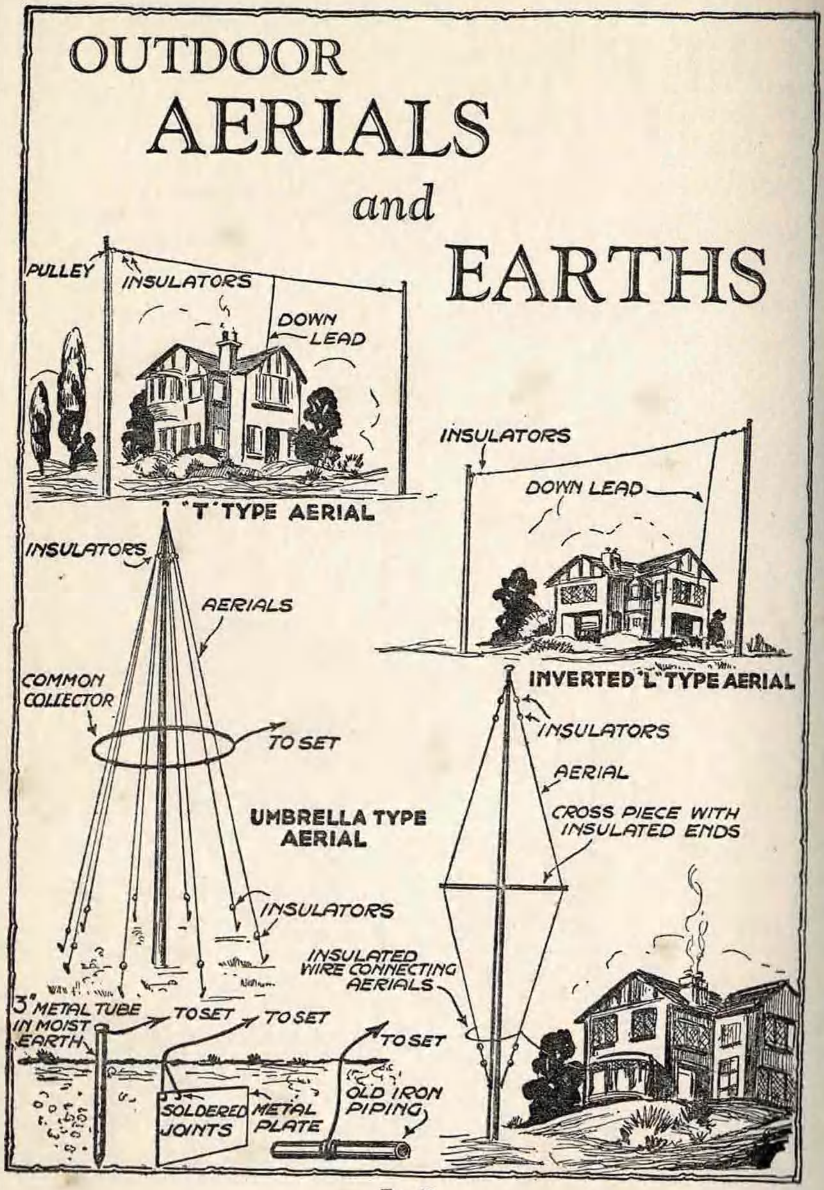

OUTDOOR
AERIALS
and
EARTHS
PULLEY
INSULATORS
DOWN LEAD
"T" TYPE AERIAL
INSULATORS
AERIALS
COMMON COLLECTOR
TO SET
UMBRELLA TYPE AERIAL
INSULATORS
INSULATORS
DOWN LEAD
INVERTED "L" TYPE AERIAL
INSULATORS
AERIAL
CROSS PIECE WITH INSULATED ENDS
INSULATED WIRE CONNECTING AERIALS
3" METAL TUBE IN MOIST EARTH
TO SET
TO SET
TO SET
SOLDERED JOINTS
METAL PLATE
OLD IRON PIPING

Fig. 37.

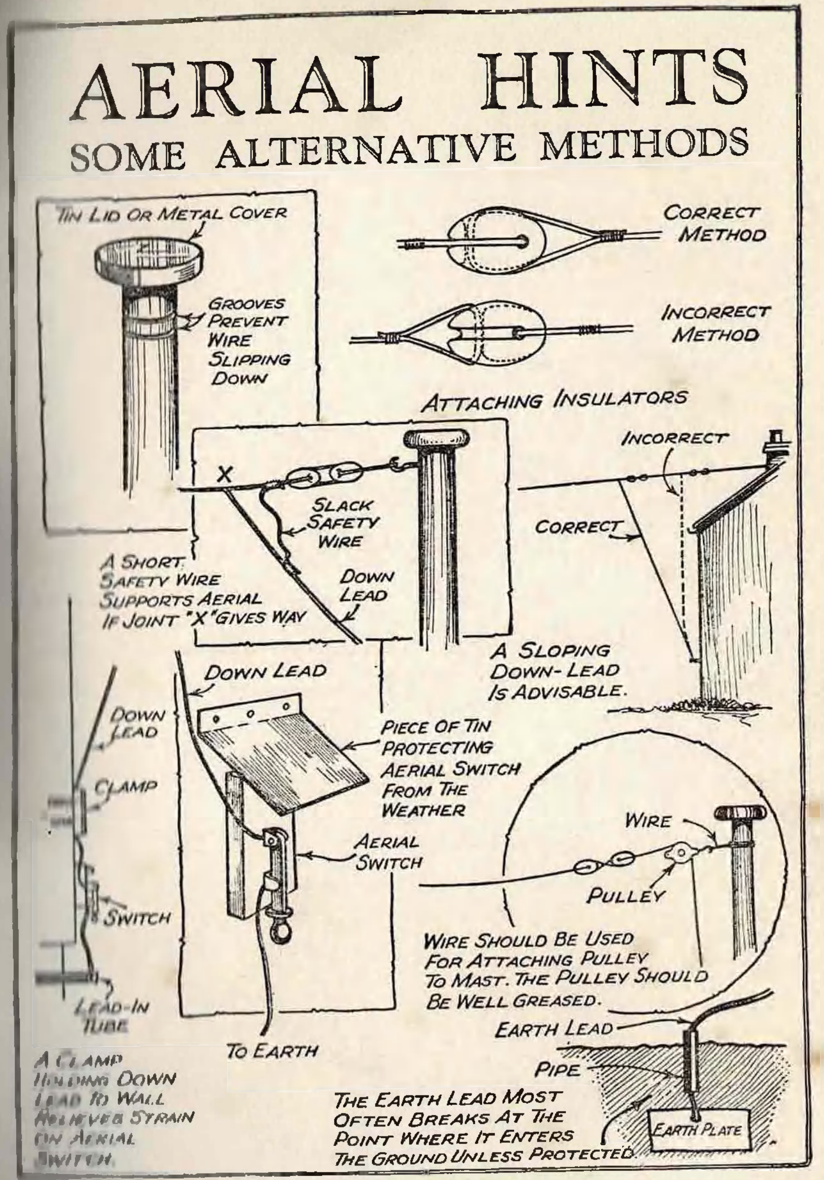

AERIAL HINTS
SOME ALTERNATIVE METHODS
TIN LID OR METAL COVER
GROOVES PREVENT WIRE SLIPPING DOWN
CORRECT METHOD
INCORRECT METHOD
ATTACHING INSULATORS
X
SLACK SAFETY WIRE
A SHORT SAFETY WIRE SUPPORTS AERIAL IF JOINT "X" GIVES WAY
DOWN LEAD
INCORRECT
CORRECT
A SLOPING DOWN-LEAD IS ADVISABLE.
DOWN LEAD
DOWN LEAD
CLAMP
SWITCH
LEAD-IN TUBE
PIECE OF TIN PROTECTING AERIAL SWITCH FROM THE WEATHER
AERIAL SWITCH
TO EARTH
WIRE
PULLEY
WIRE SHOULD BE USED FOR ATTACHING PULLEY TO MAST. THE PULLEY SHOULD BE WELL GREASED.
EARTH LEAD
PIPE
EARTH PLATE
A CLAMP HOLDING DOWN LEAD TO WALL RELIEVES STRAIN ON AERIAL SWITCH
THE EARTH LEAD MOST OFTEN BREAKS AT THE POINT WHERE IT ENTERS THE GROUND UNLESS PROTECTED.

Fig. 38.

that actually this is a very large tuning coil.

Directional Property. The principal feature of this type of aerial is

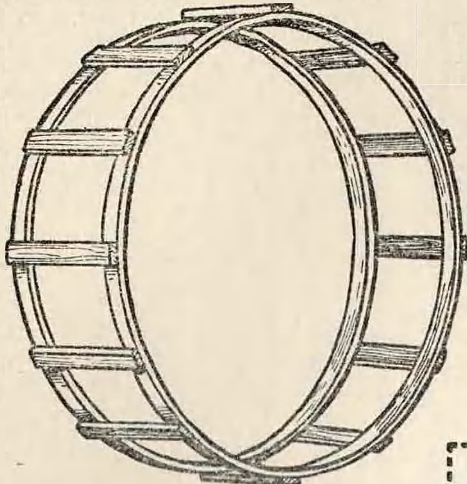


Fig. 195.—A Circular Aerial.

its directional property, and it is this which makes it so valuable. In use, the frame acts as two vertical aerials, the top and bottom being ignored for the sake of this non-technical explanation. If, now, you imagine a signal from a station passing through the air, and the frame aerial being turned in the plane of the oncoming waves, it is obvious that the waves will strike one side of the aerial before they arrive at the other side. Forces are therefore generated which are "out of phase," and a current flows. If, however, the waves hit the aerial broadside on, both vertical aerials receive the impulses at the same moment, and, therefore, no signal current will flow. It therefore follows from this that maximum signals are heard when the frame is in the plane of the received signals, and the signal strength will diminish as the aerial is rotated until, when the frame is at right angles, no signals will be heard. This valuable property has made possible the direction finder employed on ships at sea, and by the post office officials for tracking out unlicensed transmitting stations and those listeners who spoil the reception of the programmes by oscillating. Listeners who live near a high-powered station will often be able to carry out satisfactory reception of distant stations by means of the frame, provided, of course, that the desired station is situated in a direction at right angles, or nearly so, to the nearby station.

The Frame. In Fig. 193 will be seen the simplest of frames. Here, four pieces of ½-in. wood, 4 in. wide by 2 ft. long, are nailed or screwed together at the ends to form

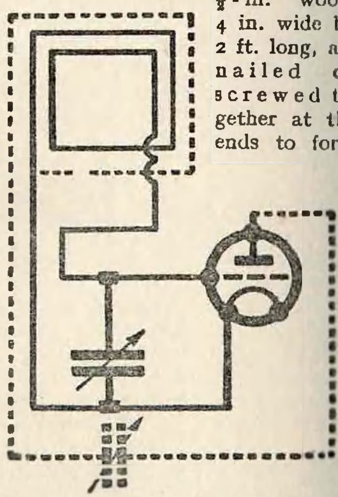


Fig. 196.—The Connections for a Frame Aerial; the dotted lines show the additional connections for capacity-controlled reaction.

a square. At one side something must be attached to enable the frame to be rotated to make use of the property above-mentioned. This may be a

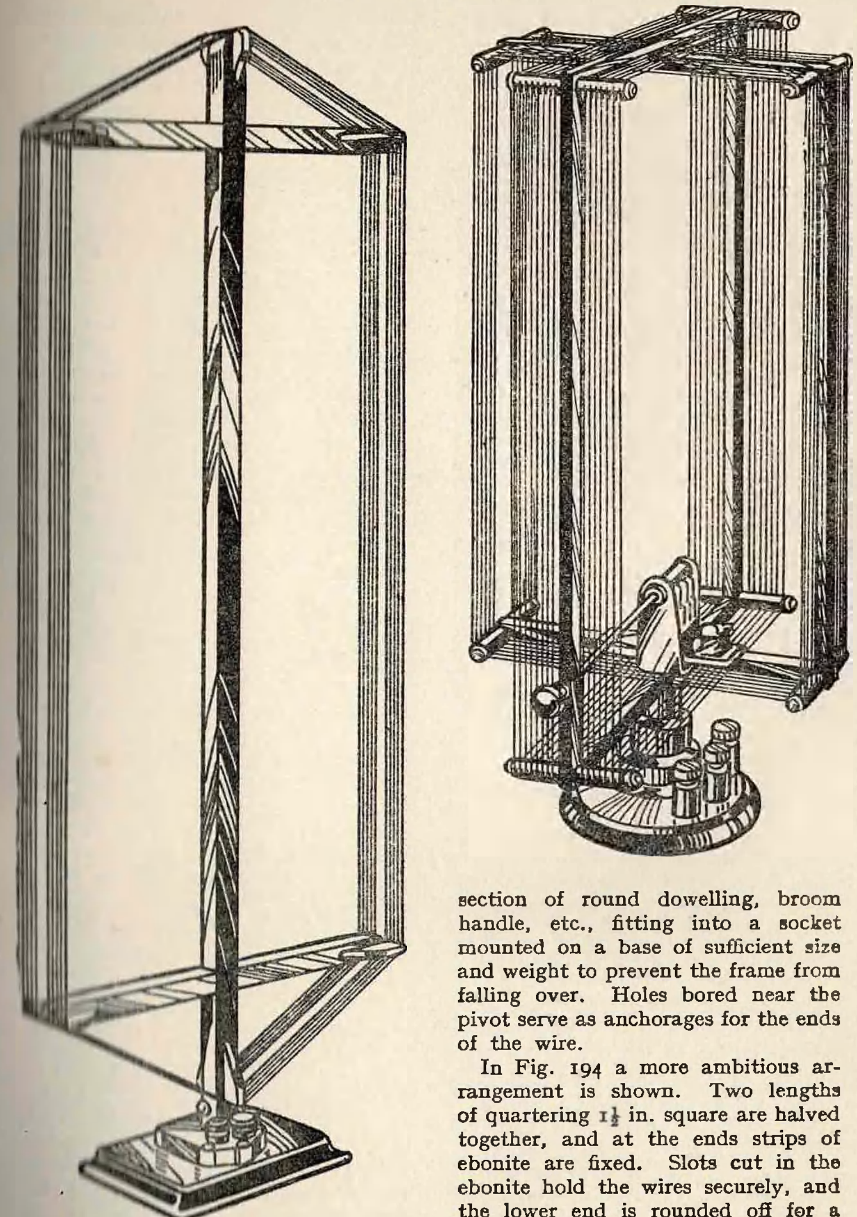
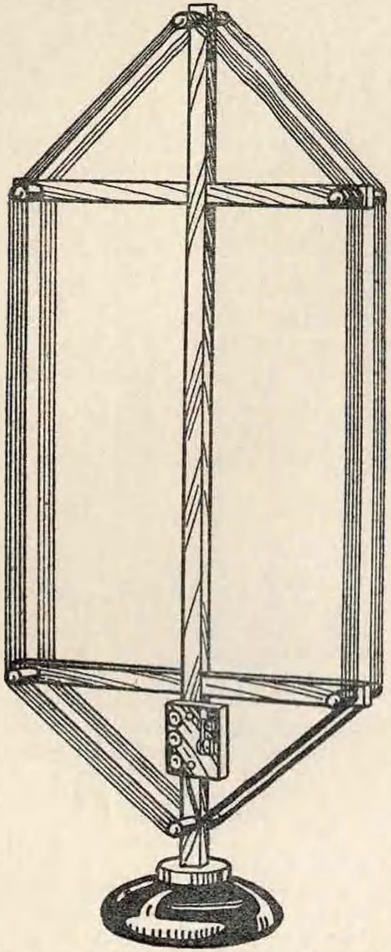


Fig. 197.—Two types of Commercial Frame Aerial.

section of round dowelling, broom handle, etc., fitting into a socket mounted on a base of sufficient size and weight to prevent the frame from falling over. Holes bored near the pivot serve as anchorages for the ends of the wire.

In Fig. 194 a more ambitious arrangement is shown. Two lengths of quartering 1½ in. square are halved together, and at the ends strips of ebonite are fixed. Slots cut in the ebonite hold the wires securely, and the lower end is rounded off for a bearing. Fig. 195 shows an arrangement which may be made to look very effective if varnished. Two ordinary hoops of the kind used by children, and about 24 in. in diameter, are held about 4 in. apart by strips of ebonite fixed round the periphery. Shallow grooves or saw-



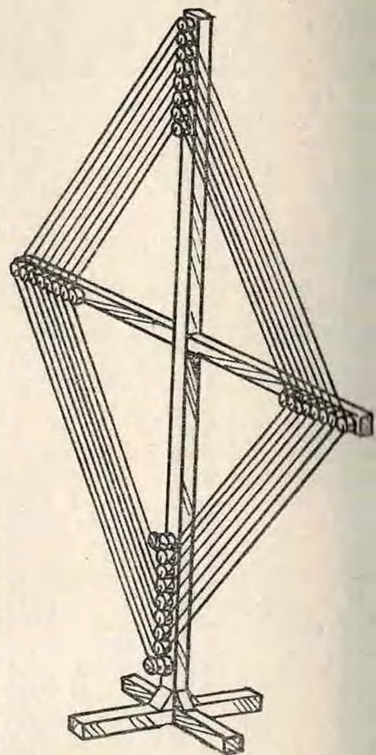


FIG. 198.—Two further types of Frame Aerial.

FRAME AERIAL DATA

Length of Side of Square Frame.	*No. of Turns.*	*Space between Wires.*	*Inductance. (Micro-henries.)*	*Self-capacity. (Micro-farads.)*	*Natural Wave-length in Metres.*
8 ft.	3	$\frac{1}{2}$ in.	96	75	160
6 ,,	4	$\frac{1}{4}$,,	124	66	170
4 ,,	6	$\frac{1}{4}$,,	154	55	175
3 ,,	8	$\frac{1}{8}$,,	193	49	185

cuts should be made in these ebonite spacers to hold the wire. Again, some form of rotatable bearing must be fitted.

The Wire for the Aerial. The wire for these aerials consists of thin flex, usually 14/36, that is, fourteen strands of No. 36 gauge wire, covered with art. silk in various colours, and costs about 2*s*. 6*d*. a 100-ft. coil. For the normal broadcast band 75 ft. should be sufficient, although the exact length will depend upon the shape of the aerial, the size of the condenser used for tuning, and the spacing between the turns. As a rule, the wire should be wound on with a space of about $\frac{1}{10}$ in. between each turn. The ends should be long enough to be rotated, and those who have the necessary tools should construct a "collector" made from two strips of brass mounted on a piece of ebonite, and connected to the aerial and earth terminals of the receiver, the ends of the frame aerial being connected to two plungers taken from a standard lamp holder, mounted on a strip of ebonite so that they bear on the brass strips. Of course, no tuning coil is necessary with this type of aerial, and if the set is fitted with one it should be removed. In the case of a simple detector circuit employing a reaction coil, four or five extra turns should be wound on the frame, the junction of these extra turns and the end of the frame proper being connected to the earth terminal. The free end of the extra turns should then be connected to the reaction condenser.

FREQUENCY.—The periodicity or number of cycles per second; the frequency of waves or oscillations.

FREQUENCY CHANGER.—The part of a super-heterodyne circuit which changes the frequency of a received signal in order that it may be amplified by the intermediate frequency amplifiers. It consists of an oscillating valve and a detector, which may be two separate valves or one valve doing the combined work, and which yields a beat note having the frequency of the difference between the received signal and the frequency of the oscillator.

FULL-WAVE RECTIFICATION.—See *Accumulator* and *Eliminator*.

FULTOGRAPH.—Apparatus for transmitting and receiving photo-

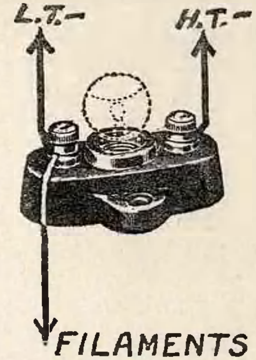


FIG. 199.—Fuse and Connections.

graphs by wireless. The picture is recorded by a stylus on a rotating drum.

FUNDAMENTAL.—The true frequency. This term may be applied to musical frequencies or the frequencies of wireless signals. In music the fundamental note is the true number of vibrations per second, and in wireless it is the actual wavelength. The fundamental is always accompanied by components having a frequency which is an integral multiple of the fundamental. For instance, a wavelength of 300 metres is accompanied by frequencies which are double, quadruple, and so on. The harmonic which is double the frequency of the fundamental is known as the "second harmonic."

FUNDAMENTAL WAVELENGTH.—The natural wavelength (of a 100-ft. aerial is approximately 120 metres).

FUSE.—A piece of wire of low

a part, but on shielding the selenium from the light rays the current flow will cease.

Now, scientists were quick to perceive that in the selenium cell they had a means for providing vision by telegraphy, but after considerable experiment it was found that unfor-

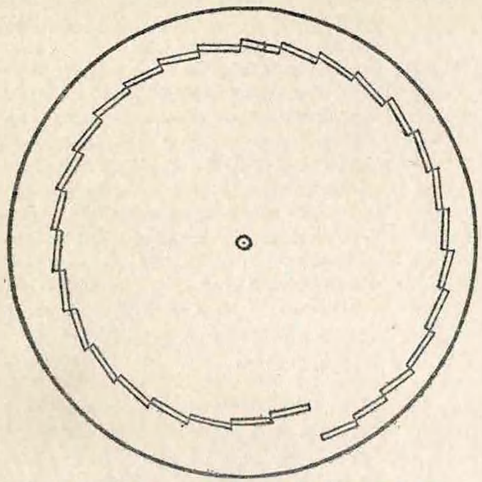
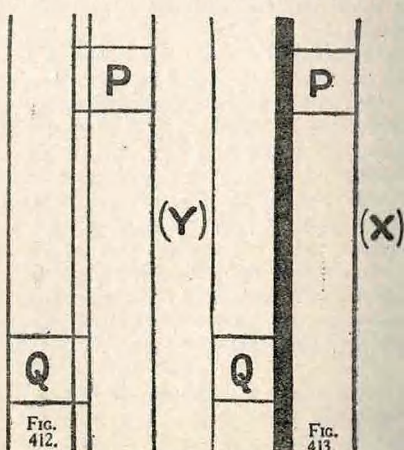


Fig. 411.—The bottom edge of one strip will just touch the top edge of the next strip as shown.

tunately selenium was much too slow or sluggish in action, and in consequence television as a science stood still. Luckily in 1888 Hertz discovered the photo-electric effect, and built up cells working on this principle. These cells turn light into electricity and, although only a minute current flows, they are instantaneous in action, a quality which television demands for its successful accomplishment. The small current response is easily made good by suitable valve amplifiers, as used in ordinary wireless practice. There is no need therefore to consider that aspect.

Undoubtedly we can look upon the photo-electric cell almost in the light of a magician's lamp, for its characteristics, to the unscientific mind, border on the miraculous. Do not run away with the idea, however, that one or more cells, because they turn light into electricity, are capable of converting an entire scene or image into equivalent and electrically intelligent current variation. Oh no, the problem is not so simple as all that; perhaps the television authorities wish it was.

Light Values. Any one scene or object if illuminated is found to be made up of countless differing light values spread over the whole area. Since the photo-electric cell gives a proportional current response for every light value to which it is exposed, our large area would only produce one average light value which, of course, is useless. We are therefore forced to split up the area into elemental light values, and allow the cell to deal with each one in turn in great rapidity. Now you see the



Figs. 412 and 413.—Details of the Light Strip.

justification for installing our light spot transmitter. A definite geometrical movement is imposed upon it so that it sweeps over the whole area or scene in a predestined path. At any one instant during the travel of the beam of light passing through the holes in the rotating disc, a minute area is illuminated. By correctly positioning the photo-electric cells their active surface can be made to pick up or absorb the light which is reflected from the subject being televised. A corresponding current variation is produced in the cell circuit which, as will be seen later, can be translated into a similar form at the receiving end.

We have the photo-electric cell causing a current to flow in the circuit of which it forms a part, through the effect of the light reflected back from the elemental square of the scene illuminated. At the next instant, when the spot has moved to its adjoining position in the light strip, so a different amount of light is reflected and the cell responds accordingly.

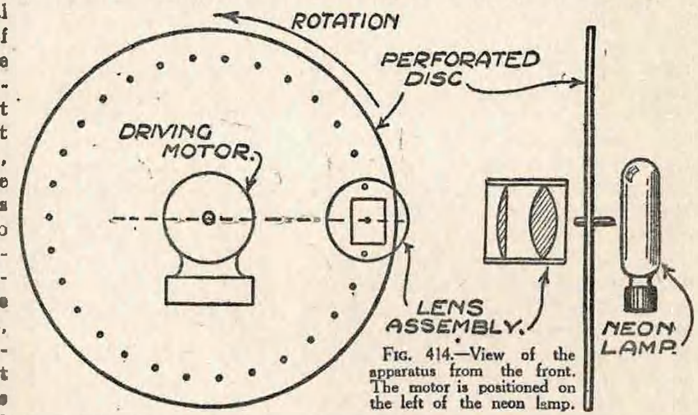


Fig. 414.—View of the apparatus from the front. The motor is positioned on the left of the neon lamp.

In this way the scene is analysed, spot by spot and strip by strip, into values of light and shade, which are handled and changed to current variations, and with each revolution of the disc so that one complete scene conversion takes place. The current values are dependent upon the reflective properties of the televised subject, anything white reflecting more light than anything black, and so on, for intermediate values.

It is important to understand thoroughly this dissecting action of the disc, so it may help matters if another method is given of looking at the scheme. The circumferential length between individual holes represents the length of our resulting picture; so if we take an ordinary photograph of that length and cut it into the same number of vertical strips as we have holes in the disc, then each strip will represent the amount of picture covered by the light spot in its vertical travel.

Dissecting the Photograph. One revolution of the disc is therefore equivalent to dissecting the photograph into the strip manner suggested, and placing each strip round the outer edge of a disc somewhat in the fashion shown in Fig. 411. The bottom edge of one strip will just touch the top edge of the next strip, the long inner edge of the first strip being on the same circumferential arc as the outer edge of the next strip.

If these strips are pasted on a large disc in the manner shown, they will constitute the individual scans