IGRANIC

SIX-VALVE

SUPERSONIC HETERODYNE RECEIVER

A fully illustrated Handbook
containing Theoretical Notes
General Description
Constructional Details
and
Operating
Data

IGRANIC ELECTRIC Co LTD

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RADIO
IGRANIC
DEVICES

In Reading this Handbook

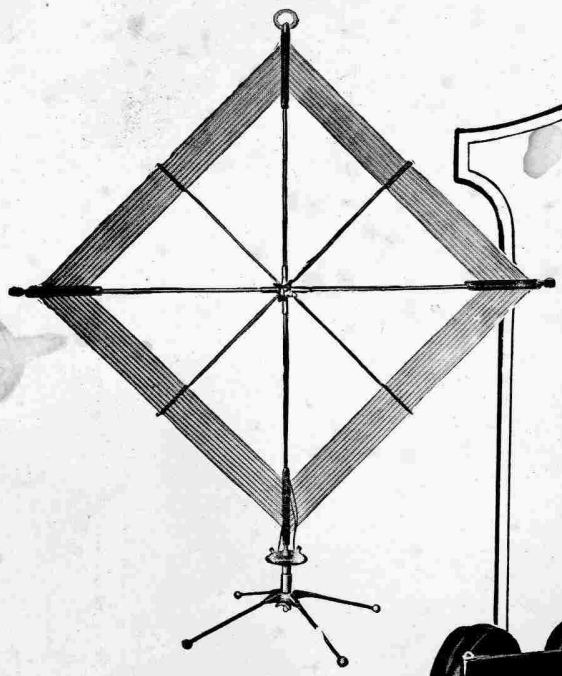
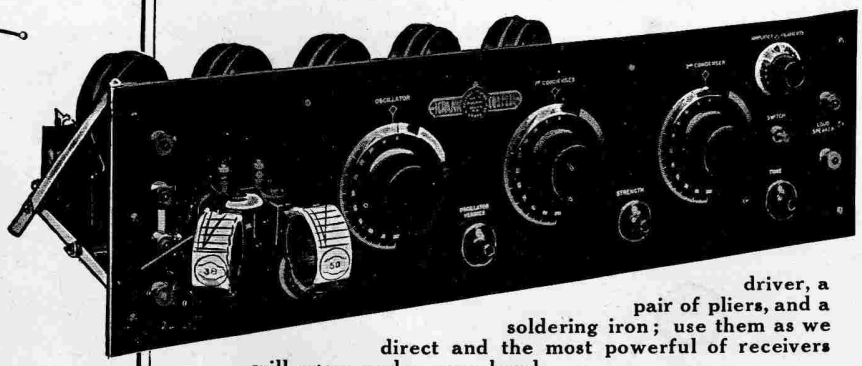


FIG. 1—The Igranic Six-Valve Supersonic Heterodyne Receiver with Igranic Patent Frame Aerial.

you cannot fail to be impressed by the many novel electrical and mechanical features incorporated in the Igranic "Super" System. You will appreciate that we have reduced the construction of a highly-sensitive multi-stage receiver to terms of **simple assembly with simple tools,** for all the intricate features which might have baffled you are embodied in self-contained units which have been permanently adjusted and require no further attention

You have only to link together in progressive stages a number of component parts and the receiver is built up step by step—a logical and simple process which is well supported by the wealth of descriptive matter and lucid photographs and drawings contained in this Handbook. Every phase of the subject has been treated so thoroughly that the possibility of misinterpretation is exceedingly remote

Now, as never before, you will find mechanical and technical experience unnecessary—all you need is a screw-driver, a pair of pliers, and a soldering iron; use them as we direct and the most powerful of receivers will grow under your hands.



BY BUILDING THIS RECEIVER you derive four material advantages:—

Firstly, you procure an apparatus which we conscientiously believe is unchallenged either technically or mechanically by any other Receiver in the markets of the World at the present time.

Secondly, by yourself performing the task of assembly you effect a financial saving of more than 50 per cent. on the list price of the nearest factory-built equivalent.

Thirdly, you "get inside" your Receiver in a manner which the user of a factory-built instrument cannot hope to emulate, hence you are able to operate it, maintain it, and (if you so desire) "stunt" with it in a really intimate way and to the best possible advantage.

Lastly, the pride of personal achievement is yours.

FIG. 2—The Igranic Supersonic Heterodyne Receiver Outfit containing the Units and Accessories which are essential for building the above Receiver according to the Igranic design (Pat. No. 253277). (*Other Patents pending*)

YOU WILL ENJOY the possession of a Receiver which has been worked out in all its aspects with absolute precision: you will welcome the vigorous reserve of power which you can call upon with the touch of a hand; you will appreciate the ease of control and the absence of "fiddling" and unstable adjustments.

Link together the standardised units and components in the manner we describe, operate in the way we indicate, and your Receiver's only range limit is that imposed by high frequency parasitics; its qualitative limit that prescribed by the emision from the transmitter

We make many other remarkable claims in this Handbook—the Igranic Supersonic Heterodyne Receiver Outfit justifies them all.

IGRANIC SIX-VALVE SUPERSONIC HETERODYNE RECEIVER

PART I.

INTRODUCTION AND TECHNICAL NOTES.

In view of the undoubted merits of the Supersonic Heterodyne Receiver—or, as it is more shortly termed, the Super Heterodyne Receiver—in respect of sensitivity, selectivity, and ease of control, it is not surprising that the number of radio enthusiasts who are constructing and operating receivers of this type is growing with ever increasing rapidity.

During the last year or so, the number of telephony stations operating within the broadcast band of wave-lengths in this country and abroad has increased greatly, and the necessity for a higher standard of selectivity in radio apparatus has become more and more essential. The Super Heterodyne Receiver, by reason of its pre-eminence in this respect, is an important step in the right direction, and will do much to surmount the difficulties due to the present congested condition of the æther.

The enormous popularity which this Receiver has achieved in the United States of America provides a convincing indication of its supremacy, and the very fact of it being used by larger numbers of radio experimenters and research workers has resulted in great advances in design. The Super Heterodyne Receiver in its original form was a complicated piece of apparatus and was not suitable for operation by any but those possessed of considerable skill. Recent designs have brought it within the reach of those whose operating skill is more limited, and excellent results may be obtained by anyone after a few minutes experience of the **two essential controls.**

Apart from simplicity of operation, the ease with which weak and distant stations may be received and the exceptional selectivity of the Super Heterodyne Receiver place it in a class by itself. In addition, speech and music may be reproduced with a remarkable degree of purity, and in view of all these facts the frequently used abbreviation—"Super" Receiver—acquires a dual significance.

One of its chief advantages is that **excellent reception is possible without the necessity of employing an outdoor aerial.** This feature will appeal to many people who have hitherto been debarred from enjoying the pleasures of radio reception owing to the impossibility of erecting an efficient outdoor aerial. **A small loop or frame aerial is all that is necessary for the most efficient reception,** and no appreciable advantage is gained by the use of an outdoor aerial. The added selectivity that is gained by reason of the directional properties of the frame aerial is a strong argument in favour of its employment.

The Receiver described in the following pages may, however, be used with an ordinary open type aerial, either inside or outside the building in which the Receiver is situated.

It is essentially a loud-speaker Receiver and the use of headphones is quite unnecessary either when "searching" or when listening to any particular station, since **even the most distant stations are reproduced in the loud speaker at comfortable strength.**

NOTES ON SIMPLE "SUPER" THEORY.

We have endeavoured in the following Notes to trace out, in logical order and simple fashion, the phenomena associated with the action of Supersonic Heterodyne Receivers. Although an appreciation of the principles involved is in no way essential, it will, we feel, considerably enhance the interest of construction and operation. Furthermore, the constructor with no previous experience of "Supers" will gain added confidence in the essential superiority of this method of reception.

Sensitivity and Responsiveness—a Distinction.

It cannot be too widely known that receivers which yield loud responsiveness on powerful or relatively near-by stations may yet prove thoroughly insensitive when called upon to deal with feeble currents set up by distant stations.

It is not difficult to perceive the reason for this; the fact is that the valve, when used as a rectifier, becomes, like the crystal, progressively inefficient as the signal current decreases. Thus, *if the signal current is halved, the rectified current is reduced to one quarter,* and a critical amplitude is soon reached below which there is no apparent rectification. In these circumstances no low frequency impulses are made available to actuate any subsequent stages of low frequency amplification and therefore nothing is heard in the telephones.

The obvious procedure, if we wish to make audible previously unheard stations, is to interpose between the aerial and the rectifier a number of valves arranged to amplify the feeble aerial currents in their original high frequency form so that they may be built up to rectifiable dimensions.

Why H.F. Amplification of Short Waves is inefficient.

Now when dealing with short wavelengths of the order used for Broadcasting, we can employ only a very limited amount of this high frequency amplification.

The limitation is the result of two effects : *(a)* that due to the copper losses in the valve circuits, *which limit the amplification per stage*, and *(b)* that due to unwanted capacitative couplings provided by the inter-electrode and inter-element capacities of the valves, which *limit the number of stages* that can be employed with freedom from spurious oscillation and general instability (see Fig. 3).

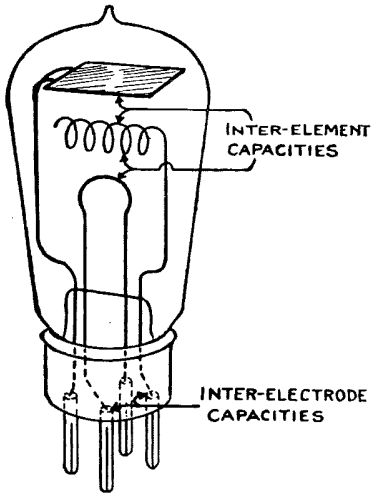


FIG. 3

Although by a complicated neutralising process these capacities can be rendered ineffective, yet the copper losses remain, and, furthermore, since to obtain any relatively high efficiency each amplifying stage must be tuned to the signal wavelength, the operation of the numerous controls over the full range of Broadcasting wavelengths becomes an elaborate matter, and, long before the limit of amplification is reached, overwhelming complications ensue.

The Efficiency of H.F. Amplification of Long Waves.

Now as the frequency of the incoming oscillations decreases, *i.e.*, as the wavelength increases, the copper losses decline, and, in addition, the unwanted capacitative couplings assume such a high reactance that they become of negligible value, so that *when dealing with long waves, not only does the amplification per stage increase, but it is also possible to use a larger number of stages with absolute stability.*

In view of these facts it would perhaps seem a pity that in dealing with Broadcasting we have not to intercept long wavelengths which we could amplify in such a highly sensitive and stable manner.

What the Supersonic Heterodyne does.

A similar thought must have passed through the mind of the inventor of the Supersonic Heterodyne Receiver for he conceived the idea of converting the incoming short waves to a much longer wavelength and then proceeding to amplify them at this long wavelength. That is precisely what the Supersonic Heterodyne Receiver does.

The Title of the Receiver.

The term "Supersonic Heterodyne" is perhaps unjustifiably terrifying since it is used to describe a very simple operation. Let us analyse this term :—The word "Heterodyne" indicates an electrical process whereby the association of two currents of dissimilar frequency results in the formation of a third current having a frequency different from either. The qualifying adjective "Supersonic" indicates that the frequency of this third current is above the audible range. (The human ear, be it noted, is usually not responsive to frequencies higher than 15,000 per second).

Explanation of the Heterodyne Action.

Let us be quite clear as to the meaning of this *inaudible* Heterodyne action. To this end we will suppose we are receiving a station employing a wavelength of 300 metres. This means that 1,000,000 oscillations per second will flow in the aerial tuning circuit. If, now, we cause one of our valves to generate 1,050,000 oscillations per second, and we pass these locally generated oscillations into the aerial tuning circuit, it is quite obvious that two sets of oscillations will be flowing in the latter.

The difference between the two sets is 50,000, so that 50,000 times per second the two sets of oscillations will flow in the same direction at the same moment, thereby assisting each other, and, a similar number of times per second they will flow in opposite directions at the same moment, thereby opposing each other.

From this it should be clear that the effective current in the tuning circuit will be increased and decreased 50,000 times per second, so that we have virtually slowed down the signal frequency, **thereby converting the incoming wavelength of 300 metres** (1,000,000 oscillations per second) **to a wavelength of 6,000 metres** (50,000 oscillations per second).

It only remains to pass these long wave oscillations to an amplifier, termed the intermediate frequency amplifier, tuned to receive them, so that they may be magnified many thousands of times before being transferred to the final rectifying valve. The audio frequency impulses resulting from the rectifying action are then passed to the audio frequency amplifier and from thence to the loud speaker.

Distribution of the Receiver Functions.

Fig. 4 indicates the way in which the functions of the Super Heterodyne Receiver are distributed. It will be seen that there are four separate electrical sections arranged in the following order :—

(1) The Frequency or Wave Changer.
(2) The Intermediate Frequency Amplifier.
(3) The Detector.
(4) The Audio Frequency Amplifier.

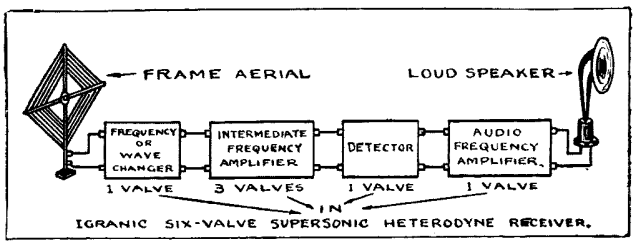


FIG. 4.—Schematic diagram of the Igranic Six-valve Supersonic Heterodyne Receiver, illustrating the functions of the various sections.

The frequency changing process involves a combination of the heterodyne and rectifying functions, and in the Igranic system one valve is made to combine the two functions efficiently, thus avoiding the necessity for a separate oscillator, and **reducing by one the number of valves employed.** (It should be noted here that the presence of the heterodyne oscillator stimulates the process of rectification and cancels the

law of progressive inefficiency to which, as we explained earlier, the rectifier would ordinarily be subject).

The amplification afforded by the Igranic Intermediate Frequency Amplifier is so great, that, as will be seen, it has been found quite sufficient to provide only one stage of audio frequency amplification in order to actuate the loud speaker in a robust manner, even when intercepting the weakest stations. **A further valve, therefore, has been saved in this connection.**

Inherent Advantages of the "Super" Set.

The main advantages possessed by well-designed super heterodyne receivers are as follows :—

(1) Sensitivity.
(2) Selectivity.
(3) Simplicity.

Let us deal with these in numerical order :—

Sensitivity.

To recapitulate, it will be appreciated that the remarkable sensitivity is the direct outcome of the very high amplification obtained per stage due to the fact that **the amplifying process is conducted on a wavelength ensuring freedom from the losses which are so restrictive on short wavelengths.** Again, as the limiting capacitative couplings are now not in evidence, **it is possible usefully to cascade a greater number of high-amplification stages on this longer wavelength.** In virtue of these two considerations, very weak signal impulses intercepted by the aerial may be amplified to such an extent as to ensure highly efficient final rectification.

Selectivity.

The extreme selectivity of the super heterodyne receiver is primarily due to two factors :—In the first place, as a direct result of the high sensitivity exhibited a *Frame Aerial* may be employed. Not only does this reduce the effect of "*Shock Excitation*" interference due to the presence of a nearby powerful station, but it also offers the only means extant of *separating two telephonic transmissions of comparable intensity on the same wavelength*, always providing, of course, that the two stations do not lie in the same or in diametrically opposite directions (see Figure 5). Assuming less extreme conditions, the directional effect is usually of value since it is, as a rule, the exception to find two mutually interfering stations in the same geographical plane of reception.

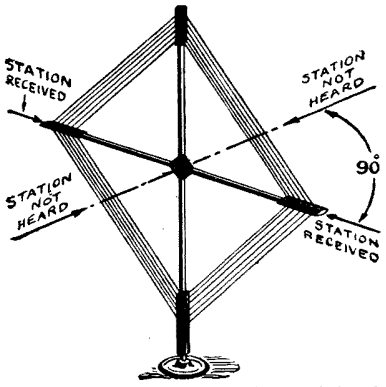


FIG. 5.—Showing the directional characteristics of a Frame Aerial. Signals are received at maximum ntensity when the plane of the windings points in the direction of the transmitting station.

Secondly, the resonance effect of the various intermediate frequency circuits is in a measure additive, and what is termed a *Band Filter* is created (Fig. 6). This, in effect, means that the intermediate frequency amplifier is equally responsive to its fundamental wavelength and to a band of wavelengths on either side but that at the outer limits of this waveband amplification falls off sharply.

The point of this may not be apparent until w remember that a Broadcasting transmitter, when ra ating speech and music, emits a group of waves on either side of its fundamental "carrier" wave. The wavelength of these "sidebands," as they are called, is regulated by the acoustic frequencies interpreted by the microphone and impressed upon the oscillating circuits of the transmitter.

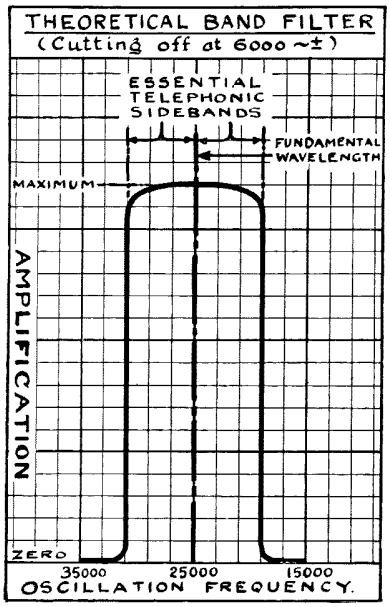


FIG. 6.

Now, if the waveband acceptable to the intermediate frequency amplifier is too *narrow*, the outer limits of the transmitted sidebands will not be amplified, hence the tonal balance at the Broadcasting Studio will not be re-created at the receiver, a state of affairs which is, of course, productive of poor quality, and, since the elimination of the higher tones is involved, especially detrimental to the intelligibility of speech.

If, on the other hand, the waveband permitted by the intermediate frequency amplifier is too *broad*, selectivity will be sacrificed, for interfering stations which produce "beats" with the heterodyne oscillator will receive a measure of amplification although not strictly resonant.

Now the Super-Heterodyne Receiver possesses a *unique advantage in that the frequency to which its amplifier responds remains constant and unchanged*, no matter what the signal frequency may be. It is this constancy of frequency which enables the width of the intermediate frequency waveband to be adjusted so that, *without any alteration, the most satisfactory selective condition is maintained throughout the entire range of received signal wavelengths.*

This has made it possible for the Igranic designers to fix the resonance and damping constants of the Intermediate Frequency Units permanently so that **amplification is confined to the essential sidebands of the selected Station.** In this way is achieved the maximum selectivity consistent with the faithful treatment of telephony transmissions.

A peculiar, and useful, feature of the super heterodyne method of reception is that *any station may be received at two settings of the oscillator condenser dial.* This means that a station may be received when the oscillator is generating oscillations of the correct frequency to produce the required intermediate frequency, irrespective of whether the local oscillations are *greater* or *fewer* than the frequency of the incoming oscillations. Therefore, if at one setting of the oscillator dial a certain amount of interference is present, this may be reduced considerably, or even eliminated, by adjusting the oscillator to produce the alternative frequency. The two oscillator settings are shown in the Oscillator Tuning Chart (Fig. 29).

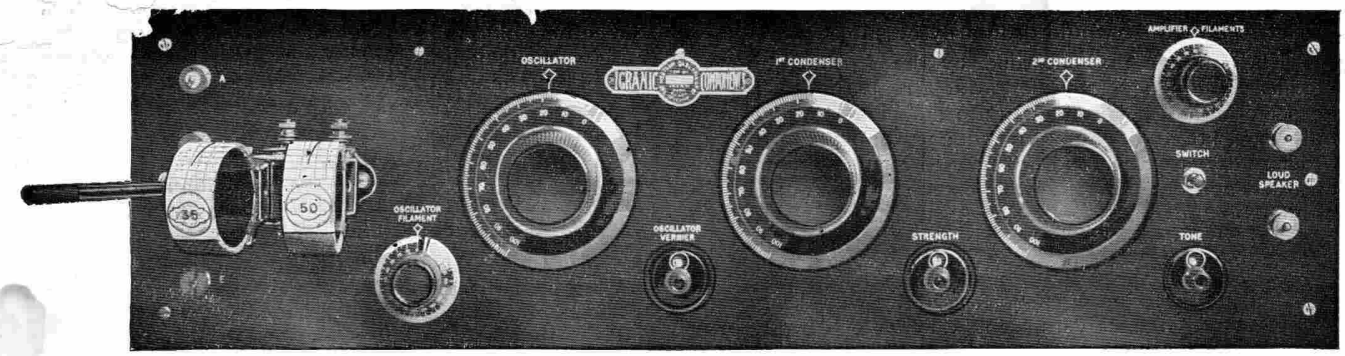


FIG. 7.—The front of the Control Panel of the Receiver showing the various controls and the coupling coils which are employed when using the 2-circuit tuner. The engraved metal Licence Plate can be seen between the Oscillator and 1st Condenser, while the engraving on the panel is clearly visible. The attractive appearance of the Control Panel will appeal to all discriminating radio enthusiasts.

Simplicity.

The ease of operation associated with "Super" receivers is not met with in any other multi-stage receiver of high sensitivity. This is self-evident when it is remembered that the **Igranic Intermediate Frequency Units have been permanently tuned to the intermediate frequency and require no adjustment** since the intermediate frequency will always remain the same no matter what the frequency of the received signals may be.

In consequence of this, it is, of course, only necessary to provide variable controls for the signal frequency tuning circuits and for the variable condenser which is used to adjust the frequency of the heterodyne oscillator.

In the case of the Igranic 6-valve "Super" Receiver operating directly with a Frame Aerial, only two controls are essential. One of these is the Frame Aerial Tuning Condenser, and the other the Oscillator Tuning Condenser.

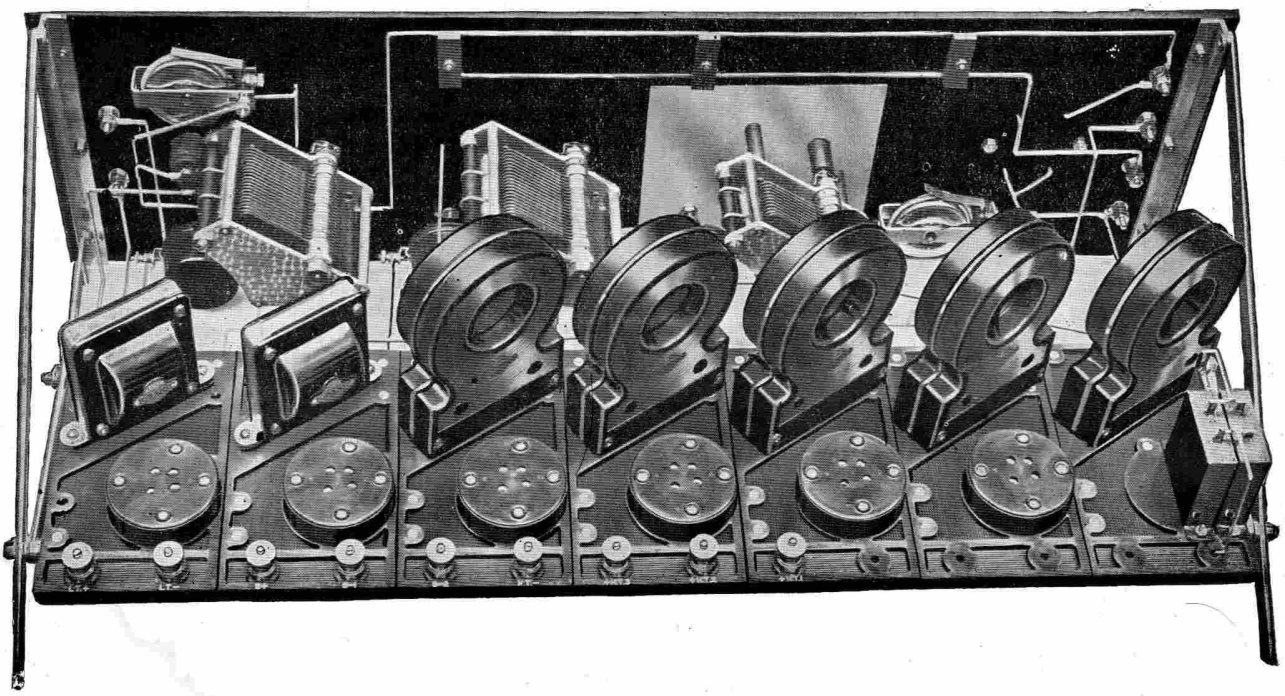


FIG. 8.—View of the rear of the Receiver showing the general construction and the disposition of the various parts. The whole of the components comprising the Base of the Receiver and the metal Framework are included in the Igranic Supersonic Heterodyne Receiver Outfit.

IGRANIC SIX-VALVE SUPERSONIC HETERODYNE RECEIVER.

PART II.

GENERAL DESCRIPTION.

Although in the preceding section of this Handbook we have dealt with a number of advantageous technical features peculiar to the Igranic Six-valve Super Heterodyne Receiver, we have by no means exhausted the list of distinctive points in its technical and mechanical design. This will be apparent now that we proceed to describe the general features of the Receiver.

Receiver Divided into Two Sections.

For purposes of construction, the Receiver is divided into two sections, these being clearly shown in the full-size lay-out drawing (No. 1). The upper half of this drawing shows THE CONTROL PANEL, which is mounted vertically in the actual Receiver. The Control Panel carries all the components which are used for the control of the Receiver.

The lower half of the drawing shows THE BASE, which is built up entirely from the various Units and Accessories contained in the Igranic Supersonic Heterodyne Receiver Outfit.

THE TWO SECTIONS ARE UNITED by means of special collapsible metal angle-brackets, one at either end of the Receiver.

THE BASE IS BUILT UP of seven moulded Bakelite unit bases, which are secured to two slotted metal bus-bars. These bus-bars are screwed at either end to one of the members of each angle-bracket, the whole providing an exceptionally rigid and light form of framework which is easy to assemble and extremely neat in appearance.

The Units Comprising the Base.

The fact that the construction of the Base involves but the assembly of a series of individually completed Units and Accessories much simplifies the constructor's task.

It should be borne in mind that **the Units have been correctly adjusted before leaving the Works and are ready for immediate use.** We would stress the fact that no further adjustment is necessary, and we advise that they be not tampered with or altered in any way as otherwise we cannot guarantee the high standard of performance which will inevitably result providing our designs are adhered to.

EACH UNIT OF THE BASE CONSISTS essentially of a moulded Bakelite Unit Base (see Fig. 9) on which is carried a container housing the coupling medium. An anti-microphonic valve-holder and appropriate terminals are mounted upon the surface of the Unit Base, to the underside of which are attached certain small components together with incidental and main bus-bar connections.

The Units will be described in numerical order, only the general features being dealt with at this stage.

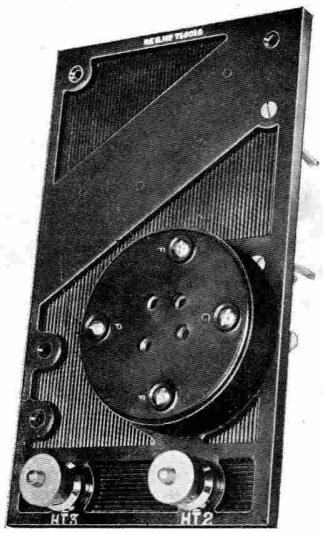


FIG. 9.—Unit Base completely assembled.
(Registered Design No. 716016)

No. 1.—The Frequency Changing Unit.

As previously stated, the first valve performs the function of frequency changing and acts in the dual capacity of heterodyne oscillator and first detector. The necessary coils associated with the oscillator function, together with a balancing condenser and stabilising resistance, are completely enclosed in a Bakelite container, termed the Oscillator Unit. This container is fitted with standardised spring clip connectors and is mounted on Unit Base No. 1, as shown in the full-size lay-out drawing (No. 1).

By means of a novel electrical arrangement the oscillations generated by this Unit are not passed to the aerial circuit, thus **there is little possibility of interference with other receivers due to radiation from the aerial, less, in fact, than when the ordinary type of oscillating receiver is employed.**

Nos. 2, 3, 4 & 5.—The Intermediate Frequency Units.

Four of these Units are provided, the necessary coils, etc., being enclosed in Bakelite containers, similar in appearance to the frequency changing unit. They are shown mounted on Bases 2—5 (inclusive) in the full-size lay-out drawing (No. 1).

In virtue of exhaustive research, and many comparative tests, there has been evolved an original form of reactance-capacity coupling which shows a marked superiority in efficiency and performance over other types. As a result, the coupling Units, which are termed "Self-Stabilising Reactance Units" (see Fig. 10), possess the extremely desirable feature of inherent stability, despite the exceedingly high amplification obtained. This stability is achieved without resorting to the deliberate introduction of losses as a means of suppressing undesirable oscillation (such as by Potentiometer control) and any self-oscillating tendency of the intermediate frequency amplifier is cut off at its source. A complete Intermediate Frequency Unit is illustrated in Fig. 11.

No. 6.—Audio Frequency Amplifying Unit.

One stage of audio frequency amplification is employed. The inter-valve coupling is provided by a special form of Igranic "E" type Audio Frequency Transformer, which is eminently suitable, both qualitatively and quantitatively, for power amplification. In place of the usual type of terminal board fitted to the standard instrument, the windings have been internally connected to four screwed pins emerging from the base.

No. 7. The Output Transformer Unit.

A special type of Output Transformer has been developed. The connections are brought screwed to pins emerging from the base of the instrument in a manner similar to the preceding Unit.

This Transformer has been designed to permit of the **alternative use of either high or low resistance loud speakers or telephones** and strapped terminals enable the required change of connections to be readily made.

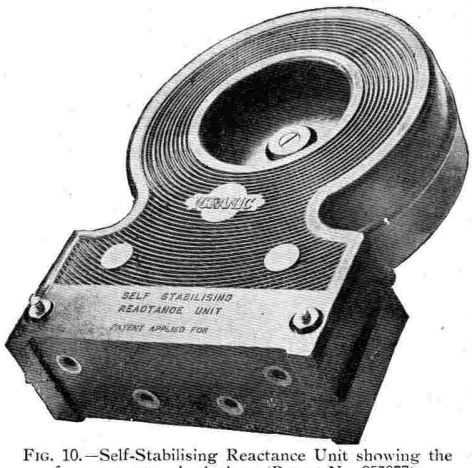


FIG. 10.—Self-Stabilising Reactance Unit showing the four connectors in the base (Patent No. 253277). (Registered Design No. 716015).

The employment of this Unit; (*a*) **conduces to stability,** since the output leads are maintained at balanced potentials, the centre-point of the system being earthed; (*b*) **protects the windings of the loud speaker or telephones** from the possibility of cumulative damage due to the "inductive kick" which occurs when the filament supply is interrupted; (*c*) **prevents demagnetisation** due to a flow of steady current through the windings of the telephones or loud speaker, and (*d*) **enables the loud speaker or telephones to be taken to points remote from the Receiver** since the capacitative constants of quite lengthy leads will now not prove detrimental (this is especially the case when low-resistance loud speaker or telephones are used in conjunction with the low-resistance arrangement of the transformer).

The Output Transformer is shown in position on Base No. 7 in the full-size lay-out drawing (No. 1).

The Components & Accessories for Base.

In addition to the Units referred to above, the Igranic "Super" Outfit contains the under-mentioned Components and Accessories :—

Six Igranic Anti-Microphonic Valve-Holders.
Two Igranic Fixed Grid Leaks, 2 megohms.
Three Igranic Fixed Grid Leaks, ·5 megohms.
One Igranic Freshman Fixed Condenser, ·002 mfd.
Five Igranic Freshman Fixed Condensers, ·0002 mfd.
Two special 1 mfd. Mansbridge Fixed Condensers.
Seven Bakelite Unit Bases on which the above Components will be mounted.
Two Collapsible Metal Angle Brackets.
Two special slotted Bus-Bars.
All necessary Connectors, Clips, Insulating Bushes, Terminals, and Screws for assembling the seven Units and the Metal Framework.

The Components and Accessories required for the Control Panel.

The Components and Accessories required for the Control Panel, as shown in the full-sized lay-out drawing (No. 1) and catalogued in the following list, are not included in the Igranic Outfit :—

One Igranic Biplug Coil-Holder for two Coils.
Two Igranic Low-Loss Square Law Var. Condensers, ·001 mfd.
One special Igranic Low-Loss Square Law Variable Condenser, ·0005 mfd., with Ebonite Spindle Coupling and Distance Pieces.
One Igranic Micro Condenser.
One Metal Screen Plate.
One Igranic Low-Value Variable Grid Leaks, 0-1 megohm.
One Igranic Plain Type Filament Rheostat, 4 ohms.
One Igranic Plain Type Filament Rheostat, 6 ohms.
One Igranic Filament Rheostat, 30 ohms.
One Igranic Radio Switch.
Six 4 B.A. Terminals (nickel-plated).
One Ebonite Panel (size 28″ × 8″ × ¼″).

All the foregoing may be obtained from Igranic dealers.

Makes and types other than those specified may be substituted, providing they possess similar values, but it will be appreciated that if this course is adopted not only will the constructional work become more involved, but the performance of the Receiver will possibly not be as meritorious as when the instrument in its entirety, is built up in strict accordance with our designs and detailed constructional information.

A Special Note relative to the Wavelength Range of the Receiver.

The Oscillator Unit which is normally supplied with the Igranic Outfit covers a wavelength range of 215 to 625 metres and is, therefore, applicable to reception from the majority of the British and Continental Broadcasting Stations.

If desired, any one of the three Oscillator Units will be supplied with the Outfit, while if all three are obtained **reception may be conducted over a continuous range of wavelengths between 215 and 3,500 metres.** Particulars of the three Oscillator Units are given below :—

Type.	Effective Wavelength Range.
No. 1	215 - 625 metres
No. 2	620 - 1850 ,,
No. 3	1500 - 3500 ,,

This range of wavelengths embraces over 99% of the World's Broadcasting Stations, and, in consequence, **the Igranic "Super" Receiver may justly be held to provide an almost unparalleled example of Flexibility in super-sensitive receiver design.**

The Valves We Recommend.

Valve constants have played a very important part in determining the general circuit constants of the Igranic "Super" Receiver, and each of the three predominant features — Sensitivity, Selectivity, and Simplicity—may be materially affected if the valves used are not of the types employed in the original design.

We are setting out below a Table indicating suitable types of two different makes, and also the filament, anode, and grid potentials applicable to the Receiver:—

Purpose	Number Required	Marconi or Osram	Mullard	Filament Volts	Filament Amps	Anode Volts	Grid Volts
Frequency Changer	1	D.E.5.	D.F.A.1	5	·25	60	—
Intermediate Frequency Amplifier	3	D.E.5.B	D.F.A.4	5	·25	120	1·5
Second Detector	1	D.E.5.B	D.F.A.4	5	·25	120	—
Audio Frequency Amplifier	1	D.E.5*	D.F.A.1*	5	·25	120	9
	*If it is desired to accommodate a volume of sound greater than the normal (as when demonstrating in large halls, etc.) and at the same time to retain tonal purity, this valve should be superseded by a Marconi or Osram L.S 5. Particulars of the alternative valve are given below.						
	1	L.S.5	—	5	·8	200	18

Either of the specified makes may be used, their technical constants and general efficiency being practically identical.

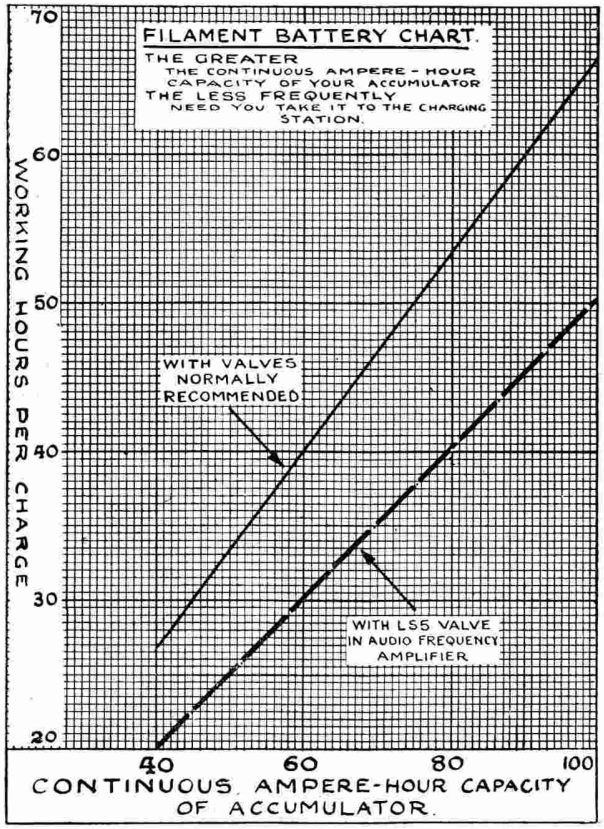
The Batteries.

Unless the Constructor possesses considerable experience, we advise that only Batteries of well-known makes be obtained.

Filament Heating.

A 6-volt Accumulator should be used for this purpose, the supply being regulated according to valve requirements by means of the rheostats mounted on the Control Panel. It is highly desirable that the continuous capacity should not be less than 40 ampere-hours. This will permit the accumulator to be used for approximately 24 working hours per charge.

The accompanying Chart indicates the approximate number of working hours per charge permitted by accumulators of various continuous ampere-hour capacities:



Anode Supply.

A 120-volt dry-cell Battery, fitted with sockets enabling the voltage to be varied in steps of a few volts, is required for the normal arrangement. If it is desired to use an L.S.5 valve in the audio frequency amplifier the battery may have a value of 200 volts or even more.

The individual cells should be of large size. Although this feature increases the initial cost, it represents an ultimate economy since the working life of the battery is more than proportionately increased.

Grid Bias.

A dry-cell battery yielding not less than 9 volts, and tapped off in steps of 1½ volts, is normally required. As an exceedingly minute current is involved, the cells may be of small dimensions.

Should an L.S.5 valve be used in the audio frequency amplifier, this battery should have a maximum value not less than 18 volts, tappings being arranged in steps of 1½ volts as before.

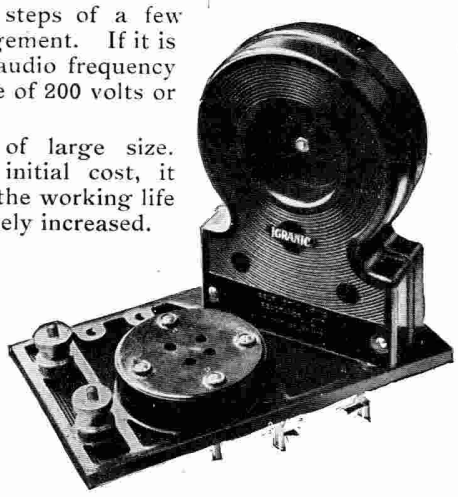


FIG. 11.—A unit of the Intermediate Frequency Amplifier completely assembled and with a Self-Stabilising Reactance Unit mounted on the Unit Base (Registered Design No. 716017

The Igranic Patent Twin Winding Frame Aerial.

The Igranic Company has developed a unique type of Frame Aerial primarily for use in conjunction with the Igranic Super Heterodyne Receiver (see Figs. 1 and 12). The employment of this Frame Aerial is optional and it is not included in the Igranic Outfit, but may be obtained separately.

FIG. 12.—Igranic Patent Frame Aerial. Folded. For Illustration of Frame Aerial open, see Fig. 1, inside front cover.

That it represents a valuable contribution to "Super" practice will be apparent to experimenters possessing comprehensive experience, for, without the employment of an open aerial, with the consequent loss of the valuable directional effect, and without the interposition of signal frequency amplifying stages or loosely-coupled tuning circuits, **this new Frame Aerial completely eliminates interference set up by stations using wavelengths in or near the band to which the intermediate frequency amplifier is responsive.**

The Igranic Patent Frame Aerial embodies two geometrically parallel windings consisting of an equal number of turns, one winding being tuned to the signal frequency by means of a condenser in the Receiver and the other winding being wound in the opposite sense and not tuned. The two windings are so arranged in the Receiver circuit that the arrival upon the Frame of a widely non-resonant frequency results in the simultaneous formation of two potentials of equal voltage and opposite sign—a condition producing mutual cancellation and an obvious elimination of the long-wave interference to which "Supers" working on direct-coupled frame aerials have always been subject.

On the other hand, when dealing with resonant frequences the responsiveness of the tuned winding rises to a maximum, while that of the untuned winding remains at a very low value, hence there are no opposing effects, and in consequence stations which it is desired to receive are in no way interfered with.

The normal Wavelength range is from 215 to 715 metres, but may be extended to 1,300 metres by connecting the two windings in series.

The Igranic Patent Frame possesses the valuable adjunct of portability, for, by loosening a thumb-screw at the junction of the four members, these members, which are hinged, will fold together. The base also folds up, similarly to the Frame cross members. The windings are permanently secured to the moulded Bakelite separating pieces and fold evenly and without entanglement when the Frame is collapsed (see Fig. 12). The Frame is extremely rigid, the cross members consisting of brass rod heavily nickel-plated. The vertical member is pivoted in the base, enabling the Frame Aerial to be rotated independently of the latter.

IGRANIC SIX-VALVE SUPERSONIC HETERODYNE RECEIVER.

PART III.

CONSTRUCTIONAL DETAILS.

Having dealt with the elementary theory of the super heterodyne method of reception, and a number of the distinctive features and advantages of the Igranic Six-valve Super-Heterodyne Receiver, we will now describe the actual construction of the instrument.

Provided that the assembly and wiring of the Receiver is executed in progressive stages, in exact accordance with the following instructions, no difficulty will be experienced in constructing a Receiver which will equal in appearance that illustrated in this Handbook, and one which will give extremely satisfactory results in operation.

The assembly and wiring of the Receiver must be effected in **two distinct sections**, *viz.*:

(1) THE CONTROL PANEL, on which are mounted the various tuning and controlling devices as set out in the list on page 6, and

(2) the horizontal platform or BASE which is built up from the seven unit bases, and which carries the whole of the essential units and accessories comprised in the Igranic Outfit and also the valves.

These two sections are respectively shown in the upper and lower halves of the full-size lay-out drawing (No. 1).

THE CONTROL PANEL.

The assembly of the control panel will be our first concern. In procuring the panel the three alternative courses referred to below are open to the Constructor and may be followed according to inclination :—

(1) A considerable amount of time and labour will be saved by procuring the control panel exactly as shown in the illustration (Fig. 7) on page 4. A panel of finest grade insulating material with a highly polished surface, accurately cut to the size required (28″ × 8″) with all drilling and engraving executed, and absolutely ready for the components to be mounted upon it is supplied by the Igranic Electric Co., Ltd., and may be obtained from all reputable radio dealers. The use of this panel will impart a very distinctive appearance to the finished Receiver.

(2) As an alternative to the above, a plain ebonite panel may be obtained ready cut and trimmed to size, but not drilled or engraved. The necessary marking out and drilling may be effected by the constructor and, when completed, the engraving of the panel may be executed by a firm which specialises in this kind of work.

(3) Many constructors who are possessed of sufficient patience and skill will prefer to carry out the whole of the work involved in preparing the panel (with the exception of the engraving) both on the score of economy and by reason of the added interest and satisfaction which may be derived from personally executing the whole of the constructional work. For the assistance of those constructors who wish to take this latter course, we have included the following information descriptive of the processes involved :—

Preparing the Control Panel.

A piece of high-grade insulating material, 28″ × 8″, is required. In purchasing this it is advisable to have it cut slightly larger than the finished dimensions, in order to allow a small amount of material to be removed along each edge during the finishing process.

Having procured the panel, the edges should be accurately marked out by means of a scriber or other pointed instrument, taking care that the scratch lines so made are absolutely square with each other. To ensure this, it is a good plan to trim one edge first and to lay out the two parallel edges which are at right angles to the first by means of a T-square or try-square. These two edges may then be trimmed and finished, after which the fourth and final edge may be marked out in a similar manner and finished to size.

When trimming the edges of the panel, it should be clamped between two stout boards in a joiner's vice, or, if this is not available, it may be secured to a table by means of suitable clamps. For the trimming process a medium-cut flat file should be used unless a fair amount of material has to be removed, in which case a coarse file should be used for rapidly filing away the excess material after which the medium file may be employed for final trimming to size.

The edges should be kept square with the surface of the panel and at intervals during the process they should be tested for straightness by means of a steel straight-edge, and if any humps or irregularities are revealed, they should be carefully levelled with the file. A good finish may be imparted to the edges by means of a piece of fine emery or carborundum cloth, which should be rubbed backwards and forwards from end to end of each edge until all scratch marks left by the file have been removed. A little pure oil applied to the edges during this operation will enable a pleasing result to be obtained.

Finishing the Surface.

The surfaces of the panel may be rubbed down to produce a pleasing matt finish, and with certain makes of ebonite this is essential as the original highly polished surface of the ebonite may have been produced by a metallic process which, unless removed, may give rise to serious electrical leakages. Other makes of ebonite

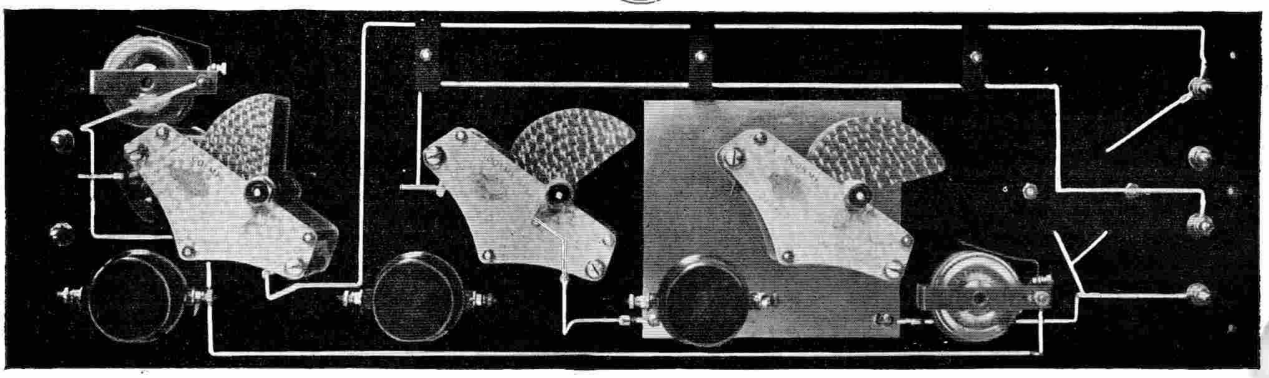


FIG. 14.—View of rear of Control Panel, completely assembled and wired as far as possible. At this stage the Panel is ready for securing to the Base of the Receiver, after which, the interconnecting leads between the two may be affixed.

have a polished surface obtained by a special method, which is not detrimental to the insulating properties of the material, and if a highly polished surface is desired it is imperative that this class of ebonite should be employed. If Bakelite or Redmanol be used no treatment of the surface is necessary.

If a matt finish is required the polished surface on both sides of the panel should first be removed by means of a piece of coarse emery or carborundum cloth, when, by using a finer grade of the same abrasive medium and a little oil, an exceptionally satisfactory finish may be obtained. The surfaces that have been treated in this way should afterwards be thoroughly rubbed down with a piece of soft cloth to remove any powdered ebonite and oil which may remain.

Marking-out the Centres.

The panel is now ready to have the various centres for fixing and spindle holes marked upon it in readiness for drilling.

The full size drilling template (Drawing No. 2), should be cut around the outer broken lines and laid upon the front surface of the panel. The flaps of the template, which will project over the edges of the panel, should be carefully folded along the full lines and temporarily secured to the underside of the panel.

Lay the panel upon a large flat board or other smooth surface, and proceed to mark the centres on the panel by making a small indentation at each point indicated on the template. A sharp pointed steel centre-punch will be found most convenient for this purpose, but if one is not available any other suitable sharp pointed instrument may be used to locate the centres by pricking through the template, after which a large nail may be used to enlarge the centres so marked. The centre-punch or nail should be held in a vertical position at each point and struck lightly with a small hammer, taking care not to use excessive force or the panel may be cracked or broken.

If any components other than those listed on page 8 are to be used in the receiver, the fixing centres as set out on the drilling template should not be used as they will not be suitable for components of other makes. This, of course, only applies to the fixing centres; the spindle centres will be correct for all types or makes of components.

In cases where components other than those recommended are used, the drilling templates supplied with such components must be used for the purpose of marking out the fixing centres, but if templates are not supplied the spacing of the centres must be determined by measurement of the actual instruments.

Drilling the Panel.

The drilling of the holes may be accomplished either with the template in position, or, provided all the centres have been accurately marked, it may be removed before the drilling is executed.

The indentations which have been made in the face of the panel will give the drills a good start at the commencement of the cut, and prevent them from wandering.

All holes which are so marked on the template should be suitably countersunk on the face of the panel, and this may best be done by means of special countersink drills, but if these are not available countersinking may be effected by means of ordinary twist drills having diameters equal to the heads of the screws which are to be accommodated. Care should be taken not to countersink deeper than is necessary to allow the screw heads to lie flush with the surface of the panel, or the appearance of the receiver may be marred.

A precaution which should be observed when drilling, is to lay the panel upon a large piece of hard wood to minimise the possibility of the drills chipping away the ebonite where they emerge at the back of the panel.

Providing the holes are drilled accurately, no difficulty should be experienced in mounting the various components in position, but should any difficulty be experienced in this direction it may be possible to rectify matters by enlarging slightly each of the fixing holes, or slotting them in the required direction by means of a small round file) thus compensating for any slight errors in drilling.

Engraving.

After drilling the panel, the lettering indicating the components and the index marks referring to the dial readings should be engraved in the positions shown in the drilling template (Drawing No. 2).

Assembling the Components on the Control Panel.

The list of components set out on page 6 and shown in the full-size lay-out drawing (No. 1), may now be assembled upon the Control Panel. It is not proposed to give here detailed instructions for mounting these components. An illustrated leaflet, fully describing the method of mounting, is enclosed with each of the recommended components, and, if these instructions are followed carefully, no difficulty will be experienced in carrying out this part of the constructional work.

Near the top of the panel will be seen three ebonite cleats, which support two of the leads running from the coil holder to the first and second condensers. These cleats should be cut from ebonite, drilled and grooved according to Fig. 15, and laid aside in readiness for wiring.

The metal screen plate does not require securing to the back of the panel by any means except that provided by the oscillator condenser and the micro-condenser. These two instruments are thoroughly insulated from the screen plate ; the oscillator condenser by means of the ebonite distance pieces and spindle coupling, and the micro-condenser by means of an insulating coupling which is enclosed within the moulded extension pillar through which the spindle passes.

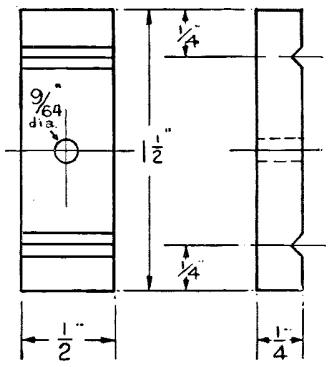


FIG. 15.

When the mounting of the components on the panel has been completed it should be laid aside in readiness for wiring.

THE BASE.

Assembly of the Unit Bases.

The assembly of the seven unit bases which form the horizontal platform at the rear of the Receiver, should now be proceeded with.

The whole of this portion of the Receiver is contained in the Igranic Outfit, and the mounting of the components on the moulded unit bases should be effected in the order indicated by the reference numbers appearing below each base in the full-size lay-out drawing (No. 1).

The seven unit bases are very similar in appearance, and can only be distinguished from each other by slight differences in the drilling of the fixing holes. To simplify the selection of the correct base for use in each of the seven units, and to enable the constructional work to be executed in accordance with these instructions, the bases in each Igranic Outfit are numbered 1 to 7 to coincide with the reference numbers in the lay-out drawing. These numbers are engraved on the underside of each unit base in the position shown in wiring diagram of the Base (Drawing No. 2).

No. 1. Upon the top surface of this base are mounted six contact clips for making connection to the oscillator unit and two special 1 mfd. Mansbridge Fixed Condensers. Beneath the base are mounted one Igranic Freshman Fixed Condenser, ·0002 mfd. (first grid condenser) and two special connectors which serve to connect the oscillator unit to the oscillator condenser.

The left hand Mansbridge Condenser should not be mounted until the base is secured to the bus-bars. All other parts may be mounted, and the base should then be laid aside until the remaining bases have been assembled.

No. 2. This base carries on its upper surface, one Igranic Anti-Microphonic Valve Holder (for the frequency changing valve), while on its underside are mounted one Igranic Fixed Grid Leak (2 megohms) and one Fixed Condenser, ·0002 mfd. These may all be mounted in the positions shown in the practical wiring diagram of the Base (Drawing No. 2) and photographic illustrations, but the milled terminal nut must not be secured to the terminal screw which makes connection to the negative filament socket of the valveholder until the base is secured to the bus-bars as this screw passes through the latter and forms a means of fixing. *This applies to all the valve-holders.*

In mounting the clips for the grid leaks it is advisable to use one of the leaks to determine the correct spacing between them as the bases of the clips are slotted to allow of adjustment. The leaks should, however, be removed before the wiring of the Receiver is commenced.

In mounting fixed condensers a nut should be slipped on each mounting screw close to the bases, after which the fixed condensers should be placed in position and secured.

No. 3. This base carries similar components to those which are mounted upon Base No. 2 with the exception that the grid leak has a resistance value of ·5 megohm, and the addition of the terminal (H.T. 1) to which the high tension supply to the first valve is connected.

No. 4. The only way in which this base differs from No. 3 is that two terminals are mounted upon it, one of these being for the high tension supply to the three intermediate frequency amplifying and second detector valves, and the other serving the same purpose in connection with the audio-frequency amplifying valve. These terminals are marked in the lay-out drawing, H.T.2 and H.T.3 respectively.

No. 5. The components on this base are similar to those on base No. 3, but although only three connections are made to the self-stabilising reactance unit, the right hand contact pin marked "C" in the practical wiring diagram of the Base (Drawing No. 2) is mounted as usual. The terminal marked B—2 is for connection to the biassing battery, for the purpose of applying suitable negative bias to the grids of the intermediate frequency amplifying valves.

No. 6. This base has mounted upon its upper surface one special Igranic "E" type Audio-Frequency Transformer, ratio 3:1, one valve-holder and two terminals, and beneath the base are mounted one fixed grid leak (2 megohms), and one fixed condenser, ·002 mfd.

The Transformer should be fixed by means of two screws passed through the extensions at either side of the base of the instrument, and through the holes in the unit base, when they may be secured by means of hexagon nuts. The four contact pins which project from the insulating strip on the transformer should be passed through the four holes in the base in readiness for the connections to be made to them on the underside. Be sure to mount the transformer so that the contact pin marked O.P. is at the right hand side of the base as shown in the full-size lay-out drawing (No. 1). The grid leak is in association with the second detector valve, which, in use, is mounted in the valve-holder on this base, and the fixed condenser is for shunting the primary winding of the audio-frequency transformer in order to by-pass the radio frequency currents in the anode circuit of the second detector. The terminal B+ is for connection to the positive side of the biassing battery, while the

terminal B—1 permits the application of a suitable value of negative grid bias to the grid of the audio-frequency amplifying valve.

No. 7. The special output transformer, a valve-holder, and two terminals, L.T. + and L.T. – are mounted upon the upper surface of this base, while the underside has nothing whatever mounted upon it. The transformer is secured in a similar manner to the audio-frequency transformer (Unit Base No. 6), the projecting contact pins on the insulating strip at the base of the instrument passing through the five holes which are drilled for the purpose.

To mount the Self-Stabilising Reactances upon the unit bases use the special 4BA screwed pins which are provided. These are threaded along their whole length and are without heads. Run a 4BA hexagon nut a distance of $\frac{3}{16}$" from one end of each screw and insert that end into each of the tapped bushes in the bases of the units, using the nuts to lock the screwed pins in position. The projecting ends of the pins should then be passed through the holes which are drilled in the unit bases and secured on the underside by 4BA hexagon nuts.

The two short pieces of ebonite rod with threaded pins should be screwed into the tapped holes in the centre of each bus-bar to afford additional support to the base.

Assembling the Framework.

Having completed the assembly of the seven unit bases, the metal Framework, consisting of the bus-bars and collapsible angle brackets, should now be assembled so that the unit bases may be mounted upon the bus-bars in readiness for wiring.

Open the angle-brackets so that they assume the shape shown in Fig. 16A, which is a side view of one of the brackets exactly as it will appear when looking at one end of the complete Receiver. The order of assembling the various parts which make up the framework is shown in Fig. 16c, which is a plan of the parts laid out in readiness for assembly. The general appearance of the finished framework is shown in Fig. 16B.

Slip one of the thick $\frac{3}{16}$" metal spacers upon the screwed end of one of the bus-bars as far as it will go. Place another of these spacers between the horizontal and diagonal members of the angle bracket, so that the hole in the spacer is in exact alignment with the holes in the two members, at the points where they effect the junction shown in Fig. 16A. Pass the screwed end of the bus-bar through the angle bracket and spacer, when the screwed end of the bus-bar will be found to project slightly beyond the outside of the angle bracket. Next, place on this portion a thin $\frac{3}{16}$" washer followed by one of the four special hexagon nuts to hold the parts together; but at this stage *the nut must not be tightened.* This, and the other three nuts should be left loose until the seven unit bases have been mounted on the bus-bars, as if they are left loose the bus-bars will automatically take up the correct position when the fixing screws in the unit bases are tightened, after which the four nuts mentioned may be tightened without imposing mechanical strain upon any portion of the framework or base.

Both bus-bars should be secured to this angle-bracket before their opposite ends are affixed to the remaining bracket. This is most important, as if both ends of one of the bus-bars are each secured to an

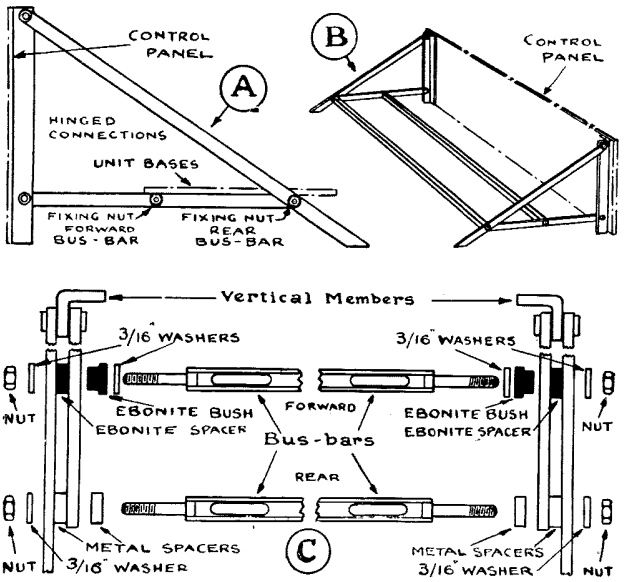


FIG. 16.—(*a*) End view of the Frame work. (*b*) Perspective view of the Framework complete. (*c*) Dissected plan of the Framework showing the order of assembly of the component parts.

angle-bracket before the second bus-bar is fixed it will be impossible to assemble the latter without removing one of the brackets.

The forward bus-bar (see Figs. 16A and 16c) must be insulated from the remainder of the framework, and for this purpose two special ebonite bushes and spacers are provided. Slip one thin metal washer and one of the ebonite bushes on the screwed end of the forward bus-bar, and insert the reduced portion of the bush into the hole which is drilled near the middle of the horizontal member of the angle bracket. Place an ebonite spacer followed by a thin $\frac{3}{16}$" metal washer, and a hexagon nut on the projecting screwed portion of the bus-bar, but do not tighten the nut for the reason previously stated.

Having secured one end of each bus-bar to one of the angle-brackets, a thin $\frac{3}{16}$" washer and an ebonite bush, and a thick $\frac{3}{16}$" metal spacer should be placed on the opposite screwed ends of the forward and rear bus-bars respectively, and following the same procedure as outlined above, loosely fix the bus-bars to the second angle-bracket.

Mounting the Unit Bases on the Bus-Bars.

Before mounting the unit bases upon the bus-bars the latter which have a channelled or U-shaped section, should be placed with the channelled side uppermost as shown in Fig. 17.

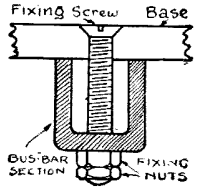


FIG. 17.

Each unit base is secured to the bus-bars by means of four screws with nuts and lock-nuts. The negative filament terminal screws of each valve-holder which pass through the bases, and from which the hexagon nuts were omitted when assembling the bases, each pass through the rear bus-bar and serve as one of the fixing screws Two screws pass through the holes, which are drilled at the top corners of each base, clearly shown in the full-size lay-out drawing (No. 1) and several of the

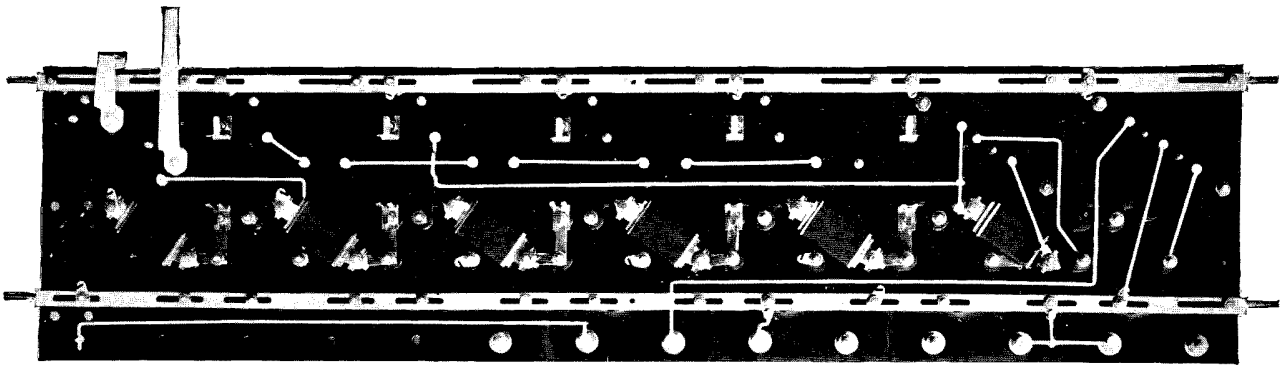


FIG. 18.—View of the underside of the Base of the Receiver showing the completely assembled Unit Bases mounted upon the bus-bars, and the first stage of wiring completed. In the receiver illustrated, the short leads connecting the fixed condensers with the grid terminals of the valve-holders and the grid leaks are made from stout copper foil, which, if preferred, may be used instead of square-section copper wire.

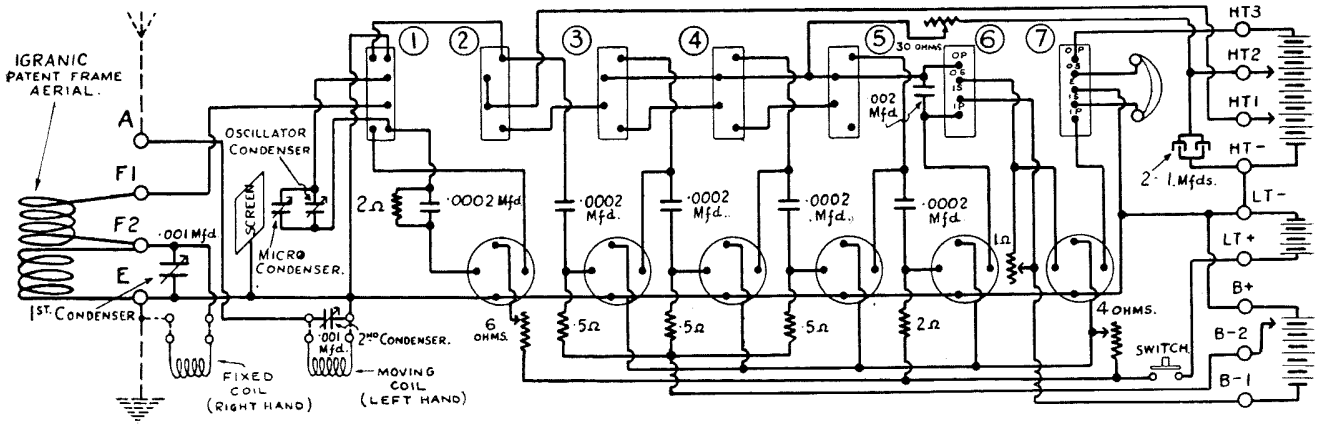


FIG. 19.—Circuit diagram of the Igranic Six-valve Supersonic Heterodyne Receiver. 1, The Base of the Oscillator Unit; 2, 3, 4 & 5, Bases of the Self-Stabilising Reactance Units; 6, Base of the Audio Frequency Transformer; 7, Base of the Special Output Transformer. The connections to Units 1 to 7 and to the valve-holders are as they appear when looking at the underside of the Base of the Receiver.

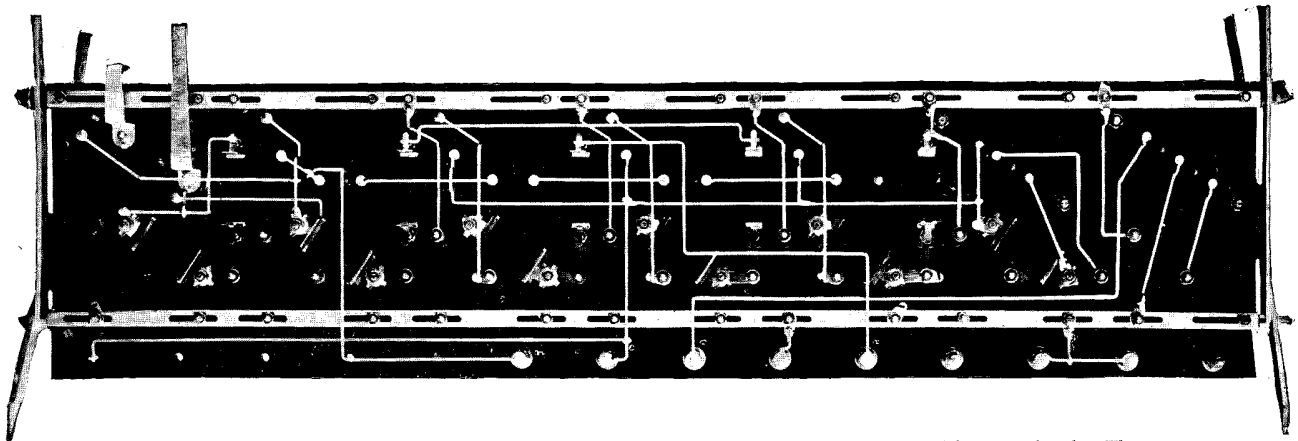


FIG. 20.—Another view of the underside of the Base showing the second stage of the wiring completed. The Base is ready for affixing to the Control Panel so that the interconnecting leads may be secured to both. In this illustration, and in Fig. 18 above, the grid leaks are not shown in the clips in order not to obscure any of the wiring. Both views demonstrate clearly the remarkable simplicity of the wiring.

photographic illustrations. The remaining fixing screw in each base passes through the lowest hole at the extreme left hand side of each base. The positions of the three separate fixing screws are clearly shown in Fig. 9 and full-size drawing No. 1.

Take Unit No. 1 and lay it across the forward and rear bus-bars at the right-hand end of the framework as shown in the full-size lay-out drawing No. 1. Pass four countersunk-head fixing screws through the fixing holes in the unit base and the slots in the bus-bars and place a hexagon nut, lock nut (and terminal tag where necessary), on the projecting end of each screw beneath the bus-bars, but do not tighten until all the units are mounted. It will be observed that four screws are used for fixing this unit as there is no valve holder mounted upon it and, therefore, an additional screw is required. This screw passes through the hole which is marked X in the full-size lay-out drawing and will be covered by the left hand Mansbridge Condenser when this is fixed in position.

Next place each of the remaining units (Nos. 2 to 7) in their correct positions on the bus-bars and loosely fix with three screws and the negative filament terminal screw of each valve-holder. The edges of each unit base should be in close proximity to those of the bases on either side—no gaps should be left between any two bases.

When all the units have been placed in position on the bus-bars the nuts securing the fixing screws should be tightened firmly, but not excessively. The 1 mfd. Mansbridge Fixed Condenser which was omitted from Base No. 1 during assembly, may then be mounted by the side of the one which was previously fixed.

WIRING THE RECEIVER.

The control panel and the base are now ready for wiring and, as previously stated, each should be wired as far as possible, separately.

It will be observed, by reference to the full-size lay-out drawing No. 1, that certain of the connections to the various components on the Control Panel are secured by means of the milled terminal nuts which are provided, while other connections can only be secured by means of soldered joints.

It is possible to secure a few of the connections to the components which are mounted upon the unit bases by means of the hexagon fixing nuts, but it is recommended for most satisfactory results and in order to make a really neat job of the wiring of the base that soldered joints be employed throughout.

Many radio constructors hesitate to attempt soldering because they imagine that it is a very difficult process; others make the attempt, but experience difficulty in effecting really secure and neat joints. There is, however, nothing which should prevent the constructor from making perfectly satisfactory joints provided certain essentials are observed and with a little patience and practice it is quite possible for anyone to make soldered joints which will be electrically and mechanically sound.

For the benefit of those constructors who have not previously attempted to solder joints in the wiring of a Receiver, we have devoted a special section of this Handbook to detailed instructions and hints on soldering (see page 21).

Wiring divided into four Sections.

It is recommended that all the connecting leads between the various components be prepared before soldering is commenced.

These leads should preferably be prepared in four sections as under:—

SECTION 1. Leads which form connections between two or more components on the control panel only (see Fig. 14).

SECTION 2. Leads which must be secured to the components on the base before those leads in Section 3 are affixed, as shown in the photographic illustration of the underside of the base, Fig. 18.

SECTION 3. Leads which are necessary to complete the wiring of the base, as shown in Fig. 20.

SECTION 4. Interconnecting leads between the control panel and base after they are united by means of the framework.

It is recommended that $\frac{1}{16}$" square section tinned copper wire be used for wiring the receiver throughout as this wire may easily be bent to the required shapes, will remain rigid and enables the wiring to be effected in a manner which imparts a neat and attractive appearance to the interior of the receiver. This wire may be procured in straight lengths, each about one yard long, or in large coils, in which case it should be straightened by stretching, and cut into convenient lengths for use.

A pair of square-nosed wire-cutting pliers will be required for cutting the wire to convenient lengths and making right-angle bends, while for forming small loops in the ends of leads which are to be secured beneath milled terminal nuts, a small pair of round-nosed pliers will be extremely useful.

Shaping the Leads.

Having prepared a number of lengths of perfectly straight wire, the shaping of the various leads in Section 1, referred to above, may be proceeded with.

The constructor will appreciate that although the shapes of the various leads in a plane parallel to the control panel are clearly shown in the lay-out drawing, it is impossible to show in a single drawing the shape of the leads in a plane coincident with the line of sight. It will be understood that in some cases one of the ends of a particular lead may be secured to a terminal or soldering tag very close to the rear surface of the control panel and it may be necessary for the lead to rise away from the panel at a right-angle for a certain distance, in order to clear another component, and again to proceed in the original direction. The positions of many of these right-angle bends in the connecting leads may be seen in the various photographic illustrations.

In cases where a lead is shown secured by means of a milled terminal nut, a small loop, as shown in Fig. 21, should be made at the end of the lead, using the round-nose pliers for the purpose. A similar but slightly smaller loop formed at the ends of leads which have to be soldered to terminal shanks, will steady the wire when making the joint and will result in a neat and secure junction between the lead and the terminal.

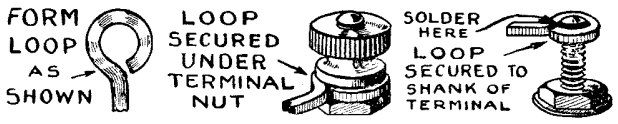


FIG. 21

Section 1.—Wiring the Control Panel.

After being shaped, the leads in Section 1 should be secured to the various components on the control panel. The ebonite cleats which hold the two long parallel leads near the top of the panel should be secured in position by means of a countersunk screw passed through each of the three fixing holes in the panel, from the front, and through the holes in each cleat. A small hexagon nut and washer on the projecting end of each screw will hold the cleats firmly. The ends of the leads referred to may now be soldered to the shanks of the appropriate terminals and to the connecting tags which are in electrical connection with the fixed banks of plates in the first and second tuning condensers. The remaining leads may then be secured to the components on the control panel, either by soldering, or by clamping the loops at their ends beneath milled terminal nuts.

The connections to the terminals of the coil holder should pass through the four holes in the panel which have been drilled for the purpose. One end of each of these four leads should be secured by means of the coil-holder terminals and the opposite ends should be soldered at the points shown.

It will probably be found most convenient to connect the four leads to the terminals of the coil holder before securing to the panel. The leads may then be inserted through the holes in the panel and connected to the correct points after securing the coil holder.

Sections 2 & 3.—Wiring the Base.

Having completed this stage of the wiring, the first part of the wiring of the base may be carried out, this being Section 2, previously referred to. The same procedure with regard to shaping and securing the leads as was described in connection with the control panel should be followed.

The wiring of the base is clearly shown in the full size practical wiring diagram (Drawing No. 2) and photographic illustrations of the underside of the Receiver which appear on page 12 (Figs. 18 and 20).

It will be seen that many of the leads make connection to more than two points or components on the base and in several cases run across two or three of the unit bases in proceeding from one point to another. In certain cases these leads have right-angle bends at several points along their lengths and it will be found convenient to shape the leads in a single length so that when the extremities have been secured the intermediate soldered connections of the lead to other components may be made in a single operation at each point. If, however, the constructor finds it easier to make such leads in two sections, there is no objection to this being done, but it will generally be found more convenient to make the lead in a single length. Instances of lead, such as those referred to above, are provided by those which make connection from the lower sides of the grid leaks in units 2 to 6 to the fixed condensers on each of the preceding units (Nos. 1 to 5), with intermediate soldered connections to the grid terminal screws of the valve-holders. It will be appreciated that each of these connections may be made either by means of two short straight connections or by a single lead with a right-angle bend at the point where it is soldered to the grid terminal screw of the valve-holder.

Having completed all the wiring comprised in Section 2, exactly as shown in the photographic view Fig. 18, Section 3 may be proceeded with to complete the wiring of the base.

If the grid leaks have previously been inserted in the clips, they should be removed while making the soldered connections to the clips to avoid possible harmful effects which may be caused by overheating.

It will be seen by reference to the practical wiring diagram of the Base (Drawing No. 2) that some of the leads in Section 3 are connected at certain points to the leads which have been previously secured. These junctions are indicated by means of small white squares in the wiring at each point where a junction occurs. Fig. 22, illustrates several good methods of making these joints, any of which may be used according to convenience under different conditions.

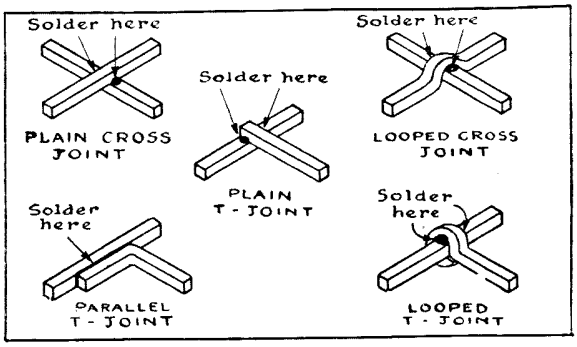


FIG. 22.

Section 4.—Inter-Connecting Leads.

The Control Panel and Base, having been separately wired as far as possible, should now be united by means of the angle-brackets. Lay the framework upon a flat surface and stand the control panel against the vertical members of the angle-brackets, so that the three fixing holes at either end of the panel register with the holes in the brackets. Pass three countersunk-head fixing screws through the panel and brackets at both ends and secure by means of hexagon nuts. The two sections of the Receiver are now rigidly united and the inter-connecting leads between the two may be secured to the appropriate components. These leads are numbered consecutively from 1 to 14 in the full-size lay-out drawing (No. 1) and in order that the corresponding leads which are not completely shown in the practical wiring diagram of the base (Drawing No. 2) shall be easily identified, they have been given similar numbers. Although these leads, must of necessity, appear to be bent in one plane only in the full-size lay-out drawing (No. 1), it will be realised that each lead has an upward bend from the base to the component to which it is connected on the control panel, the position of this bend depending upon the distance from the panel of the connecting point on the component.

A metal strap will be required for connecting the terminals F1 and F2 for use under certain operating conditions which are referred to in Part IV. of this Handbook. This strap may be cut from a piece of sheet brass or phosphor-bronze and slotted as shown in Fig. 23 or it may be shaped from [illegible] wire that has [illegible] for wiring the Receiver as shown in the same figure.

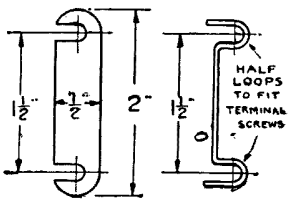


FIG. 23.

General Remarks on Wiring.

It will be noticed, upon inspection of the various drawings and photographs in this Handbook, that the disposition of the connecting leads has been very carefully arranged with a view to securing highly efficient operation and at the same time to preserve a neat and symmetrical appearance.

Special attention has been given to the arrangement of the oscillatory high-potential leads so as to avoid undesirable capacitative couplings. It will be observed in this connection that all leads directly communicating with the grids and anodes are extremely short and well separated from other leads.

The connections from the oscillator condenser to the oscillator unit have been arranged with a very definite spacing between them, and it is essential that these leads should be shaped exactly as shown in Fig. 24 and that the correct spacing between them should be maintained. The two special connectors which are mounted on the underside of Unit base No. 1, and which project beyond its forward edge, automatically provide for the correct spacing between these leads at one end, while the two connecting tags on the oscillator condenser preserve the correct spacing of the leads at their opposite ends.

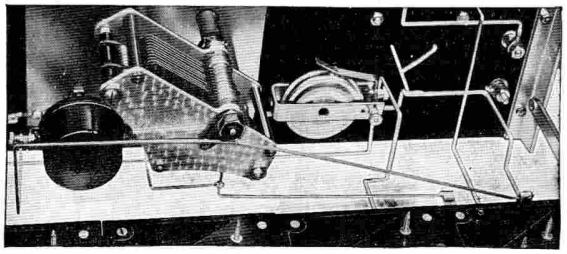


FIG. 24.—Showing leads to Oscillator Condenser.

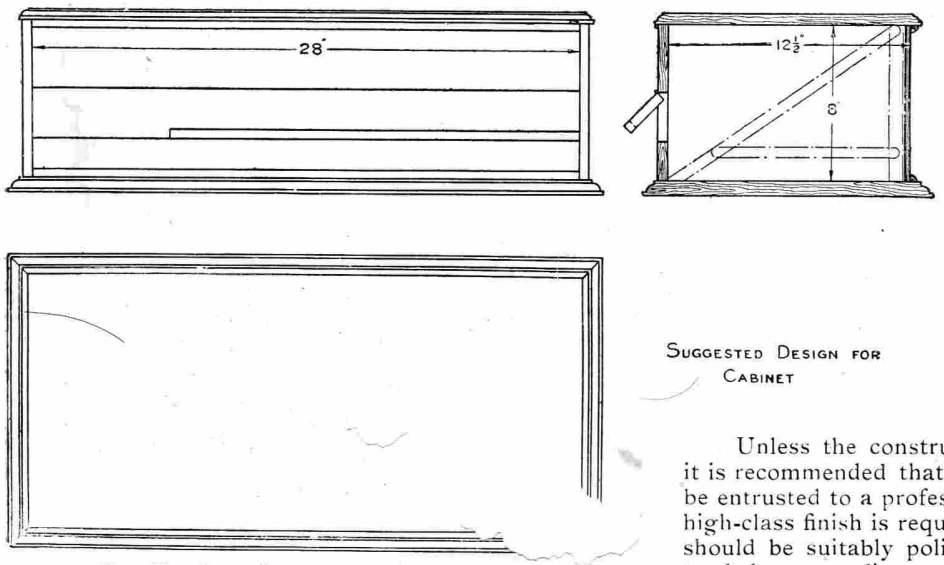
All leads should be shaped so that they connect any two points or terminals without strain, as if force has to be used to bring a lead into contact with the terminal or tag to which it has to be soldered, there is always a danger that if the joint is not perfectly sound the lead may at some future time break away from the connecting point and, owing to the springiness of the wire, make contact with another lead, possibly with disastrous results to the valves or other components.

THE CABINET.

Many constructors of the Igranic Six-valve Super Heterodyne Receiver will wish to procure a suitable cabinet in which to enclose it for the dual purpose of protection and the elimination of dust. Such a cabinet will impart a handsome appearance to the complete instrument and will justify its installation in the most tastefully furnished room. The Igranic Super Heterodyne Receiver is essentially a drawing-room instrument owing to the fact that the only connections which need be visible are those from the frame aerial to the Receiver and from the latter to the telephones or loud speaker, while all batteries may be concealed and their connecting leads brought to the Receiver by means of a small hinged flap in the back of the cabinet. The Igranic Frame Aerial is beautifully finished and of very dignified appearance, and no objection to its being used in any room, on the score of untidiness or unsuitability, could reasonably be raised.

A suggested design for a cabinet, with general dimensions, which will be found extremely suitable for the Receiver, is given in this page (Fig. 25). The top of the cabinet is hinged to facilitate easy removal of the Receiver at any time and to enable the oscillator unit to be changed when desired. When closed the lid of the cabinet locks the control panel in position and so prevents the Receiver sliding from the cabinet during transport. Two small hooked catches should be provided at either end of the cabinet to secure the lid when closed.

The design need not be strictly adhered to in regard to detail, as it may be desired to obtain a cabinet which will harmonise with a special scheme of furnishing. The cabinet may be constructed from any suitable hard wood, such as oak, walnut, or mahogany, the choice of which also may be governed by existing conditions.



SUGGESTED DESIGN FOR CABINET

FIG. 25.—Suggestion for a suitable Cabinet.

A hinged flap is provided in the back of the cabinet to facilitate the making of connections from the batteries to the receiver, and a portion of the lower edge of the flap is removed to allow it to be closed without disturbing the leads. An alternative method which may be preferred by some constructors is to dispense with the hinged flap and to provide a row of small holes through which the various leads may be passed. This form of construction will probably be more effective in excluding dust.

Unless the constructor be an expert wood-worker it is recommended that the construction of the cabinet be entrusted to a professional cabinet-maker if a really high-class finish is required. The cabinet, when made, should be suitably polished to harmonise with its intended surroundings, and this also will best be done by a skilled French polisher.

IGRANIC SIX-VALVE SUPERSONIC HETERODYNE RECEIVER.

PART IV.

OPERATING DATA, QUESTIONS AND ANSWERS AND CONCLUDING NOTES.

Preliminary Considerations.

Carefully check the Assembly and Wiring and make sure that all has been carried out exactly as specified in this Handbook and the associated full-size drawings.

A quantity of cable, preferably of the rubber-covered multi-strand type, sold as high-tension flex, should be procured for use in connecting up the Receiver. Where wander plugs are not required it will be found advantageous to solder spade type connectors to the ends of the leads. The use of these spade connectors will prevent the ends of the multi-strand cable from fraying and will enable a neat appearance to be preserved.

Connecting the Batteries and Loud Speaker.

The terminals at the rear of the base of the instrument serve to link the Receiver with the various batteries, while the terminals upon the Control Panel are connected to the particular aerial employed and also to the loud speaker. The batteries should be connected as indicated in Fig. 26, the aerial afterwards being attached according to subsequent directions. Do not connect terminal H.T. – to the anode battery until the appropriate Valves (see Page 6) have been inserted in their holders and found to glow when the Oscillator and Amplifier filament rheostats are set at, say, position 140 and the Switch is closed. Upon the resistance of the loud speaker will depend the way in which the terminal panel on the output transformer should be inter-connected. Fig. 27 indicates the procedure to be followed according to whether a low resistance or high resistance loud speaker is employed.

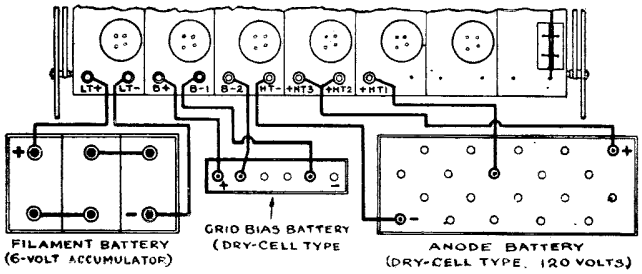


FIG. 26.—Showing the method of connecting the batteries to the Receiver.

KEY TO THE CONNECTIONS.

LT+	To positive terminal of 6-volt Accumulator.
LT–	To negative terminal of 6-volt Accumulator.
B+	To positive terminal of Grid Bias Battery.
B–1	To 9-volt tapping of Grid Bias Battery.
B–2	To 1½-volt tapping of Grid Bias Battery.
HT–	To negative terminal of Anode Battery.
+HT3 / +HT2	To 120 volt tapping of Anode Battery.
+HT1	To 60 volt tapping of Anode Battery.

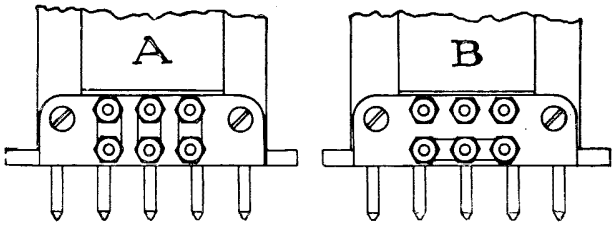


FIG. 27—Output Transformer Terminal Board.
(*a*) Arrangement of connecting links when using low resistance loud speaker or telephone. Secondary windings in parallel.
(*b*) Arrangement of links when using high resistance loud speaker or telephone. Windings in series.

Choice of an Aerial and Tuning System.

The Igranic Receiver is provided with comprehensive, yet simple, means enabling the employment of either a Frame Aerial, Indoor Aerial or Outdoor Aerial, and in all cases the type of aerial chosen may be coupled to the Set either directly or through the intermediary of a 2-circuit tuner.

These alternatives have been made available to meet the convenience of the user and to provide specific remedies for particular classes of interference which may be encountered. The connecting and operating schemes will be dealt with separately, the advantages peculiar to each method being made clear in the form of an interference Chart when this has been done.

Method A.—Employing Igranic Patent Frame Aerial.

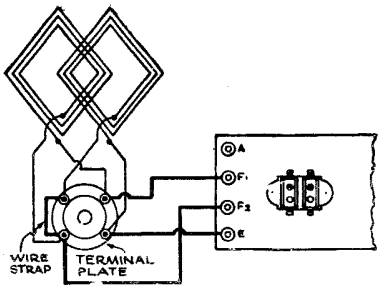


FIG. 28.—Method A.

This Frame Aerial consists of a number of turns tuned by the 1st Condenser, an equal number of turns being wound in the opposite sense and not tuned. The inside ends of the two windings should be connected together by means of a metal or wire strap as shown in Fig. 28. A lead taken from one of these should be connected to F.2, while one of the outside terminals should go to F.1 and the other to E. These leads should not be twisted together and, to enhance the directional effect of the Frame Aerial, they should be made as short as convenient.

To tune to any wavelength consult the Oscillator tuning chart (Fig. 29) and adjust the Oscillator control in the vicinity of either of the indicated points. Allow the Oscillator to remain on the Oscillator control and with the other hand swing the 1st Condenser. As the 1st Condenser brings the Frame tuning into the correct relation with the Oscillator tuning, the loud speaker

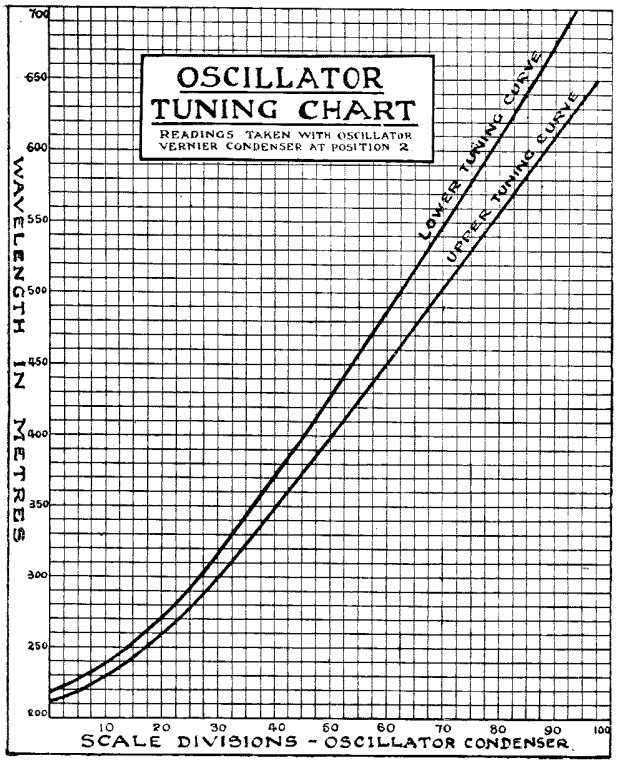


FIG. 29

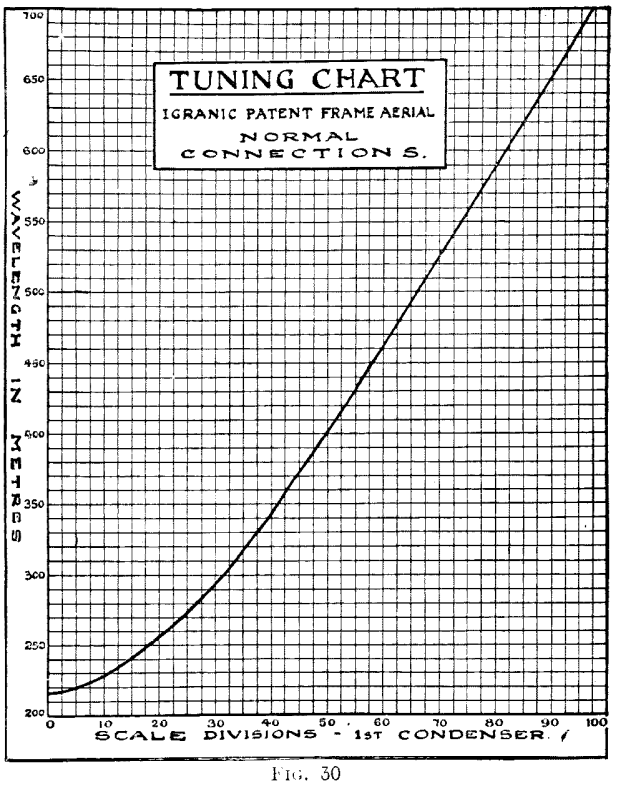


FIG. 30

will come into action, emitting any signals that are present, or, alternatively, the usual slight "background" of parasitic noise indicating that the Set is "alive" and responsive to signal frequency impulses arriving upon the Frame. When the desired station is heard, the Frame Aerial should be rotated to the plane giving the greatest intensity, the final tuning adjustments then being made to secure the most favourable effect. It will be found that only the Oscillator tuning is at all critical, and to simplify its adjustment on feeble stations the Oscillator Vernier has been provided.

The Strength Control imparts a variable degree of reaction to the intermediate frequency amplifier, and this reaction effect may be used to strengthen very weak stations. Rotating the knob in an anti-clockwise direction will strengthen signals but if the amplifier oscillates the control must be retarded or the quality of reproduction will suffer.

The function of the Tone Control is to curtail the strength of powerful stations so that they shall not overload the audio frequency amplifying valve and produce distortion due to grid-current and back-bend effects. Position 7 provides maximum strength and the volume may be decreased in a continuously variable manner by reducing this reading.

When it is desired to predetermine the adjustments for a particular station or to ascertain the approximate wavelength of a station already [illegible] the Oscillator tuning and Frame tuning chart [illegible] should be consulted. This is not necessary when making a "general search," since the simultaneous use of both hands enables the Oscillator and 1st Condenser controls to be so rapidly synchronised, that to explore a waveband is but the task of a minute or two. The rapidity of operation arises from the fact that the Oscillator control is the *governing* adjustment, and if this control is varied progressively, the 1st Condenser control may, with a like progressive variation, be "kept in step" throughout the waveband by noting the character of the output from the loud speaker.

Method A.1.—"Loading" the Igranic Patent Frame Aerial.

The Igranic Patent Frame Aerial may be loaded for the reception of longer waves, in the manner shown in Fig. 28a. The frame aerial and associated loading coil are connected to the receiver in a manner which retains the advantages of the special counter-winding for the elimination of possible long wave interference. Suitable loading coils may be chosen by reference to Table No. 1.

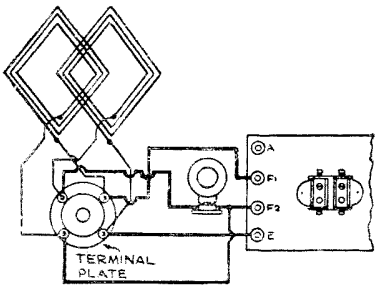


FIG. 28A

Table No. 1 - METHODS A.1 & B.

Igranic Patent Frame Aerial.

Wavelength Range in Metres.	Loading Coil (Tuned by 1st Condenser)
215—715	—
600—1725	No. 150
1600—3500	,, 250

Method B. Using a Simple Frame Aerial.

Attach the two ends of the usual type of frame winding to terminals F.2 and E, afterwards connecting together F1 and F2 as shown in Fig. 31.

The operating procedure is similar to that outlined above in connection with Method A.

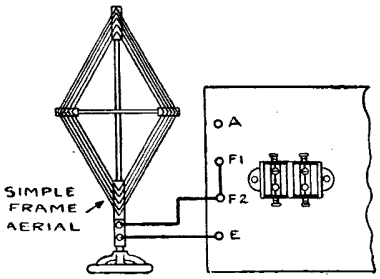


FIG. 31.—Method B.

"Loading" the Simple Frame Aerial.

When using Oscillator Units 2 or 3 an Igranic Coil of suitable value should be inserted in the lead already connecting the frame to terminals F1 and F2. Suitable coils may be chosen by reference to Table No. 1.

Methods C.1. and C.2.—Employing the 2-Circuit Tuner in Frame Working.

(C.1.) When the IGRANIC PATENT FRAME is used, first remove the linking strap joining together the two windings and totally disconnect both windings. Afterwards connect the two ends of one winding (it does not matter which) to A and E respectively, following this by connecting together F1 and F2 (see Fig. 32).

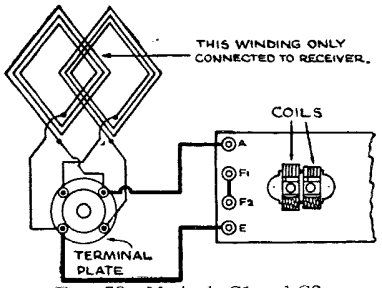


FIG. 32—Methods C1 and C2.

(C.2). When a SIMPLE FRAME is used, first connect the two ends of the winding to A and E respectively and join together F.1 and F.2. It will be seen that the leads are arranged in a manner similar to C.1.

The chosen frame having been connected to the receiver, place suitable Igranic Coils in the moving and fixed coil-holders according to Table No. 2 and couple the coils tightly, afterwards adjusting the Oscillator and 1st Condenser controls as previously described. When a station is located separate the two coils gradually, re-tuning with the Oscillator and 1st Condenser controls, and also with the *2nd* Condenser control, as required. Aim at effecting the weakest possible coupling (*i.e.*, the greatest separation of the coils) which will yield the required volume of sound. It will be found that excellent results will be obtained with exceedingly weak couplings, and it should be noted that in this latter condition all the tuning adjustments are independent of each other and are more sharply defined than usual.

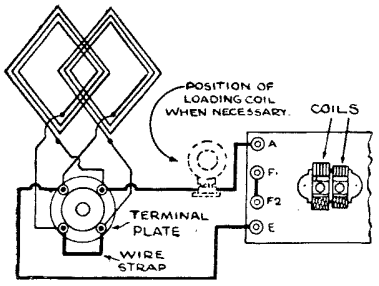
When working above 700 metres it will be noted the two windings of the Igranic Frame Aerial are connected in series, the appropriate re-arrangement of wiring being indicated in the Diagram included in Table No. 2.

In the case of a Simple Frame Aerial the loading coil must be chosen [illegible] Table No. 1 and the adjustments [illegible].

Table No. 2 - METHOD C1.

Igranic Patent Frame Aerial with 2-Circuit Tuner.

Wavelength Range in Metres.	Loading Coil (Tuned by 2nd Condenser)	Moving Coil	Fixed Coil (Tuned by 1st Condenser)
215—715	—	No. 150	No. 50
*Frame Windings in Series.			
480—1350	—	,, 300	,, 100
1050—2600	No. 150	,, 750	,, 200
1900—3500	,, 300	,, 1250	,, 400



*To connect windings in series, when working above 715 metres, re-arrange terminal connections on frame aerial as shown.

Method D.—Using an Indoor or Outdoor Aerial.

Whilst almost any form of indoor or Outdoor Aerial may be attached to the Igranic Receiver, it is as a rule beneficial to employ a short one.

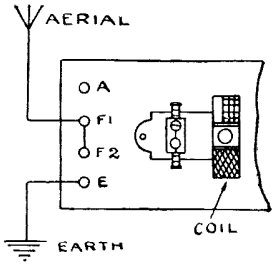
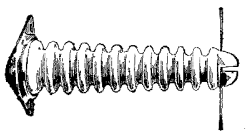


FIG. 33—Method D.

A suitable Indoor Aerial may consist of an insulated single wire having a total length of the order of 25 or 30 feet, the down lead feeding the Receiver being taken from one end or from the centre. The wire should preferably not be allowed to approach nearer to the wall than 4 or 5 inches, but such is the magnitude of the available amplification that no difficulty will be experienced in obtaining good results with almost any arrangement.

The Aerial should be connected to F.1 and the earth to E, terminals F.1 and F.2 being strapped (see Fig. 33). Place an appropriate coil (see Table No. 3) in the fixed coil-holder according to the Oscillator Unit employed and operate with the 1st Condenser and Oscillator controls on the general lines indicated for Method A.



Igranic Stand-Off Insulator, suitable for Indoor Aerials.

Table No. 3 - METHOD D.

Indoor or Outdoor Aerial.

Wavelength Range		Wavelength Range in Metres	Fixed Coil (Tuned by 1st Condenser)
	,, 30	1000—2000	No. 150
	,, 40	1500—3000	,, 200
	,, 75	2000—4000	,, 300
1400	,, 100	—	—

Method E.—Employing the 2-Circuit Tuner in Aerial Working.

Connect the aerial to A and the earth to E and see that terminals F.1 and F.2 are strapped as shown in Fig. 34. Place Igranic Coils in the moving and fixed coil-holders, according to Table No. 4, and proceed with operation on the lines indicated for Method C.

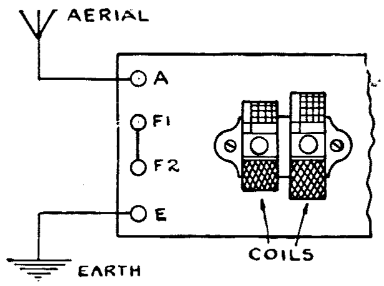


FIG. 34—Method E.

TABLE No. 4—METHOD E.

INDOOR OR OUTDOOR AERIAL WITH 2-CIRCUIT TUNER.

Wavelength Range in Metres	Moving Coil (Tuned by 2nd Condenser)	Fixed Coil (Tuned by 1st Condenser)	Wavelength Range in Metres	Moving Coil (Tuned by 2nd Condenser)	Fixed Coil (Tuned by 1st Condenser)
200-400	No. 30	No. 50	1000-2000	No. 150	No. 200
300-600	,, 40	,, 50	1500-3000	,, 200	,, 200
500-1000	,, 75	,, 100	2000-4000	,, 300	,, 400
700-1400	,, 100	,, 100	—	—	—

NOTE.—The ranges specified in the foregoing Tables represent conservative approximations and are only applicable when **Igranic Triple Honeycomb Coils** are used.

AN INTERFERENCE CHART.

In practically every case Method A will prove eminently satisfactory and will yield the best possible results. In certain localities, however, peculiar conditions may obtain and for this reason the alternative methods of operation have been specified and their particular advantages in combating regional interference dealt with in the following Chart :—

CAUSE.	EFFECT.	REMEDY.	NOTES
Station working near the wavelength of the Intermediate Frequency Amplifier.	A whistling note which changes as the Oscillator control is rotated, but which makes its appearance at *both* Oscillator settings of *whatever* station is tuned in.	Completely eliminated by Method A, or, with greater attendant complexity, by Method C.2. Method D will also effect entire elimination, but at the expense of the valuable directional effect.	Most likely to occur when Method B is used.
Station working on the same wavelength as the desired station.	The interfering station produces a whistling note which does not change when the Oscillator control is rotated.	Only the directional effects obtaining in Method A or Method B will prove effective.	Most difficult to eliminate when Method D is employed.
Station working in the second channel of wavelength made available by the frequency changing process.	A heterodyne note which is not experienced at *both* Oscillator settings and which changes twice as rapidly as usual for the same movement of the Oscillator control.	Explore the alternative Oscillator setting. This will eliminate the original interference, but may be productive of fresh interference, in which case employ Method C1 or C2. Method E may also be used effectively.	Most likely to occur when Method D or Method B is used.
Static (Atmospheric Disturbances).	Irregular crackling or grinding noises. To diagnose, disconnect the Frame or other Aerial, and Earth (if any) from the Receiver and note that these noises are greatly reduced.	The elimination of strong static is not possible, but the ratio of signals to static may be improved by using Method A or alternative Methods C1, C2, or E.	Unduly prominent when Method D is used, embodying a lengthy and high aerial.

ANALYSIS OF THE CHART.

An analysis of the Chart ind[illegible]ates t[illegible] one of all the possible combinations, [illegible] t Frame either used by itself (Metho[illegible] [illegible] Tuner (Method C.1), will pro[illegible] in dealing with every class of [illegible]

The alternative in order of [illegible] indoor aerial either by itself (Metho[illegible] 2-circuit tuner (Method E).

It will have been realised that the Metho[illegible] do not employ the 2-circuit Tuner involve but [illegible]wo tuning adjustments, and hence are most advantage[illegible] is desired to conduct a general search and to [illegible] from station to station.

The use of the 2-circuit Tuner inv[illegible] [illegible]hree adjustments, but if the operator has patience, [illegible] desire to [illegible]eive each station to the be[illegible]t [illegible] [illegible]al complication will [illegible] [illegible]ng or eliminating [illegible] [illegible] [illegible]s also preferab[illegible] [illegible] [illegible]e vicinity [illegible]

RADIO IGRANIC DEVICES

QUESTIONS AND ANSWERS.

QUESTION No. 1. Should I order the Igranic Super Heterodyne Outfit from the manufacturers?

ANSWER. No. The Igranic Company distributes its products through the Trade and conducts no direct retail business. Enquire of your Radio dealer who will be able to give prompt delivery.

QUESTION No. 2. Is it possible to obtain factory built Receivers of the Igranic Six-valve Super Heterodyne type?

ANSWER. No. The Igranic Company specialises in the design and production of components and accessories for the constructor and experimenter and does not manufacture complete Receivers.

QUESTION No. 3. Why are no terminals provided for headphones?

ANSWER. The Igranic Receiver is essentially a loud-speaking apparatus and even in the case of the most distant stations it is unnecessary to use headphones. If it is desired to employ them they should be connected to the terminals marked "loud-speaker."

QUESTION No. 4. Why are anti-microphonic valve holders used?

ANSWER. To entirely eliminate the unpleasant "ringing" noises which occur when the controls of a dull-emitter valve receiver are manipulated or when there is any vibration in the vicinity of the set. In addition, these holders totally obviate microphonic reaction effects which would cause "howling" when the loud-speaker works at great intensity in the immediate neighbourhood of the valves.

QUESTION No. 5. Would the sensitivity of the Receiver be increased by the addition of a further stage of intermediate frequency amplification?

ANSWER. No. The use of high amplification valves working in long-wave circuits designed to suit their constants enables the three stages to yield the highest amplification which may usefully be employed. Increased amplification would not, save under exceptionally favourable conditions, increase signal intelligibility since the ratio of the limiting long-distance parasitics would not change.

QUESTION No. 6. May dry cells be used for heating the filaments?

ANSWER. No. Although the 1½ ampere consumption of filament current is small for a powerful multi-stage Receiver, it is too high to permit of the economical employment of dry cells.

QUESTION No. 7. Do the batteries need any preparation before use?

ANSWER. The anode and grid bias batteries, which should be tested in the purchaser's presence, are ready for use and this also applies to the accumulator battery if it is supplied in a fully-charged condition.

QUESTION No. 8. How shall I know when my dry-cell batteries are running down?

ANSWER. Crackling noises which occur irrespective of the presence of an aerial or of the relation of the aerial tuning and oscillator controls, may indicate that the batteries have deteriorated. It is the best practice to obtain a double-scale voltmeter and to use it to check the condition of the batteries every two or three weeks. This test should be made while the Receiver is in operation and if the voltage is found to have fallen below 75% of the rated value the batteries should be discarded and fresh ones substituted.

QUESTION No. 9. How shall I know when my accumulator is running down?

ANSWER. The brilliancy of the valve filaments will decrease and this will be accompanied by a rapid decline in signal strength. The low voltage scale of the voltmeter previously referred to, should be used to check the condition of the accumulator, which, if a reading of less than 5½ volts is registered, should be taken to the charging station. This test should be carried out while the battery is delivering current to the filaments and should be made at least five minutes after the commencement of working.

QUESTION No. 10. How shall I deliver the appropriate anode voltages to the various valves?

ANSWER. Reckon the voltages from the negative (—) end of the battery and place wander plugs in the appropriate sockets.

QUESTION No. 11. How shall I apply the grid bias voltages?

ANSWER. Reckon the voltages from the positive (+) end of the battery and place wander plugs in the appropriate sockets.

QUESTION No. 12. Are the anode voltages specified in the Valve Table (page 6) irrevocably fixed?

ANSWER. No. They represent the values normally used and while it is as a rule unwise to vary the intermediate frequency, second detector, or audio frequency voltages, it may sometimes prove advantageous to vary the oscillator voltage.

QUESTION No. 13. Will the control settings I have recorded for particular stations hold good when the Receiver is used in a different locality or on a different aerial arrangement?

ANSWER. In the case of a different locality—Yes. If a different aerial arrangement is used the aerial tuning may alter slightly but the reading of the oscillator control will not change, and, since this is the governing adjustment, any slight discrepancy of the aerial tuning control may be corrected almost automatically.

QUESTION No. 14. What resistance loud-speaker or telephones will prove most satisfactory?

ANSWER. The low resistance type, between 1[illegible] and 250 ohms.

QUESTION No. 15. Is a Licence necessary when an indoor aerial or frame aerial is used?

ANSWER. Yes. [illegible] user of any Radio Receiver [illegible] Broadcasting Licence which is obtainable from any Post Office [illegible] costs 10[illegible] and is renewable yearly.

QUESTION No. 16. W[illegible] king upon a given wavelength is it best to use a large [illegible] with a small [illegible] loading, or a small coil with a large [illegible]?

ANSWER. [illegible] should be used if selectivity is the [illegible]

[illegible] No. 17. Ho[illegible] [illegible] To conserve the [illegible] lowest [illegible] [illegible] ate [illegible] [illegible] retain the correct [illegible] [illegible] of [illegible] in [illegible]

ANSWER. If the recommended components have been obtained direct from the radio dealer and have not been subjected to previous use we may eliminate them from our survey of possible faults.

The following steps should be taken:—

(a) See that the Tone control is set at position 6 or 7.

(b) Examine, clean, and adjust the valve pins, splaying the pins where necessary.

(c) Check all battery voltages and make certain that the positive and negative poles are connected correctly.

(d) Check the emission of the valves. To do this, connect the headphones across the .002 mfd. condenser secured to the underside of unit base No. 6, switch off the oscillator valve, and remove the audio frequency valve. Substitute the spare valve so obtained for each of the intermediate frequency valves in turn. If in any case the substitution of this valve enables the long-wave (intermediate frequency) stations to be received, or effects a noticeable improvement, the original valve should be forwarded to the radio dealer for an emission test and possible replacement. When the long-wave stations are received re-insert the oscillator unit and manipulate the appropriate tuning controls until signal frequency stations are heard. If results are negative place the audio frequency valve in the oscillator valve holder and test.

(e) In the unlikely event of failure to diagnose the trouble, communicate with:

SERVICE DEPARTMENT,
IGRANIC ELECTRIC CO. LTD., ELSTOW CONTROLLER WORKS
BEDFORD

QUESTION No. 21. When employing Methods D or E what earth should be used?

ANSWER. Connect the earth terminal to a water supply pipe if one is near the Receiver. Alternatively obtain a metal earthing stake from your radio dealer and bury it in damp soil. A further alternative is provided by the use of some 20 or 30 feet of insulated wire laid under the carpet.

QUESTION No. 22. In the absence of signals or static how may it be proved that the Receiver is sensitive?

ANSWER. By touching together the ends of a loop of wire in the vicinity of the Receiver and noting a sharp click in the loud speaker.

QUESTION No. 23. What is the cause of broken speech or music ("blasting"), and how may it be remedied?

ANSWER. Assuming that this is not due to transmission phenomena, it may be due to—

(1), overloading of the audio frequency valve, or—

(2), saturation of the second detector. Strange as it may appear to those unacquainted with the potentialities of such a powerful Receiver, this latter effect may be produced by Stations many hundreds of miles away.

To remedy (1) reduce the Tone control. If this is not effective, the trouble is due to (2) and the Strength control should thereupon be reduced and/or the aerial tuning circuit(s) mistuned.

QUESTION No. 24. Is it inefficient to "load" a frame aerial for reception on higher wavelengths?

ANSWER. Yes, but the necessity for a high degree of loading arises chiefly in connection with the usual type of simple frame aerial and a more satisfactory alternative to this arrangement is provided by an indoor aerial. If, however, the Igranic Patent Frame is employed with the 2-circuit tuner, the two windings may be connected in series. This will enable the frame to be used on wavelengths up to 1,300 metres without loading and above this wavelength only a small amount of loading, will of course, be necessary. It is worth noting that even with a highly loaded simple frame Daventry may be received satisfactorily in any part of the United Kingdom.

QUESTION No. 25. How can I determine the extent to which the Igranic Patent Frame Aerial eliminates long-wave interference?

ANSWER. Proceed as in Method B save that the terminals on only one side of the Igranic Frame should be employed, those on the opposite side remaining disconnected.

QUESTION No. 26. What may be the cause of a steady humming or buzzing, particularly on low wavelengths?

ANSWER. This is probably due to induction from electric motors, lighting systems, or power circuits in your immediate vicinity. Relief is sometimes afforded by the directional properties of a frame aerial, preferably arranged on the lines indicated for Methods C1 and C2. In the case of an open aerial the coupled circuit arrangement (Method E) should be tried, the earth connection being attached preferably to a counterpoise underneath the aerial consisting of an insulated wire a few feet above the ground running in the same plane and having the same length as the aerial wire.

QUESTION No. 27. Does a glowing filament indicate that the valve is in a perfect condition?

ANSWER. No, not necessarily. It may have lost its emission in which case it will give no results. See Question No. 20 (d) for diagnosis.

QUESTION No. 28. Why should long-wave interference be experienced when a simple frame aerial (Method B) is used?

ANSWER. Every transmitter induces a voltage in a receiving aerial irrespective of the wavelength to which the latter is tuned. The responsiveness of an aerial to widely non-resonant transmission is, however, negligibly small and in systems arranged to amplify at the aerial frequency the effect of widely non-resonant voltages is still further reduced, hence they are rarely made audible. But the Super-heterodyne Receiver, it must be remembered, amplifies many thousandfold a small band of frequencies which are widely non-resonant to the aerial system and if voltages of similar frequency are present in the latter they may receive sufficient amplification to bring them to audible intensity. Complete remedial measures are available on the lines specified in the Inter[illegible] chart.

QUESTION No. 29. What is the effect of making the intermediate frequency amplifier oscillate by manipulating the Strength control?

ANSWER. [illegible] the intermediate frequency amplifier will [illegible] be obscured by a whistling noise [illegible] or control is rotated. This co[illegible] [illegible] owing receivers but it should [illegible] the [illegible] of the Strength con[illegible] [illegible] k of oscillation the tone [illegible] practically eliminated. [illegible] coils specifi[illegible] he n[illegible] [illegible] mate to the wavelengths [illegible] coupling medi[illegible] between the [illegible] and they are in parallel with the inductance of the [illegible] ne resonance condition does not apply.

[illegible] shall I learn of any future developments [illegible] [illegible] est to be kept informed of [illegible] [illegible] sted to hear of your results [illegible] [illegible] you posted in any new pr[illegible] which may still [illegible] [illegible] [illegible] them.

USEFUL HINTS ON SOLDERING.

The Soldering Iron.

The Soldering Iron used for wiring in Radio work should be very carefully selected, as upon its suitability for the work to be done will depend, in a large measure, the success or failure of this part of the constructional work. An Iron with a medium sized copper bit will be found most suitable for general use. If the bit is too small it will not retain the correct temperature for any length of time and it will be found necessary to re-heat the Iron after each joint has been made. If, on the other hand, the bit is too large, it cannot be inserted into positions which are difficult of access.

There are two general types of soldering irons which find favour with Radio constructors; one in which the bit is affixed to the iron in a straight line, and the other in which the bit is set at a right-angle to the iron. Either type may be used according to the preference of the constructor, but it will be found that the straight pointed type of bit will be most convenient in wiring the Igranic Super-Heterodyne Receiver. Certain makes of soldering irons have an adjustable bit which may be set at any desired angle with relation to the shaft of the Iron. When a suitable electric supply is available, an electric soldering iron will be found extremely convenient. A well-designed iron of this type will quickly heat to the correct temperature for soldering and will remain in this condition as long as the current supply is maintained. Moreover, an electric soldering iron is much more pleasant to use and avoids the necessity of employing a soot-producing gas jet or other form of flame heating device. A very efficient type of electric soldering iron is supplied by the Igranic Electric Co. Ltd., and may be obtained

Igranic Electric Soldering Iron.

from all Radio dealers. This soldering iron is manufactured in three sizes; light, medium, and medium heavy, and can be supplied for voltages between 95 and 250, A.C. or D.C. It can also be supplied to suit a 32-volt supply if required. The exterior of the iron is perfectly smooth, having no projections which might catch and damage delicate work. All parts are easily removable, replacable, and interchangeable. Particulars of the power dissipations, dimensions and weights of the three sizes are set out below:

Watts	Tip Diameter	Length	Weight
100	$\frac{3}{8}$"	12$\frac{1}{4}$"	18 ozs.
200	$\frac{5}{8}$"	13"	26 ozs.
300	$\frac{7}{8}$"	13$\frac{3}{4}$"	42 ozs.

Cleaning and Tinning the Bit.

Before commencing soldering it is necessary that the bit should first be thoroughly cleaned and afterwards tinned. The necessity for absolute cleanliness of the iron and of the parts to be soldered, cannot be stressed too strongly; it should be remembered that the least trace of grease or dirt may result in complete failure. The point of the bit should be cleaned by means of a smooth file or rough emery cloth until it is bright all over. The iron should then be heated to the requisite temperature either by a flame or the use of an electric current, according to the type of iron employed. When using a flame for heating purposes it is important that the iron should not be allowed to become red-hot. There is a certain temperature beyond which the iron should not be heated for most satisfactory results, and this will best be found by experience.

A good method of tinning the bit, when heated, necessitates the melting of a little solder into a tin lid containing a small quantity of soldering flux. After rapidly restoring the bit to its original brightness by means of the file or emery cloth, the part to be tinned should be well rubbed into the solder and flux. If this operation is carefully carried out a thin film of solder will adhere to the bit and the iron is then ready for use.

It will be found convenient to keep a slip of emery cloth tacked down to a flat board when soldering so that if the tinning of the iron is destroyed as a result of frequent re-heating, the bit may be re-tinned after it has been cleaned by rubbing upon the emery cloth. Any soot or grime which may accumulate at the tip of the bit when using a flame for heating purposes may also be removed in this manner.

Preparing the Work.

If tinned copper wire is used for wiring purposes it will not be necessary to tin the ends of the connecting leads before making the joints. If, however, bare copper wire is used the ends of each lead must be coated with a thin film of solder in the following manner:— Clean the ends of the leads with a piece of emery cloth and dip into the soldering flux. Hold a stick of solder against the point of the soldering iron until a small globule adheres to the bit. Apply this to the ends of the leads, when the solder should quickly run over the surface of the leads and adhere thereto. The shanks of terminals or the tips of connecting tags should be tinned in a similar manner. In this case, however, a very small amount of flux should be applied to the work (after cleaning with emery cloth) by means of a match or the end of a small screw-driver.

An important point in connection with soldering in Radio work is that the smallest possible amount of a non-corrosive flux should be used. An excellent flux which is absolutely non-corrosive, is "Nokorode" Soldering Paste, supplied by the Igranic Electric Co. Ltd., and obtainable from all Radio dealers. It is very economical in use, clean, free from acid, and causes no fumes. It is suitable for soldering all metals except aluminium and may be obtained in tins containing 2 ozs., 4 ozs., or 1 lb.

Any trace of flux which remains when a joint has been made should be carefully removed before the work has cooled. Methylated spirits or petrol applied by means of a small brush, provide a very effective method of cleaning soldered joints and may also be used for removing any flux which may have splashed on to the panel. Extreme caution is necessary when using these spirits as they are highly inflammable and must not approach an open flame. It is extremely important that any flux which may have splashed on the panel when soldering, should be removed, otherwise it may cause leakage paths and seriously impair the efficiency of the receiver. A useful method of preventing this is to wrap a small piece of rag round terminal shanks or to place a piece beneath junctions of leads when soldering.

Making the Joints.

Having tinned the tips of terminal shanks, connecting tags, or other work to which leads are to be secured, place a very small amount of flux upon each.

Apply a stick of solder to the tinned point of the bit until a small globule adheres to it. Hold the end of the connecting lead by means of a small pair of pliers (to avoid burning the fingers) and place it in position at the point to which it has to be soldered.

The tip of the bit carrying the globule of solder should then be applied to the junction, where, if the temperature of the iron is correct, the solder will run freely and unite the parts, thus effecting a sound electrical and mechanical joint. This should be thoroughly cleaned in the manner prescribed, taking care that all traces of flux are removed.

RADIO IGRANIC DEVICES

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INCLUDE

Triple Honeycomb Inductance Coils. 17 Sizes. Plug and Gimbal Mounted.

"Xllos" (extra low loss) Inductance Coils.

Short Wave Inductance Coils.

Honeycomb High-Frequency Transformers.

Unitune Aperiodic Fixed Coupler.

Variable and Fixed Condensers.

Dual Variable Condensers.

Vernier Condensers.

Balancing Condensers

Variometers

Coil-Holders for Plug Type Coils.

Universal Coil Holders.

Gimbal Coil-Holders

Filament Rheostats for Bright and Dull Emitter Valves.

Auxiliary Rheostats.

High and Low Resistance Potentiometers.

Variable Grid Leaks.

Fixed Grid Leaks.

"Nonmic" Valve Holders.

Tone Control.

Audio-Frequency Transformers.

Telephone Transformers.

Telephone Connectors, Earthing Switches, Battery Switches.

Transmitting Apparatus.

Vernier Tuning Devices.

Stand-Off Insulators.

Soldering Irons.

Knob and Dials.

Etc., etc.

IGRANIC-PACENT RADIO DEVICES.

Bakelite and Porcelain Rheostats for Bright and Dull Emitter Valves.

Bakelite and Porcelain Potentiometers.

True Straight Line Frequency and Square Law Variable Condensers.

The Microvern: A Super Tuning Device.

The Radiodyle and Radiofile: Tuning and Calibrating Dials.

The Super Audioformer: The Low-Frequency Transformer with the Unique Amplification Curve.

Plugs and Jacks for every purpose.

Plug and Jack Adapters.

Jack Name Plates.

The Balcon: Balancing and Neutralising Condenser.

Battery and Jack Switches.

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INSTRUCTIONAL HANDBOOK

ERRATA.

The diagrams Figs. 28, 28a, and 32, also the diagram in Table No. 2 are incorrect. These should be as shown below.

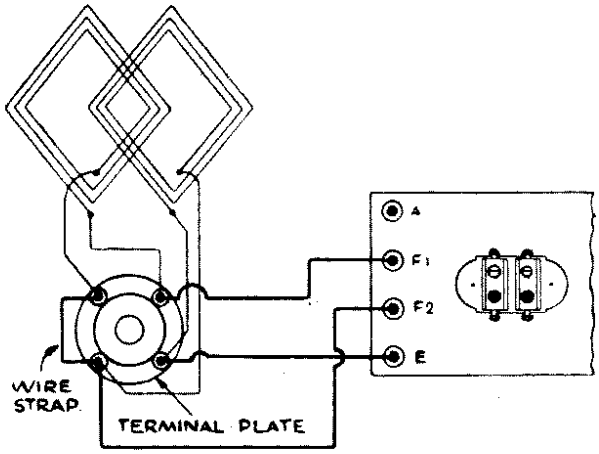

Fig. 28.

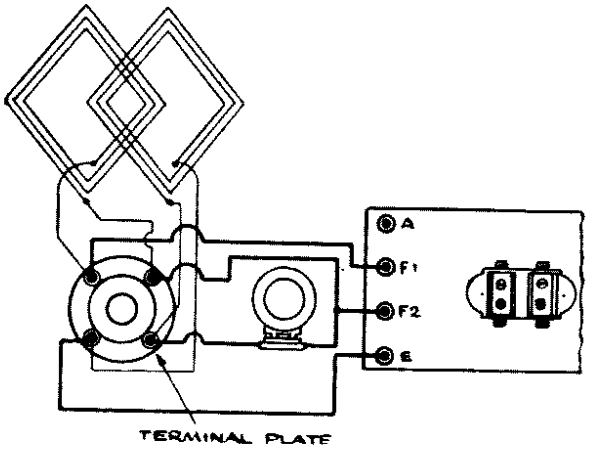

Fig. 28a.

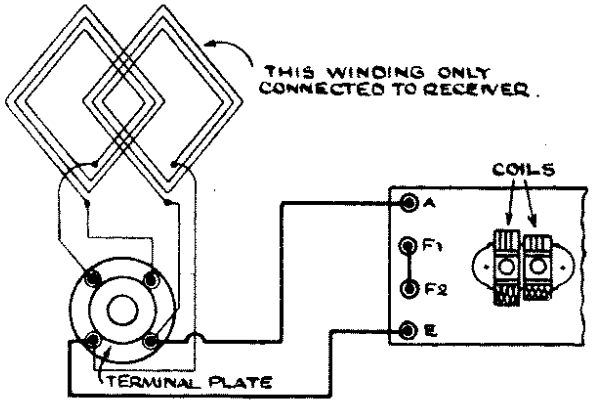

Fig. 32.

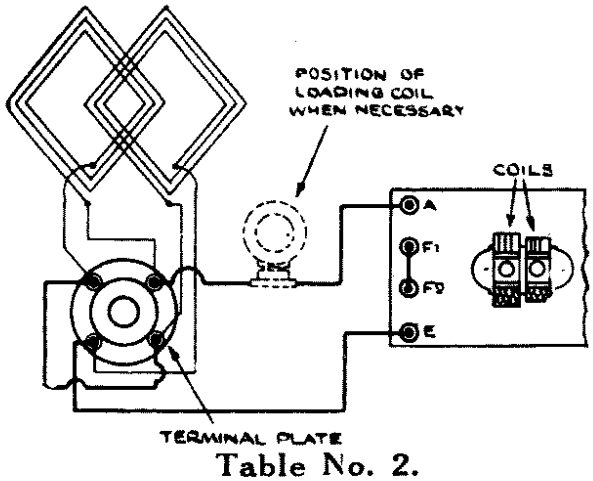

Table No. 2.