



Edi- Wissenssammlung Einbereichs- Superherts (1600 KHz- Super)



**Inklusive mehrerer Bauanleitungen
und Schaltungsbesprechungen**

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Vorwort

Sehr geehrte Radiofreunde,

Es geht mir auf meiner Internet- Seite und in den „Edi- Büchern“ um die Erhaltung alten Wissens.

Thema hier ist der „Einbereichsuper“, ein Rundfunkempfänger, der nahezu in Vergessenheit geraten ist.

Aber er gehört zu einer der ersten Radioschaltungen, ich konnte diese bis 1926 recherchieren.

Der großen Menge an Informationen wegen teile ich das in zwei Bücher auf, um jeweils deutsche und ausländische Artikel vorzustellen.

Es geht hierbei nicht darum, WER als Erster WAS erfunden hat, nur um die Konzeption an sich.

Viele hunderte Geräte wurden wegen der einfachen Konzeption von Bastlern gebaut. Die ersten Geräte waren damaligen Berichten nach noch wirklich abenteuerlich.

Es gibt nur wenige industrielle Gerätetypen , die aufwendiger gebaut wurden, was aber der sprichwörtlichen Einfachheit widersprach.

Auch ist manchmal fraglich, ob man die realisierten Varianten als Einbereichsuper gelten lassen kann, das ist 50 bis 100 Jahre später... unwichtig. Die genannten Autoren, sowie viele Bastler entwickelten den Einbereichsuper weiter, und brachten ihn -oft in Fleißarbeit- zu manchmal gerade noch ausreichender, manchmal guter, und manchmal sogar zu sehr guter Leistungsfähigkeit.

Erfreuen wir uns einfach an den Ergebnissen ihrer Arbeit !

Vielleicht bekommt der eine oder andere Radiofreund Lust, auch so ein Radio zu bauen- mit historischen, aber vielleicht allen Bauteilen- Röhren, Transistoren, oder sogar integrierte Schaltungen, das Konzept des Einbereichsupers kann mit allen diesen Bauteilen realisiert werden.

Heutzutage gibt es nur noch wenige Großsender auf den klassischen AM- Bereichen Mittel- und Langwelle, dadurch entfallen oft Maßnahmen, starke Sender „aussperren“ zu müssen- was gutem Empfang entgegenkommt.

Hier sind etliche Bauanleitungen, die als Grundlage dienen können.

Ich würde mich freuen, wenn sich jemand an so einem Gerät versucht, und mir berichtet, vielleicht mit Bildern, damit ich das Gerät vorstellen kann.

Ich wünsche gutes Gelingen !

Olaf Freiberg ((Edi)

Einbereichssuper/ Einbereichs- Empfang

(Originaltext unten, Übersetzt: Edi, 2024)

Ein System der Superhet- Empfangstechnik, bei dem keine mit dem Oszillator gleichlaufende Vorkreis- Abstimmung vorhanden ist.

Der Eingang von der Antenne bis zur ersten Röhre besteht aus einem Filter, das alle Frequenzen durchlässt, die den gesamten Empfangsfrequenzbereich darstellen; zum Beispiel werden in einem Rundfunkempfänger alle Frequenzen von 200 bis 2000 Meter (150 kHz bis 1500 kHz) mit mehr oder weniger gleicher Stärke durchgelassen, während höhere Frequenzen abgeschnitten werden.

Wie bei einem gewöhnlichen Überlagerungsempfänger wird ein Oszillator dazu genutzt, mit der Eingangsfrequenz eine Mischfrequenz zu erzeugen.

Aber diese Mischfrequenz ist höher als die höchste empfangene Signalfrequenz, nicht niedriger, wie im Fall eines gewöhnlichen Überlagerungsempfängers.

Einer der Hauptvorteile des Systems besteht darin, dass nur ein einziger variabler Abstimmkondensator erforderlich ist, nämlich der im Oszillatorkreis, wobei die Notwendigkeit für mechanisch gekoppelte Kondensatoren vollständig entfällt.

Zweitens ist kein Umschalten erforderlich, um von Mittel- zu Langwellen zu wechseln, da der gesamte Empfangsfrequenzbereich durch den Oszillatorfrequenzbereich abgedeckt wird.

Die Verwendung eines einzigen Abstimmkondensators wird durch die hohe Oszillatorfrequenz ermöglicht, die verwendet wird, nämlich 1600 kHz oder mehr.

Mit dieser Zwischenfrequenz muß der Oszillator über den Bereich von 1650 bis 3100 kHz arbeiten, um das komplette Wellenlängenband von 150 kHz bis 1500 kHz abzudecken, und dies erfordert ein maximales bis minimales Kapazitätsverhältnis von nur 1: 3,14.

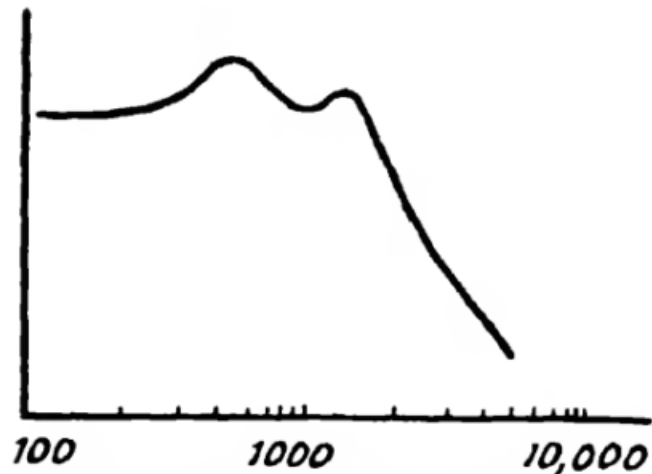
Störungen durch Spiegelfrequenzen würden auftreten, wenn Sender im Frequenzbereich von 3350 bis 4700 kHz betrieben würden, und die Antennenkopplung zur ersten Röhre über diesen Bereich nicht effizient wäre.

Aus diesem Grund sollte der Abfall der Durchlaßkurve des Eingangsfilters bei etwa 1500 kHz erfolgen, und diese Filterkreise werden auch genau so ausgelegt.

Die Signalfrequenzen unterhalb des nützlichen Bereichs sind unerheblich, und der Antennenfilterkreis kann bequemerweise in Form eines Tiefpassfilters vorliegen.

Aufgrund der Natur des Antennenkreises selbst ist ein symmetrischer Tiefpassfilter unmöglich, und es muss ein Kompromiss gefunden werden.

Dies bedingt die Form des bekannten Bandpassfilters, die Kopplung zwischen den Filterkomponenten ist ausreichend gering, um eine Spitzenbegrenzung in der zweihöckrigen Resonanzkurve von etwa 800 kHz zu erzielen, wobei eine Spitze bei etwa 700 kHz und die andere bei etwa 1200 kHz liegen.



SINGLE-SPAN TUNING. Fig. 1.
Response curve of coupled aerial circuits.

Courtesy of "The Wireless World"

Die Durchlaßkurve, die mit einer solchen Anordnung erhalten wird, ist in Abbildung 1 dargestellt.

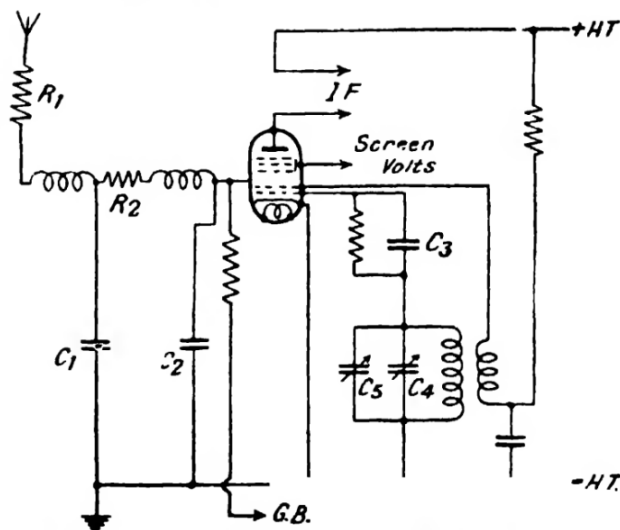


Fig. 2. Simplified diagram showing arrangement of filter and connexions to frequency-changer valve.
Courtesy of "The Wireless World."

Eine praktische Schaltungsanordnung ist in Abbildung 2 dargestellt, die den wesentlichen Antennenfilterkreis und die Mischröhre des Heptodentyps zeigt. Die Widerstände R1 und R2 sind enthalten, um die Spitzen der zweihöckrigen Bandpassfiltercharakteristik zu reduzieren.

Der Oszillatorkondensator C4 ist der einzige, der für die Abstimmung verwendet wird, wobei C5 nur ein Trimmer- Kondensator ist.

Normale Bandpassfilter können in den Filtern mit der Zwischenfrequenz von 1600 kHz verwendet werden, und weitere Verfeinerungen können gemäß der normalen Praxis hinzugefügt werden. Die Diagramme werden mit freundlicher Genehmigung von "The Wireless World" bereitgestellt, dem das System zu verdanken ist.

Das Prinzip des Einbereichsuperhets wurde nicht weiterentwickelt, und seine Möglichkeiten blieben weitgehend ungenutzt.

SINGLE-SPAN TUNING

SINGLE-SPAN TUNING. A system of superheterodyne reception in which there is no variable tuning in the signal frequency circuits. The circuit between the aerial and the first valve consists of a filter which passes all frequencies comprising the whole range of wavelengths to be received; for instance, in a broadcast receiver all frequencies corresponding to wavelengths from 200 to 2,000 metres (1,500 to 150 kc.) are passed with more or less equal strength, whereas higher frequencies are cut off.

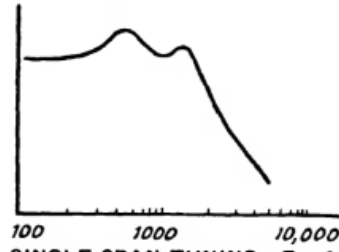
As in an ordinary superheterodyne receiver, local oscillations are made to interact with the signal frequency oscillations to produce a beat frequency after rectification by the first detector. But this beat frequency is higher than the highest signal frequency received, not lower as in the case of an ordinary superheterodyne.

One of the main advantages of the system is that it requires a single variable "tuning" condenser only, namely that in the oscillator circuit, the necessity for ganged condensers being eliminated altogether. Secondly, no switching is necessary to change from medium to long waves, the whole wavelength range being covered by the single range of oscillator frequencies.

The use of the single tuning condenser is made possible by the high supersonic frequency employed, namely 1,600 kc. per second or more. With this "intermediate" frequency the oscillator would work over the range from 1,750 to 3,100 kc. to cover the complete 200 to 2,000 metre wavelength band, and this requires a maximum to minimum capacity ratio of 3.14 only.

Second channel interference would occur from stations operating over the frequency range of 3,350 to 4,700 kc. if the aerial coupling to the first valve were efficient over that range. For this reason the cut-off should occur at about 1,500 kc. per sec., and filter circuits are designed to this end. The passing of signal frequencies below the useful range is immaterial and the aerial filter circuit can conveniently be in the form of a "low pass" one. But owing to the nature of the aerial circuit itself a symmetrical low pass filter is impossible and

a compromise has to be effected. This takes the form of the well-known band-pass filter used for tuning purposes, but the coupling between the units is made



SINGLE-SPAN TUNING. Fig. 1. Response curve of coupled aerial circuits.

Courtesy of "The Wireless World"

sufficiently tight to give a peak separation in the double-hump resonance curve of about 800 kc., one peak occurring at about 400 kc. and the other at about 1,200 kc. The

type of response curve obtained with such an arrangement, using capacity coupling, is shown in Fig. 1.

A practical circuit arrangement is given in Fig. 2, which shows the essential aerial filter circuit, and the frequency-changer valve of the heptode type. The resistances R_1 and R_2 are included to reduce the peaks of the double-hump band-pass filter characteristic.

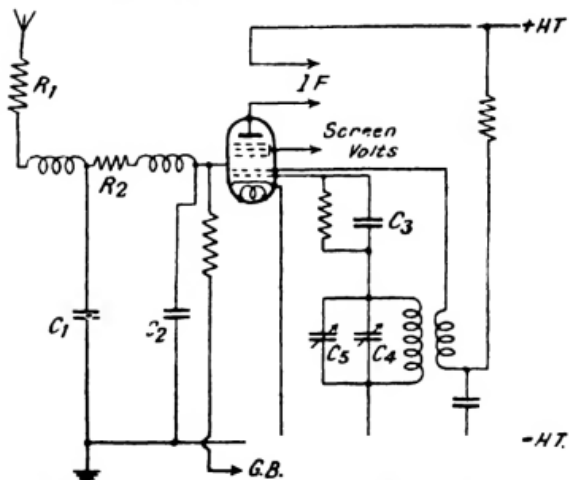
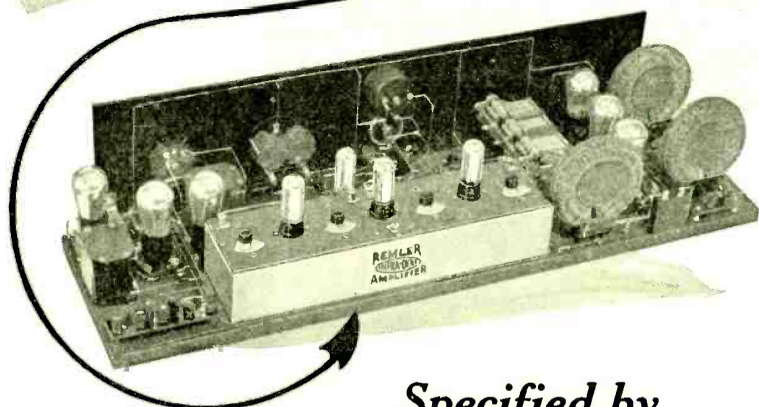
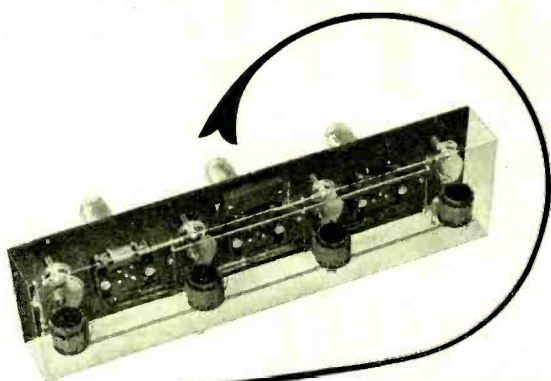


Fig. 2. Simplified diagram showing arrangement of filter and connexions to frequency-changer valve. Courtesy of "The Wireless World."

The oscillator condenser C_4 is the only one used for tuning, C_5 being a pre-set condenser only. Normal band-pass filters may be used in the 1,600 kc. intermediate frequency circuits and other refinements may be added, according to normal practice. The diagrams are by courtesy of "The Wireless World," to whom the system is due. The single-span tuning principle was not developed and its possibilities remain largely unexploited.

New Remler Infradyne Amplifier



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THE REMLER No. 700 Infradyne Amplifier is a product of advanced radio research. It retains every advantage of multi-tube amplification at a fixed frequency and eliminates undesirable features present in other receivers of this general type.

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Tell them that you saw it in RADIO

5

The Infradyne

A New and Efficient Ten-Tube Circuit Employing Three Stages of Intermediate Frequency Amplification at 3200 Kilocycles

By E. M. Sargent

WHEN an incoming radio frequency current is mixed in a circuit with a locally generated oscillating current two new frequencies are generated. One, the beat or *difference* frequency, is used in the superheterodyne. The other, the *sum* frequency, is employed in the infradyne so as to get greater distance, better selectivity, and quieter amplification than the writer has secured with any other circuit during his fifteen years' experience in radio construction.

The use of the *sum* frequency has been neglected because of the general belief that this extremely high frequency of 3,200,000 cycles cannot be efficiently amplified. But after building and discarding nearly five hundred models Mr. L. C. Rayment and the writer finally found the means whereby practically the same degree of amplification can be produced at any frequency. The same principles as are used in the infradyne amplifier will eventually be applied to 80, 40, 20 and 5 meter reception.

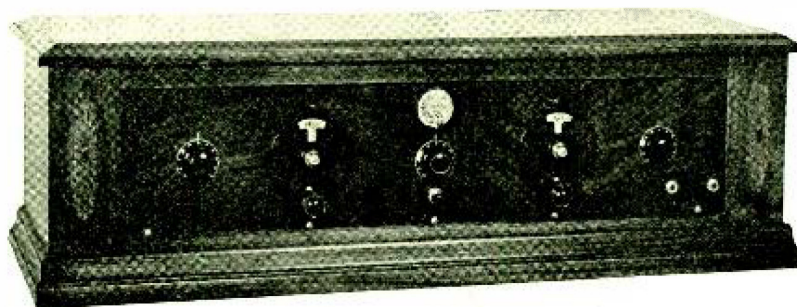
A receiving set using this *sum* frequency amplifier has the advantages of eliminating arc "mush" or harmonics of double or treble a station's wavelength and in using but one oscillator setting for each station. As the intermediate amplifier is sharply peaked at one wavelength and is very inefficient at any other, noises from the radio frequency tubes are not amplified. Since iron core transformers are not needed to secure r.f. amplification the cost of construction is reduced and any "freaks" due to the peculiarities of the iron are eliminated. Finally the intermediate frequency employed may be used universally, being oscillator, two stages of r.f. amplifica-

- LIST OF PARTS USED BY WRITER**
- 1 Remler Infradyne Amplifier.
 - 1 Continental triple vernier condenser.
 - 1 Remler .00035 condenser.
 - 1 Tapped inductance (see text for constructional details).
 - 1 Gen. Radio No. 301 30 ohm rheostat.
 - 1 Set No. 33 Thorola Doughnuts.
 - 2 National Type B CCW Dials.
 - 7 Benjamin UX Sockets.
 - 1 112 Amperite.
 - 2 1-A Amperites.
 - 1 6V-199 Amperite.
 - 1 30 ohm U. S. L. Rheostat.
 - 1 10 ohm U. S. L. Rheostat.
 - 1 Centralab 50,000 ohm Radiohm.
 - 3 2-in. rheostat dials.
 - 1 Yaxley Filament switch.
 - 1 single closed Electrad jack.
 - 1 single open jack.
 - 1 Jewell No. 135 0-5 D. C. voltmeter.
 - 1 Electrad grid leak mounting.
 - 1 Electrad fixed Condenser mounting.
 - 1 1-megohm Electrad Fused Metallic Leak or Arthur H. Lynch fixed Resistor.
 - 1 2-megohm Electrad Fused Metallic Leak or Arthur H. Lynch fixed Resistor.
 - 1 Electrad .0001 mfd. condenser.
 - 2 Electrad 1 mfd. condensers.
 - 2 Sangamo .0005 condensers, 1 with clips.
 - 1 Electrad .00025 condenser.
 - 9 Eby Binding posts.
 - 1 Formica Walnut panel 3/16x7x30.
 - 1 Redwood baseboard 3/4x10x34.
 - 2 Amertran De Luxe Transformers.

tion, first detector or mixer, three stages of 95 meter amplification, second detector or de-modulator, and two stages of audio frequency amplification. It has two tuning controls, one dial operating a triple condenser to tune the two r.f. stages and another the oscillator tuning condenser. Since the *sum* frequency is used the capacity of one condenser increases while that of the other decreases, thus requiring condensers that turn in opposite directions so that the dials may read in the same direction.

Except for the infradyne amplifier, whose connections and constructional details are given at the close of this article, the circuit arrangement is simple, as shown in Fig. 1. But in order to insure a duplication of the good results secured by the writer it is essential to follow the placement of parts indicated in the baseboard layout of Fig. 2 and the panel layout of Fig. 3.

The importance of following exactly the layout cannot be over-emphasized.



Panel View of Completed Infradyne Receiver.

independent of the overlapping frequencies of local stations.

The infradyne set uses ten tubes, an oscillator, two stages of r.f. amplifica-

A common failing among both amateur and professional set builders is to pay too much attention to wiring diagrams and too little to the layout of the ap-

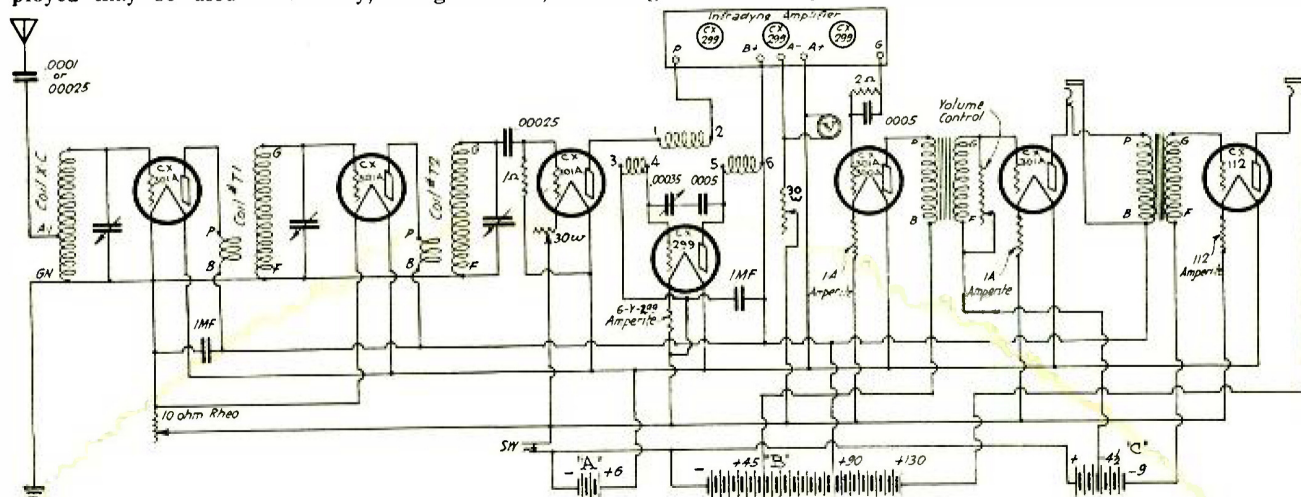
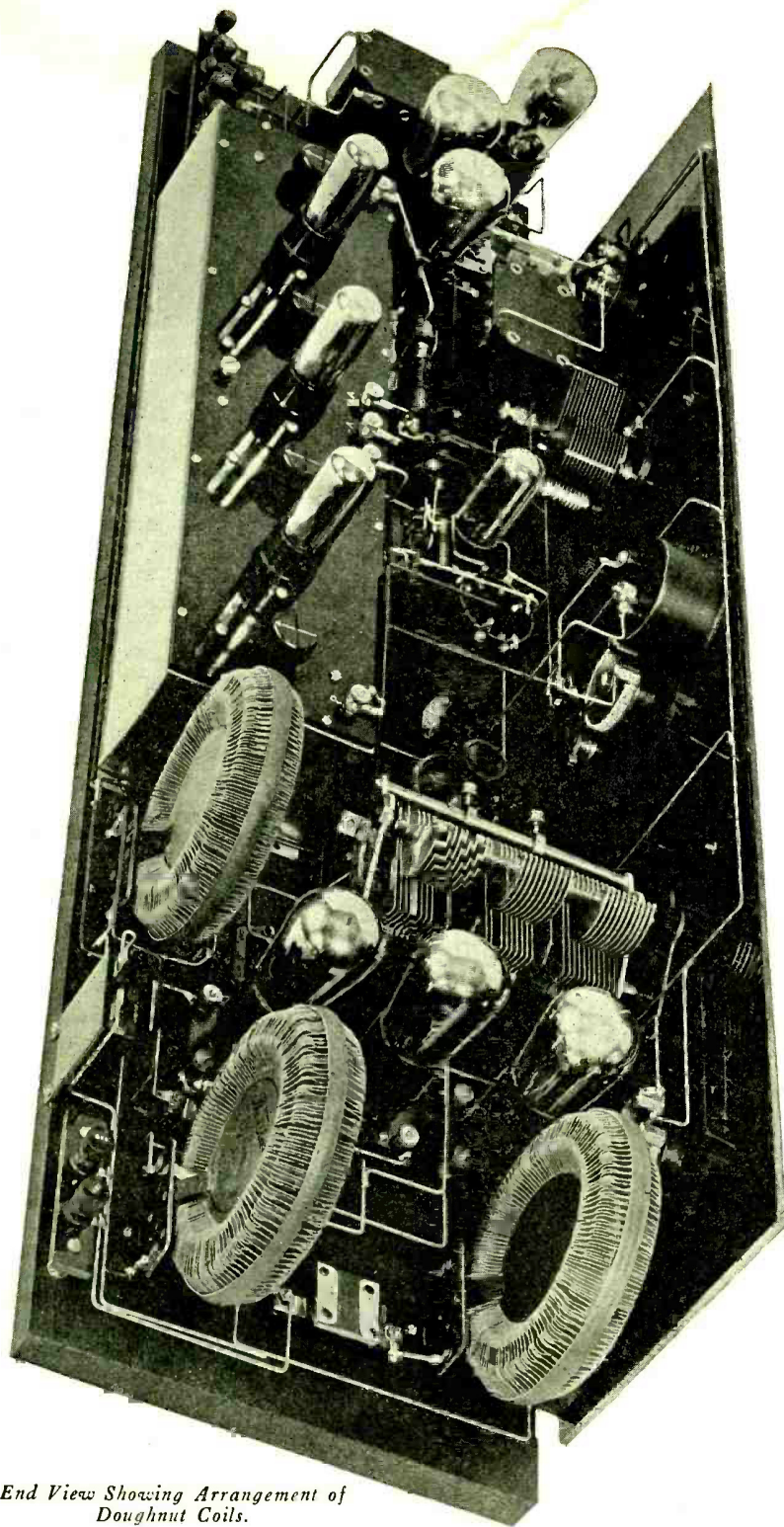


Fig. 1. Circuit Diagram of Infradyne Receiver. (Correction: 6V-299 should be 6V-199).



End View Showing Arrangement of Doughnut Coils.

paratus. A wiring diagram would be sufficient if the radio currents really travelled only in the paths in which we are accustomed to think of them as travelling, but we all know that they take short cuts via stray inductive and capacitive fields. The writer has made a detailed study of these fields insofar as they affect the set here described, and the layout is the result of this study. It would not be an exaggeration to say that with the same parts and hookup, but with a different arrangement, it would be a different set entirely and might exhibit several annoying freaks. This is true not only of the infradyne but of the super-heterodyne, the neutrodyne, or any other multi-tube set.

Another thing; do not try to put the infradyne in your phonograph or in a suitcase. Borrow a leaf from the book of Zenith, Kellogg, Stromberg-Carlson or any of the others who have found that a multi-tube radio set has to contain a certain number of cubic inches of space in order to give good results. Make your infradyne large enough to give it a chance to produce the results of which it is capable.

The two National dials included in the list of parts are specified because of instructions given later for setting this dial in relation to the condenser position. Any other dial that reads in the same direction can be used if the panel drilling is changed to suit. The Thorola toroid coils have been used throughout all our experiments and seem to line up perfectly with the Continental condenser. No doubt there are other toroids that will also work, but not having tested any others the writer is not in a position to name any alternates. It is important that toroid type coils be used, however, as neutrodyne type coils will not give the same selectivity.

The tapped inductance can be very easily constructed by the builder. It consists of three coils wound on a piece of bakelite tubing $1\frac{1}{2}$ in. in diameter and 2 in. long, as shown in Fig. 4. These coils are of 14, 14, and 8 turns respectively and are all wound with the same direction with No. 24 d.s.c. wire. There should be a space of $\frac{1}{16}$ in. between the two 14 turn coils and of $\frac{3}{16}$ in. between the 14 and 8 turn coil. Commencing with the 8 turn coil the terminals should be num-

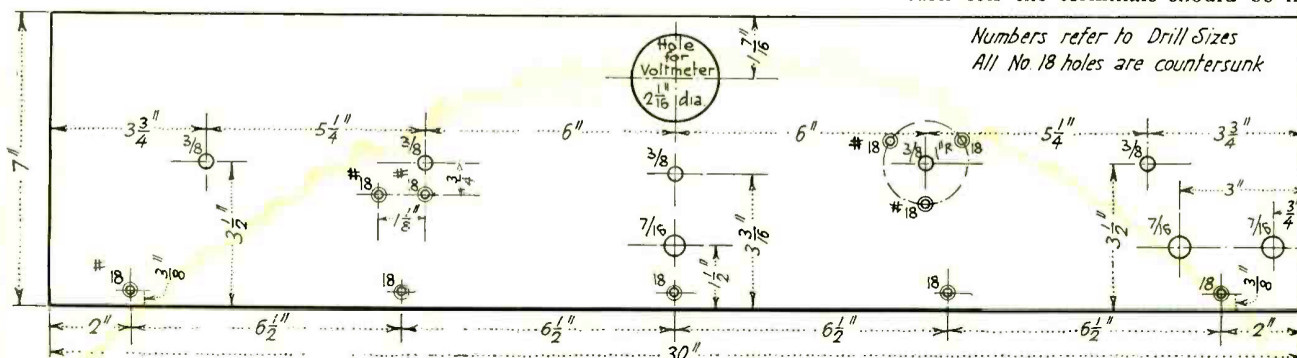


Fig. 3. Infradyne Panel Layout.

bered from 1 to 6 as shown in the sketch of Fig. 4, 1 being the outside and 2 the inside terminal of the 8 turn coil, 3 the terminal of the 14 turn coil nearest the 8 turn coil and 4 the other end of this 14 turn coil, 5 the inside terminal of the second 14 turn coil and 6 the outside terminal of this coil.

These numbers correspond to those used in the wiring diagram. To insure operation of the set these directions for coil winding should be followed exactly,

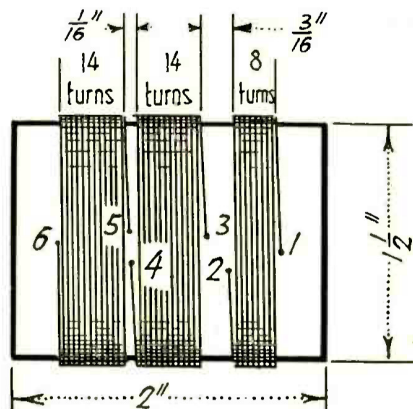


Fig. 4. Constructional Details of Tapped Inductance.

particularly as regards their all being wound in the same direction. This tapped inductance should be mounted in the position of the oscillator coupler as shown in the baseboard layout, Fig. 2.

Although the drawings are in the main self-explanatory, there are several minor details in regard to building up the set which should be mentioned. No shielding is desirable or necessary. The arrangement of the parts and wiring is such that there is no tendency toward body capacity.

Do not use rosin core solder if you wish to avoid the possibility of making any "rosin joints." Run the plate lead of the first detector and the grid lead of the second detector as directly as possible. On the binding post strip there are no posts for $+C$ or $-B$. These were left off to make more room for the others and to make possible the use of a Jones battery cable and plug instead of binding posts if desired. The $+C$, $-B$, and $-A$ should all be connected to the $-A$ post.

The bypass has purposely been left off the primary of the first audio transformer as the set operates a little smoother without it. If one is used it should not exceed .0001 mfd.

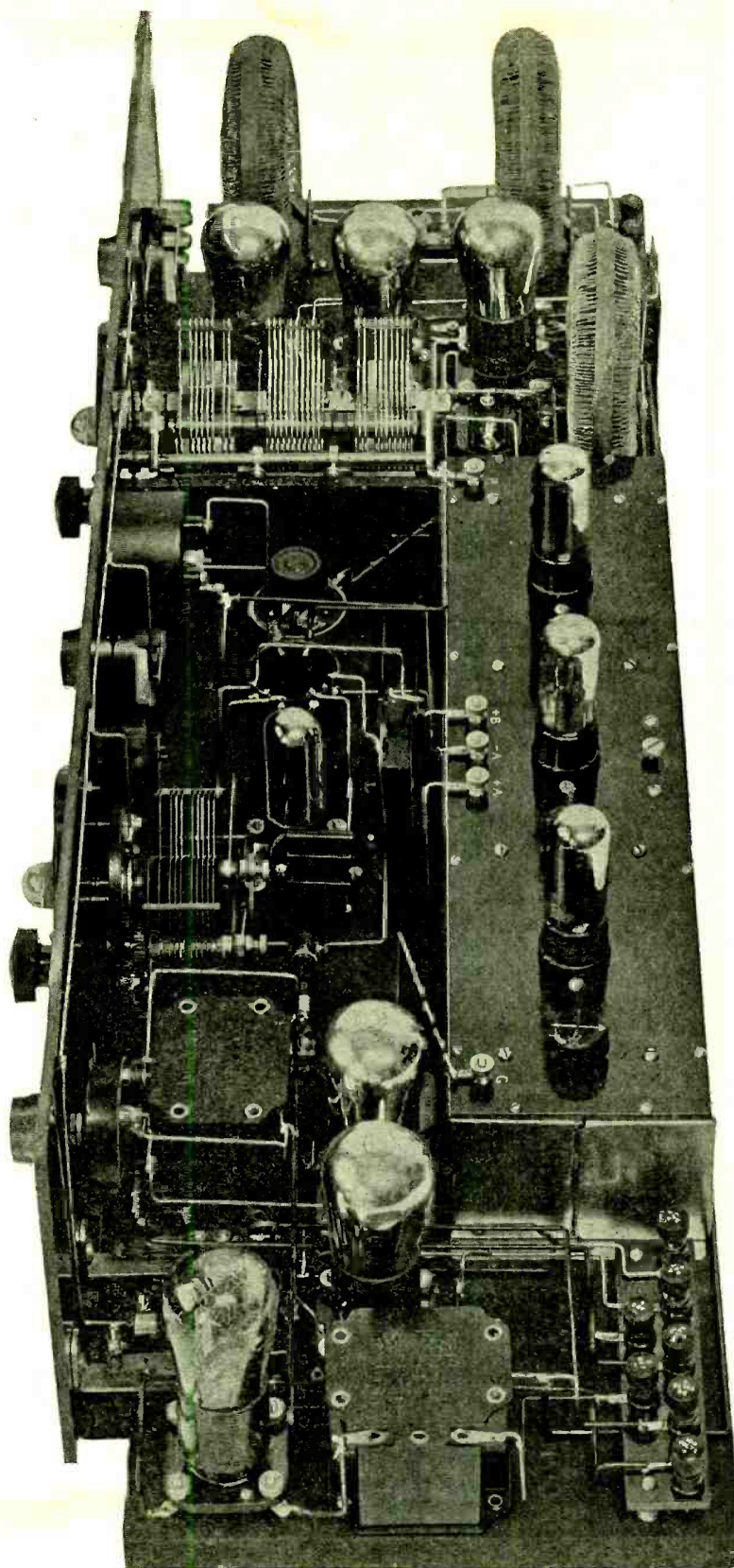
Operating Directions

AFTER the circuit has been checked over carefully, insert the tubes in their proper sockets and connect up the A battery. Turn on the filament switch and advance all rheostats enough to see that the tubes light. Examine the Amperites to see that they are all in their right places and that none are burned out. Everything being in good order so far, leave the set turned on and the

$-A$ connected, disconnect the $+A$ wire and touch it in turn to the 45, 90, and 135 volt posts, meanwhile carefully watching to see whether any tubes light. This is a test to see whether any A and B wires have been unintentionally crossed.

Next, turn both the three-gang condenser and the oscillator condenser so

that the plates are fully meshed. Set the triple condenser dial at 100, and the oscillator dial at 12° . Then turn both to about 60. Turn the four vernier knobs on the infradyne amplifier to the marks where they were "lined up" at the factory. Turn the adjusting screw on the amplifier so that it is almost all the way out.



Rear View of Infradyne Receiver.

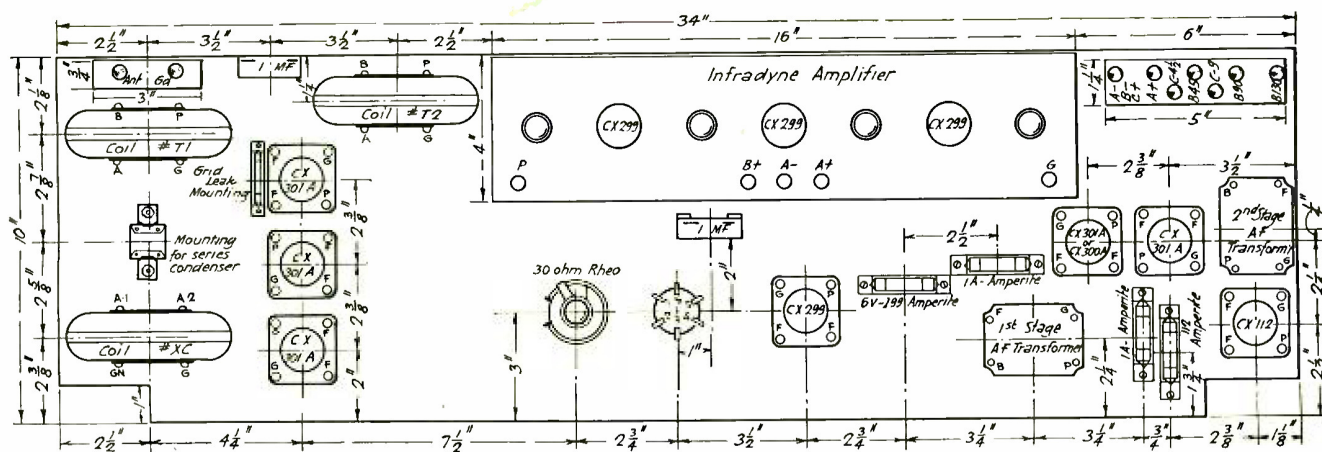


Fig. 2. Baseboard Layout for Infradyne.

The set is now ready to operate. Connect the antenna, about 50 ft. long, and a good ground and hook up the batteries. Turn the first detector rheostat (on baseboard) all the way on, turn rheostat on first two tubes (left hand one on panel) to about 30, turn intermediate tubes up to 3 volts, and leave the volume control at 0. Plug the loudspeaker in the second stage. The set is now tuned to about 315 meters and if there are any local stations near that wavelength they can easily be found by moving the dials slightly. Tune the set exactly like a super-heterodyne, that is, "cross" the dials continually using both hands to tune with. The dials will run almost together over the full scale. The rheostat on the first two tubes is best operated rather low and is used as a regenerative control, care being taken not to throw the tubes into oscillation.

With the set adjusted as above, tune in and log a few locals, then try to find some station about 150 miles away, the idea being to get some moderately weak

station for a test signal on which to further line up the set. When such a station has been found, set the two main tuning dials and leave them, and try a slight readjustment on the vernier knobs on the amplifier unit. The first three will probably be best at their original settings but the right hand one may differ some on account of different detector wiring. After the best setting on the verniers has been found, tighten up the adjusting screw on the amplifier with a screwdriver. Do this slowly, as this is the adjustment (with the filaments at 3 volts) that brings the amplifier up to the peak. Tighten this screw until the amplifier breaks into oscillation, then back it away again until the oscillation stops, and leave it there. That finishes the adjustment of the intermediate amplifier, and once adjusted it should not be disturbed again.

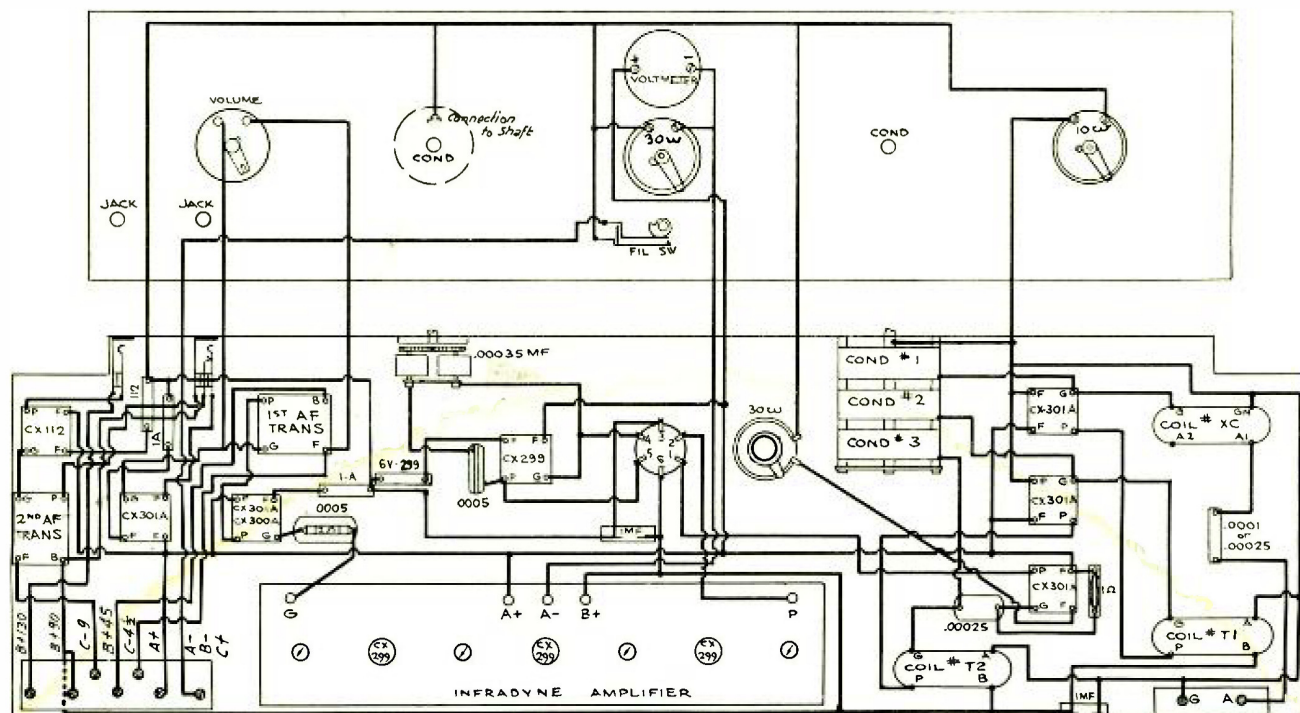
The rheostat on the baseboard should now be slowly backed down, the signal strength being carefully noted during the operation. As the rheostat is turned

down the signal will decrease until a point is reached where it will rapidly increase again. Passing this point will sometimes throw the tube into oscillation, but will usually only result in another decrease in strength. The rheostat should be left in a non-critical adjustment near this amplification peak. If the peak cannot be found, turn the rheostat all the way on and leave it there.

Next is the lining up of the "front end." This is very important, and upon the care with which it is done will greatly depend the selectivity of the set. To start with, adjust both sliding vernier plates on the triple condenser so that they are in the half way position. Then turn up the panel rheostat to get good volume and tune in some moderately loud station, preferably not a local, and at about 60 or 70 degrees on the dials. Set the oscillator dial right on the station and leave it there.

Swing the triple condenser slowly

(Continued on Page 46)

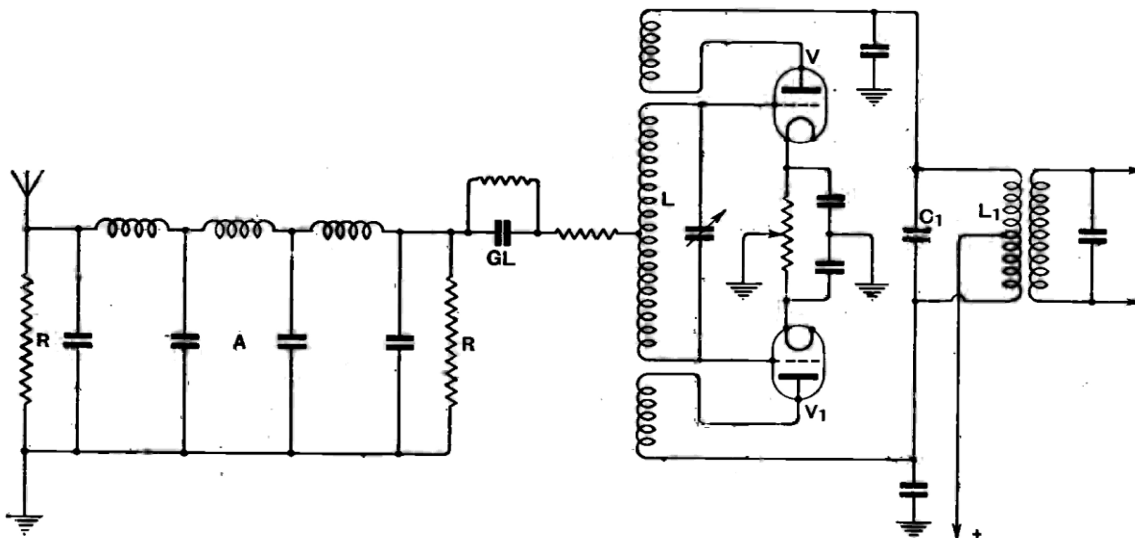


Pictorial Diagram of Connections. (Correction: 6V-299 should be 6V-199).

Wireless Engineer 1932, Heft 4, S. 244, Patentanmeldung.

Übersetzt: Edi, 2024, Originaltext unten

Dies ist ein Patent, welches einen Superhetempfänger- Eingang mittels eines Tiefpaßfilters vorsieht, es gibt also, wie für den Einbereichsuper typisch, keine Vorkreisabstimmung. Die Höhe der Zwischenfrequenz ist allerdings nicht angegeben.



Übereinkommensanmeldung (USA), 20. November 1929. Nr. 359760. Ein Tiefpassfilter A ist unterhalb der oberen Grenze des zu empfangenden Wellenbands abgestimmt und wird von zwei Widerständen R beendet, wobei einer im Antennenkreis liegt. Der andere Widerstand ist über einen Kondensator und eine Gitterkombination GL in Serie mit einer Induktivität L mit den Gittern von zwei rückgekoppelten Röhren V, V1 verbunden, die den lokalen Oszillator bilden. Die Eingangsenergie wird in Phase auf die Röhren geführt, aber der Ausgang wird differentiell auf den Schaltkreis C1, L1 geführt. Die Komponenten, die durch die Phasendifferenz zwischen den lokalen und den angelegten Schwingungen bestimmt werden (d. h. die Schwebungsfrequenz), werden im Ausgangskreis addiert, während unerwünschte oder störende Signale ausgeglichen werden. Der Schaltkreis L1, C1 ist auf die Zwischenfrequenz abgestimmt und ist mit weiteren Stufen zur Zwischenfrequenz- Verstärkung gekoppelt. Patent erteilt an Marconis Wireless Telegraph Co., Ltd.

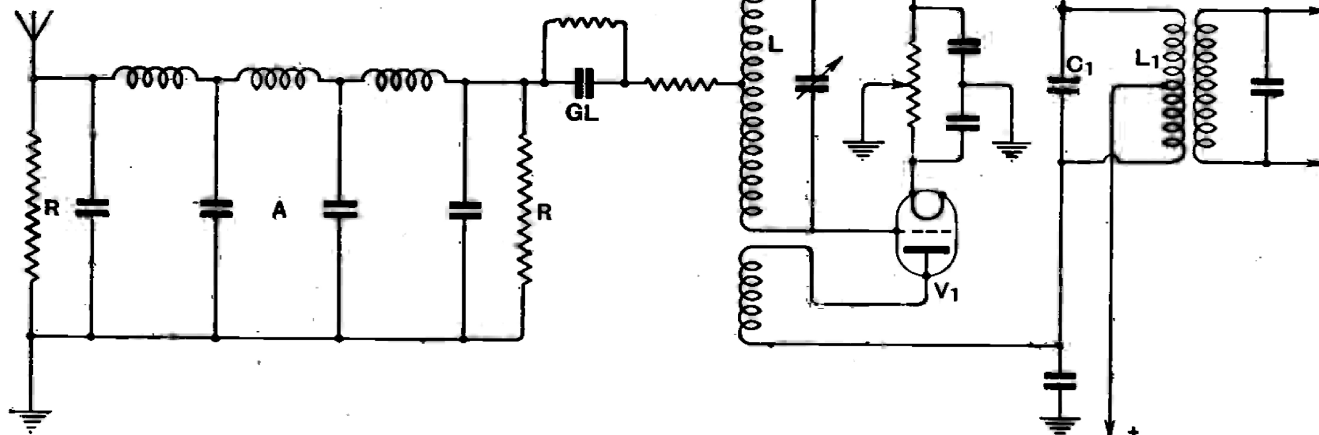
(Übereinkommensanmeldung: Eine beim Patentamt eingereichte Patentanmeldung, die ein Prioritätsdatum auf der Grundlage derselben oder einer im Wesentlichen ähnlichen Anmeldung in einem oder mehreren der Übereinkommensländer beansprucht, wird als Übereinkommensanmeldung bezeichnet. Edi)

April, 1932

SUPERHETERODYNE RECEIVERS.

Convention date (U.S.A.), 20th November, 1929.
No. 359760.

A low-pass filter A is tuned below the upper limit of the waveband to be received and is terminated by two resistances R , one being in the aerial circuit. The other resistance is connected through a condenser and leak GL in series with an inductance L to the grids of two back-coupled valves V, V_1 , forming the local oscillator. The input energy is applied to the valves in phase, but the output is fed to the circuit C_1, L_1 differentially.



No. 359760.

Components determined by the phase-difference between the local and applied oscillations (*i.e.*, the beat frequency) are added in the output circuit, whilst undesired or interfering signals are cancelled out. The circuit L_1, C_1 is tuned to the beat frequency and is coupled to further stages of intermediate amplification.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

A New Receiving

Single Control Tuning Over 200-2,000 Metres Without Switching or Ganging

By W. T. COCKING

IN the past all receivers with any pretensions to selectivity have embodied several tuned circuits which required adjustment for every different wavelength. In the earliest sets each tuned circuit was separately controlled, but the difficulties of handling such a set soon led to attempts to link the various controls together mechanically so that they might all be operated by a single knob. A considerable measure of success has attended these efforts, and ganged receivers are now the rule rather than the exception. The components used in such a set, however, must be made with a high degree of accuracy, and coils and condensers must be matched within very close limits. A natural consequence of this is that the components become bulky and expensive.

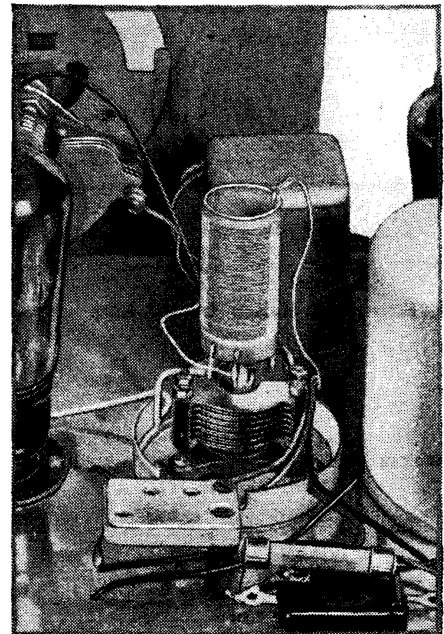
Of even greater importance, however, is the question of the initial adjustments which are necessary when putting a new receiver into operation. Although these are not essentially difficult, troubles are

often experienced because some component fails to come up to the requisite accuracy of matching, due, perhaps, to its having received careless handling at some time in its life.

A receiver in which no ganging is required and yet has only a single tuning control would remove all these difficulties at one stroke, but seems too good to be true. A receiver, moreover, which will tune over the full wave-range of 200 to 2,000 metres without necessitating any switching is the set of one's dreams, for it removes once and for all the bugbear of poor switch contacts.

These features and many others are obtained in the new receiving system developed by *The Wireless World*, and a skeleton circuit diagram showing the essentials appears in Fig. 1. The receiver is a superheterodyne, but differs from all other superheterodynes in having no signal-frequency tuned circuits. The oscillator condenser only is varied for tuning, and this is the only tuning control.

ONE of the greatest drawbacks of ordinary receivers is the ganging of the various tuning controls, for such a high degree of accuracy of matching in coils and condensers is required for a high standard of performance that components become costly and easily damaged. The initial adjustments, moreover, require to be performed with precision. All these disadvantages are removed at one stroke by a new receiving system, which will be known as single-span tuning, developed by "The Wireless World" and described for the first time in this article.



Air-cored coils of low-loss construction with air-dielectric trimming condensers are used in the I.F. circuits.

Experience with ordinary superheterodynes would lead one to believe that such a system would be useless on account of second channel interference, and this would indeed be the case if a normal value of intermediate frequency were used. Instead of a frequency of 110 kc/s, however, an intermediate frequency of 1,600 kc/s, or even higher, is used in the new system, and leads to many important differences, in particular the possibility of covering a very wide waveband with a small tuning capacity.

Broadcasting stations lie between the

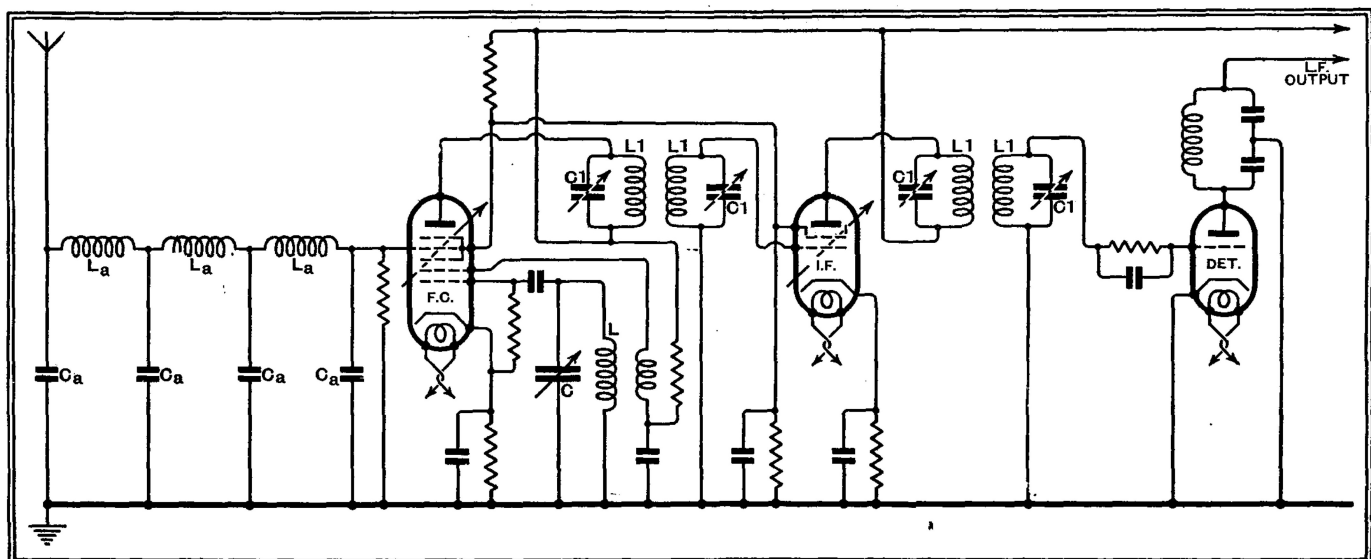


Fig. 1.—A skeleton diagram showing the essentials of the new receiver. The aerial circuit is aperiodic over the 200-2,000 metres band, but rejects signals of lower wavelength. A very high intermediate frequency is used, and as a result the full band can be covered by the oscillator tuning condenser C.

System

extreme wavelengths of 200 and 2,000 metres, or 1,500 kc/s and 150 kc/s, so that a frequency range of 10-1 must be covered. To do this in a single step with ordinary arrangements would mean a circuit in which the capacity could be varied over a 100-1 ratio, and a variable condenser with a capacity of some 0.005 mfd. would be needed! If we use a superheterodyne with an intermediate frequency of 1,600 kc/s, however, the oscillator can cover a much smaller range. For the reception of a station on 1,500 kc/s, the oscillator would work at 3,100 kc/s, and for a station on 150 kc/s at 1,750 kc/s. The oscillator need cover only the band of 3,100-1,750 kc/s, therefore, and for this a capacity change of only 3.14-1 is needed! It is, in fact, possible to use a short-wave type variable condenser of 160 mmfd. capacity and cover the range with ease. So far as the oscillator circuit is concerned, the problem of covering a wide range without switching is thus solved by using a high intermediate frequency.

The problem of the signal-frequency tuning is solved in a drastic fashion by not using any such circuits. Owing to the high intermediate frequency, second channel interference from a station in the 200-2,000 metres band is an impossibility. The only possibility of second channel interference comes from a station on a frequency 3,200 kc/s higher than that of the received signal. Second channel interference, therefore, can only be caused by stations between 4,700 kc/s and 3,350 kc/s, or 63.8 and 89.5 metres. These frequencies are so widely removed from those of the desired receiving range that it is a simple matter to design a fixed aerial coupling system which will pass frequencies between 1,500-150 kc/s and reject all others.

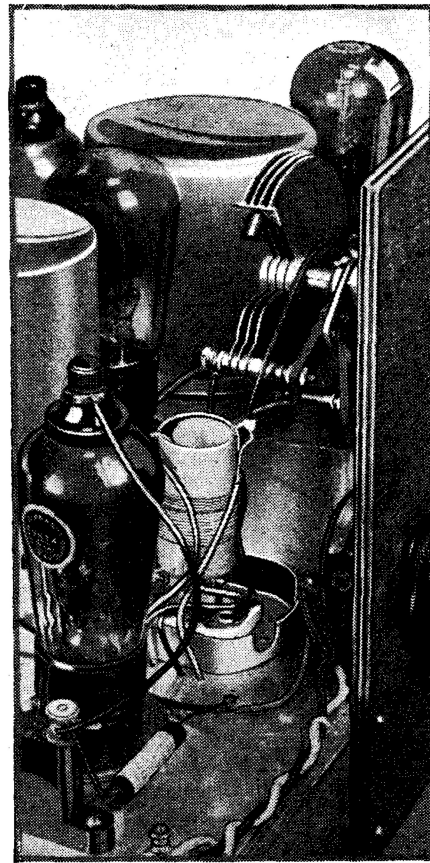
The Aerial Coupling

One particular aerial coupling is shown by the coils La and condensers Ca of Fig. 1. These constitute a low-pass filter and effectively prevent second channel interference. Other methods are available and the one shown here is not necessarily the best from all points of view.

It will be seen that all signals in the broadcast band are applied simultaneously to the tetrode control grid of the Heptode frequency-changer. It is, therefore, essential that this valve has essentially linear characteristics, otherwise cross-modulation by powerful stations would cause serious interference. In practice, however, no trouble has been experienced on this score.

The circuit diagram of the rest of the set shows no abnormality, save that a single small coil L is used for the oscillator and is tuned by a small condenser C, which forms the only tuning control. The I.F. amplifier can follow standard prac-

tice except that the circuits LiCi are tuned to 1,600 kc/s instead of the usual 110 kc/s. Although no changes are essential in this part of the apparatus, they may be advisable, and the most successful of the receivers which have been used in the experiments have embodied an unusual form of I.F. amplifier. Full details of this will be given in a later article, and it will suffice to say here that it includes variable selectivity. This is an important point, since it enables the selectivity to be varied in order to suit



The tuning system of the new set consists of only one small coil with a S.W. type variable condenser.

the particular conditions of interference pertaining to the desired station. It is thus always possible to obtain the highest standard of quality of reproduction that interference will permit.

It will be seen, therefore, that the new system is unique in that the aerial system is aperiodic over the 200-2,000 metres range and that frequency-changing produces an intermediate frequency which is higher than the incoming signals instead of lower. As a result, a very wide range

Features of the New Development

200-2,000 metres tuning range without gaps or switching. Single control tuning without ganging. No matched coils or condensers. No second channel interference or other whistles. Variable adjacent channel selectivity. No signal-frequency tuned circuits.

of wavelengths can be covered by a very small capacity condenser, and as all tuning is carried out by the oscillator condenser, the need for ganging is entirely eliminated. The initial adjustments in a receiver of this type, therefore, are confined to lining up the I.F. amplifier, an extremely easy process. Not the least of the advantages of the system, however, lies in the avoidance of matched coils, for this means that the construction of the various coils comes well within the capabilities of the amateur, since elaborate apparatus for matching is unnecessary.

Selectivity

Before concluding this article it may be as well to make some mention of what at first might seem to be a failing of the method. The ordinary superheterodyne was developed largely because it presented the easiest way of obtaining high selectivity, since a tuned circuit operating at a low frequency is inherently more selective than one working at a high frequency. By changing the signal frequency to a lower value, therefore, a considerable gain in selectivity was obtained. With the new system, however, the signal frequency is changed to a higher value, so that one would expect a deterioration in selectivity. This would indeed be the case if selectivity were dependent only on the operating frequency. It is, however, also controlled by the number and efficiency of the tuned circuits, and experience has shown that by correct design it is not difficult to obtain adequate selectivity for present-day needs at a high intermediate frequency.

To sum up, the new receiving system offers important advantages over the customary methods in regard to the absence of waveband switching, the wide waveband which can be covered, the absence of any ganging, the ease of construction of the coils, the absence of second channel interference or other whistles, the ease with which variable selectivity may be obtained and the consequent improvement in quality of reproduction.

The illustrations to this article show some of the details of one of the experimental receivers used in the development of the new principle and one which proved capable of giving a highly satisfactory performance. It is intended to give constructional details of a set of this nature in the near future, and an announcement concerning this will appear in a later issue. The technical considerations involved in the application of the system will be dealt with next week.

THE TECHNIQUE OF Single-span Tuning

The Aerial and Reaction Circuits

By W. T. COCKING

IT will be remembered that the chief point in single-span tuning is the ability to cover a wide waverange with only a single small condenser, and that a contributory cause of this is the use of an aerial system which is aperiodic over a wide range. The design of such an aerial system offers special problems, and it is important to understand the factors involved.

The manner in which the energy picked up by the aerial is transferred to the first valve of the receiver must be such that the efficiency of transference is high over the receiving range and low over the second channel range. For broadcast reception with an intermediate frequency of 1,600 kc/s, the efficiency must be high over the 150-1,500 kc/s band and low over the range of 3,350-4,700 kc/s, while it is advantageous if it be also low at 1,600 kc/s.

It is obvious that high efficiency over the receiving range means increased signal strength. High efficiency in itself, however, is of secondary importance, for the most important factor is a high ratio of efficiency in the receiving range to efficiency in the second channel range. The primary function of the aerial coupling is to reduce second channel interference to negligible proportions.

An aperiodic aerial system commonly employed in S.W. receivers and illustrated in Fig. 1 is of little use for single-span tuning, therefore. The inductance L is a choke of high impedance, and if a suitable component be used, the voltage applied to the grid of the valve is nearly equal to that set up in the aerial by a signal. The efficiency, moreover, can be made very nearly constant over the whole of the 150-1,500 kc/s band. Unfortunately, however, the efficiency is still high over the 3,350-4,700 kc/s band so that there is little discrimination against second channel interference. The variation of efficiency with frequency follows the lines indicated by curve B of Fig. 2, whereas an ideal

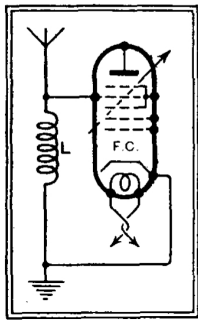


Fig. 1.—A common aperiodic aerial circuit.

system would give a response such as that of curve A.

The circuit of Fig. 1, however, will give different results if it be used with a moderate, instead of a high, value for L . The aerial possesses inductance, capacity and resistance, and if the value of L be so chosen that the resonant frequency of the system as a whole occurs towards the middle of the received band some discrimination against second channel interference may be expected.

When the values are selected so that the efficiency over the received range does not vary excessively a response curve such as C of Fig. 2 is obtained. Clearly there is a considerable improvement, but the second channel rejection is insufficient for a satisfactory performance.

Choosing the Aerial Circuit

The next step is obviously to a low-pass filter such as that shown in Fig. 3. A properly built and terminated filter having a sufficient number of sections will give a response curve approximating to curve A of Fig. 2 and have an efficiency of 50 per cent. reckoned on the present basis. In practice, however, a filter of this type gives only moderately good results for the efficiency varies greatly over the pass range due to the fact that correct termination is hardly possible.

For correct results a filter requires to be terminated by resistances, and the aerial

does not even approximate to a resistance. A practical form of filter, therefore, gives a response indicated by curve D of Fig. 2. Although this is not of the type required, it is capable of giving moderately good results, and it is by no means useless. For the best results, however, a better form of aerial circuit is required.

Now the arrangement of Fig. 1, when tuned to the middle of the received band offers the most promising performance, although in itself it is not good enough. It is obvious, however, that if by any

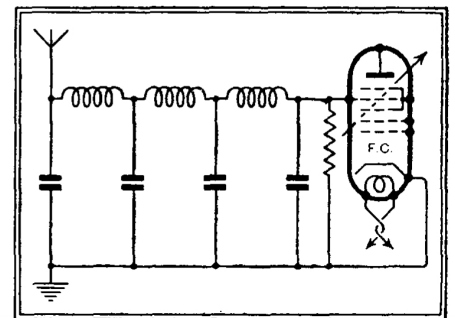


Fig. 3.—A low-pass filter which leads to moderately good results.

means a curve such as E of Fig. 2 could be obtained, the results would be very greatly improved. Although the efficiency would not be uniform over the range, it would not vary greatly, and the efficiency over the second channel range would be low.

A curve of this type is the same as that given by the familiar band-pass filter comprising two tightly coupled tuned circuits. This immediately gives the clue to the system, and one could use a circuit such as that shown in Fig. 4. The capacity of C_1 would be made equal to the aerial capacity, and L_1 equal to L plus the aerial inductance, while R_1 would be adjusted to prevent the efficiency at the peaks rising excessively to give a very uneven response over the waveband. The circuit capacity being fixed by the aerial capacity, the inductance is determined by the tuning range required, and is chosen so that it resonates with the capacity at the middle of the band. The mutual inductance between L and L_1 is then given a value such that one peak in the response curve comes

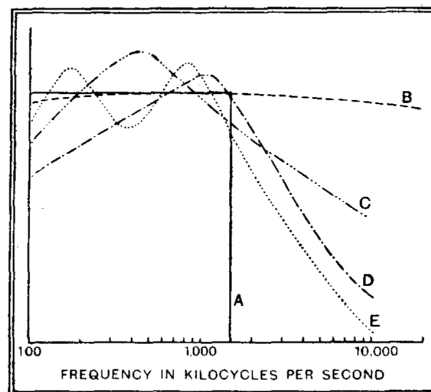


Fig. 2.—Curves illustrating the characteristics of different types of aerial coupling. Curve A is the ideal.

The Technique of Single-Span Tuning—

at about 400 kc/s while the other falls at about 1,200 kc/s. The response is then as indicated by curve A of Fig. 5.

An examination of this curve reveals two defects—the response falls off at the

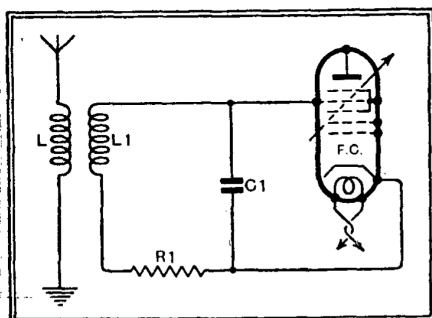


Fig. 4.—A coupled aerial circuit of the band-pass type gives a good performance.

lowest frequencies, and only a moderate attenuation is secured in the second channel region. A little thought shows that these defects are due to the type of coupling adopted, for the reactance of an inductance increases with frequency. It would appear, therefore, that a capacitatively coupled filter would be capable of a better performance. Such a filter is illustrated in Fig. 6. Curve B of Fig. 5 shows the performance, and demonstrates that the theoretical considerations are borne out in practice. A curve of this nature is highly satisfactory, and the variation in response over the whole waveband is limited to within ± 8 db, while the relative attenuation in the second channel is always over 40 db. An attenuation of this order is sufficient in practice, because signals on the 3,350-4,700 kc/s band are themselves usually considerably weaker than those in the broadcasting range.

Reaction and Selectivity

So much for the aerial circuit. Let us now consider some of the problems attendant upon the attainment of adequate selectivity. Operating at a given frequency there are two ways of obtaining high selectivity, a large number of tuned circuits of moderate efficiency may be used, or a small number of high efficiency. Considerations of cost, space, and ease of initial adjustment preclude the use of more than a moderate number of tuned circuits. It is, however, impossible to obtain tuned circuits of high enough efficiency at a high operating frequency without going to extremes in the matter of avoiding incidental losses. It is by no means rare to find that the losses in a valve-base alone are sufficient to halve the selectivity of an efficient circuit, and it is obviously out of the question to employ decapped valves in a receiver for general use.

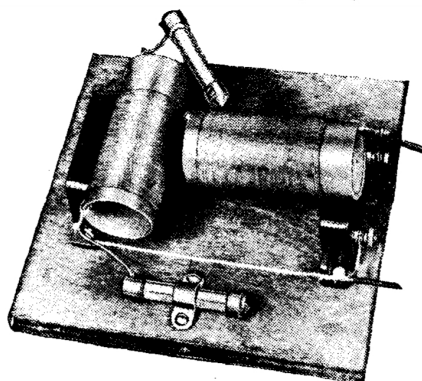
We must, therefore, have recourse to the benefits of reaction if sufficient selectivity for distant reception is to be obtained economically. In the case of a detector set, reaction leads to little difficulty; this is hardly the case, however,

where a high degree of pre-detector amplification is used.

If the full benefits of reaction are to be secured, it must be obtained from a valve to which only weak signals are ever applied. This means that the detector cannot be used to provide reaction, since modern practice dictates that it be supplied with a large input. The weakest signals are obviously to be found in the coupling between the frequency-changer and the first valve of the I.F. circuits, so that reaction would naturally be applied at this point. Even at this point, however, quite large potentials may be found when receiving a station spaced from a local by only a small amount, and such potentials tend to overload the valve providing reaction and prevent the full benefit being obtained from it.

Variable Selectivity

As much selectivity as possible, therefore, should be obtained prior to the reaction circuit, and the valve providing reaction should have linear characteristics so that it can handle a large input. In



An experimental form of the capacity-coupled aerial system of Fig. 6.

practice, therefore, two coupled circuits are used between the frequency-changer and the I.F. valve, and reaction is applied to the secondary, while the valve providing reaction is of the small power class.

Since a special valve is used for reaction it would be natural to suppose that the I.F. amplifier is arranged in normal fashion and the grid of the reactor valve connected in parallel with that of the first I.F. valve. This is not the case, however,

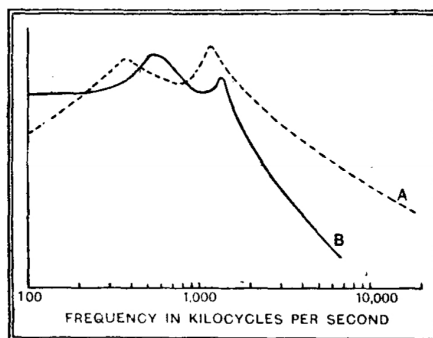


Fig. 5.—The response of coupled aerial circuits. Curve A is for an inductively coupled system and Curve B for a capacity coupling such as that of Fig. 6.

for such an arrangement leads to very unsatisfactory results. It must be remembered that the best screen-grid valve is not perfect, and there is always some coupling existing between its grid and

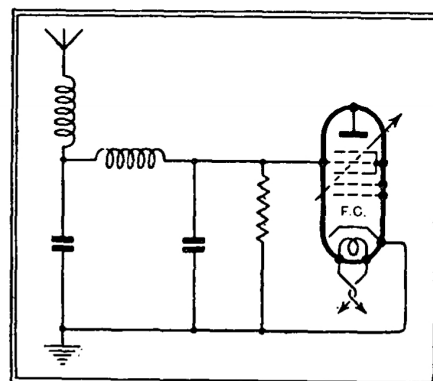


Fig. 6.—The final form of aerial circuit is really a two-stage capacity-coupled band-pass filter.

anode circuits. If the resistance of the grid circuit be reduced sufficiently, therefore, self-oscillation will occur. Consequently, if reaction be applied from a reactor valve, self-oscillation of the I.F. amplifier will occur before reaction is pressed to the degree necessary to make the reactor itself generate oscillations.

These difficulties are very largely overcome, however, by connecting the reactor valve in the I.F. chain. The reactor valve, or as it is perhaps more correctly termed in its new position, the buffer valve, is coupled to the frequency-changer by a pair of tuned circuits to the secondary of which reaction is applied from its anode circuit. The I.F. amplifier proper follows the buffer valve, and the first valve is coupled to it by an aperiodic coupling. Provided that proper precautions to reduce avoidable stray couplings are taken, the net result is a circuit in which reaction affects only the pair of circuits between the frequency-changer and the buffer valve.

Reaction and A.V.C.

The next point about reaction is that as normally applied it requires skilled operation. Reaction does not increase selectivity by reducing interference but only by increasing the strength of a wanted signal relative to the interference. Coupled circuits, on the other hand, reduce the interference without affecting the wanted signal to the same degree. In practice, therefore, where reaction is used to obtain selectivity, it is usually necessary to reduce the amplification, otherwise the only results are to increase the strength of the desired station beyond the value required, and to leave the interference unaffected. This difficulty of operation is got over automatically by using A.V.C., for an increase in the setting of the reaction control then automatically reduces the interference and sharpens the tuning. The application of reaction makes no difference to signal strength, but only affects selec-

The Technique of Single-span Tuning—tivity and quality, and the reaction control thus really becomes a selectivity control in more than name.

The practical result of including variable selectivity is to improve the quality of reproduction, for on no station need the selectivity, and hence the sideband cutting, be greater than is dictated by the amount of interference present on that station. When conditions are good, therefore, selectivity may be reduced and

a better high-frequency response obtained.

It will be seen, therefore, that the problems involved in the production of a receiver operating on the single-span principle have been both many and varied, and not confined alone to the development of the tuning method. To secure a wide tuning range and a satisfactory performance with freedom from ganging has necessitated research into many matters at first sight unconnected with the principle.

In Next Week's Issue :—

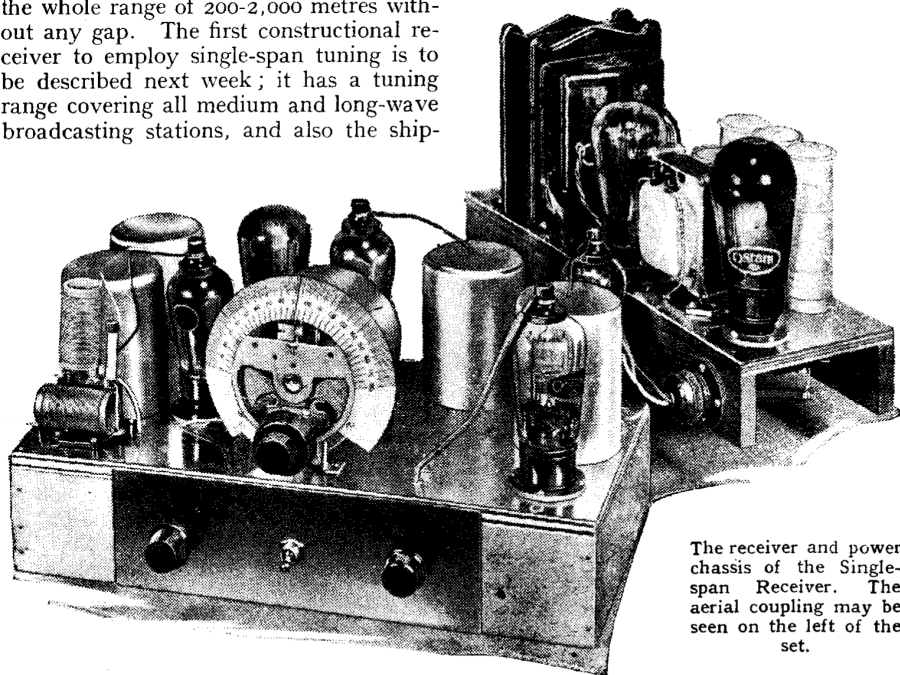
The Wireless World

Single-span Receiver

A Quality Set with Full Waveband Coverage and No Ganging

RECENT issues of *The Wireless World* have contained details of the new principle of single-span tuning which obviates the necessity for any ganging and provides single-dial tuning over the whole range of 200-2,000 metres without any gap. The first constructional receiver to employ single-span tuning is to be described next week; it has a tuning range covering all medium and long-wave broadcasting stations, and also the ship-

a duo-diode-triode. This valve is resistance-coupled to an output triode delivering some 2,500 milliwatts to the energised moving-coil loud speaker. An indirectly heated mains rectifier is used.



The receiver and power chassis of the Single-span Receiver. The aerial coupling may be seen on the left of the set.

ping and aircraft bands which are missed with all ordinary sets.

Tuning is carried out by a single small condenser fitted with a dual-ratio dial permitting rapid searching, yet accurate tuning. No ganging is involved, and no matched coils are required, so that the construction of the various coils is well within the capabilities of the amateur. The initial adjustments are few in number and consist merely of tuning the I.F. circuits to the same frequency and adjusting a single trimmer to ensure the correct waveband coverage being obtained.

The valves are arranged as a heptode frequency-changer followed by a buffer valve and two I.F. valves, while signal rectification, delayed A.V.C., and first stage L.F. amplification are obtained from

Provision is made for operating the set to reproduce records, and the manual volume control is operative on both radio and gramophone. The quality of reproduction obtainable is of an unusually high order, due largely to the inclusion of variable selectivity—a new feature which permits the best compromise between selectivity and quality to be obtained under all conditions.

Only four controls are fitted to the set—the tuning control covering 200 to 2,000 metres, the selectivity control, the manual volume control, and the radio-gramophone switch.

On test the receiver proved capable of a high standard of reproduction with adequate volume for most purposes. The sensitivity was sufficient for the daylight

reception of numbers of Continental transmissions, while the selectivity proved sufficiently high for general reception under modern conditions. Second channel and similar whistles were completely absent as well as cross-modulation, and the hum level was negligibly small.

LIST OF PARTS

After the particular make of component used in the original model, suitable alternative products are given in some instances.

RECEIVER UNIT

- 1 Variable condenser, 0.00016 mfd. Polar Type "E"
- 1 Dial, slow motion type
- 2 Bulbs, 6 volts 0.15 amp. Polar Micro-drive semi-circular Bulgin 615
- 1 Slow motion reaction condenser, 0.0002 mfd. Eddystone 957
- 1 Tapered volume control, 250,000 ohms (Claude Lyons, Rothermel, Watmel) Magnum
- 1 Double-pole change-over switch Bulgin S.98
- 3 Valve holders, 5-pin Clix Chassis Mounting Standard Type
- 2 Valve holders, 7-pin Clix Chassis Mounting Type
- 1 Compression Condenser, 100 mmfds. Colvern
- 4 Microcondensers, 100 mmfds. Eddystone 900
- 6 Fixed condensers, 0.1 mfd. 200v. working T.C.C. 50
- 2 Fixed Condensers, 0.01 mfd. T.C.C. Type "M"
- 2 Fixed Condensers, 0.001 mfd. T.C.C. Type "M"
- 5 Fixed Condensers, 0.0001 mfd. T.C.C. Type "M"
- 2 Fixed Condensers, 0.0005 mfd. T.C.C. Type "M"
- 1 Fixed Condenser, 0.0002 mfd. T.C.C. 34

- (Dubilier, Graham-Farish, Peak, T.M.C.Hydra, Telsen)
- 2 Electrolytic Condensers, 50 mfd. 12v. working T.C.C. 501
- 2 Metallised Resistances, 250 ohms 1 watt Dubilier
- 3 Metallised Resistances, 2,000 ohms 1 watt Dubilier
- 1 Metallised Resistance, 10,000 ohms 1 watt Dubilier
- 1 Metallised Resistance, 20,000 ohms 1 watt Dubilier
- 2 Metallised Resistances, 50,000 ohms 1 watt Dubilier
- 3 Metallised Resistances, 100,000 ohms 1 watt Dubilier
- 1 Metallised Resistance, 1 megohm 1 watt Dubilier
- 2 Metallised Resistances, 2 megohms 1 watt Dubilier
- 1 Metallised Resistance, 4,000 ohms 3 watts Dubilier
- 1 Metallised Resistance, 6,000 ohms 3 watts Dubilier
- (Eric, Graham-Farish, Claude Lyons, Seradex, Watmel)
- 1 Resistor, 30 ohms Bulgin A.R.30
- 1 Resistor, 50 ohms Bulgin A.R.50
- 1 Screened H.F. Choke Bulgin H.F.8
- 1 5-way Connector Wilburn
- 1 5-pin Plug British Radio Gramophone Co. (Bulgin)

- 1 5-way Cable with twin 70/36 leads Goltone (Harbros)

- 4 Knobs Bulgin K.6

- 4 Ebonite Shrouded Terminals, A., E., Pick-up (2) Belling-Lee Type "B"

- 4 Coil Screens, 3½ x 2½ ins. diam. White Bros. & Jacobs
- 1 Coil Screen, 4 x 3½ ins. diam. Colvern

- Materials for Coils:

- 12 ins. Faxolin tube, 1 in. diam. Wright & Weaire
- 2½ ins. Faxolin tube, ½ in. diam. Wright & Weaire
- Quantity No. 32, 36 and 38 D.S.C. wire.

- or 1 Set of Coils

- 1 Length Screened Slewing Harbros

- 2 ozs. No. 20 Tinned Copper Wire, 8 lengths Systoflex, wood, etc.

- Plymax Baseboard, 8 x 15 x ½ ins. Peto-Scott

- Screws:—

- 14 ½ in. No. 4 R/hd.; 36 ½ in. No. 4 R/hd.

- 8 ½ in. No. 4 R/hd.; 2 ½ in. No. 4 R/hd.

- All with nuts and washers.

- 1 ½ in. No. 6 B.A., with metal thread and nut and washer.

- Valves:—1 Ferranti VHT4, 1 Ferranti VPT4, 1 Osram or Marconi ML4, 1 Osram or Marconi VMS4, 1 Osram or Marconi MHD4.

POWER UNIT

- 1 Mains transformer, primary, 200 to 250 volts, 50 cycles; secondaries, 350-0-350 volts, 100 m.a.; 4 volts, 2.5 amps., centre-tapped; 4 volts, 1 amp., centre-tapped; 4 volts, 5 amps., centre-tapped

- Heayberd Type W.W.7

- (B.N.R., British Radio Gramophone Co., Bryce, Challis, Davenset, Claude Lyons, Rich and Bundy, Sound Sales, Vortexion)

- 1 Smoothing choke, 10 henries Wearite H.T.11

- (Bulgin, Davenset, Ferranti, Sound Sales.)

- 1 Fixed condenser, 0.01 mfd. T.C.C. Type "M"

- (Dubilier, Graham-Farish, Telsen)

- 1 Electrolytic condenser, 4 mfd., 440v. working T.C.C. 802

- 3 Electrolytic condensers, 8 mfd., 440v. working T.C.C. 802

- (Dubilier, Peak, Telsen)

- 1 Electrolytic condenser, 50 mfd., 50v. working T.C.C. 521

- (Dubilier)

- 1 Metallised resistance, 10,000 ohms, 1 watt Dubilier

- 1 Metallised resistance, 100,000 ohms, 1 watt Dubilier

- 1 Metallised resistance, 250,000 ohms, 1 watt Dubilier

- 1 Metallised resistance, 700 ohms, 2 watts Dubilier

- (Eric, Graham-Farish, Claude Lyons, Seradex, Watmel)

- 4 Valve holders, 5-pin Clix Chassis Mounting Standard Type

- 1 5-pin Plug British Radio Gramophone Co. (Bulgin)

- 1 Loud speaker with 2,500 ohms field with triode type transformer. Celestion Type E.8

- (Magnavox, Rola)

- Quantity No. 22 tinned copper wire, 2 lengths Systoflex, wood, etc.

- Plymax Baseboard, 15 x 5 x ½ ins. Peto-Scott

- Screws:—

- 18 ½ in. No. 4 R/hd.; 12 ½ in. No. 4 R/hd.

- All with nuts and washers.

- 2 ½ in. No. 6 BA with metal threads and nuts and washers.

- Valves:—1 Osram or Marconi PX4; 1 Osram or Marconi MU12.

Single-Span Dissected

Simplified Diagrams Explaining the New
Tuning System Step by Step

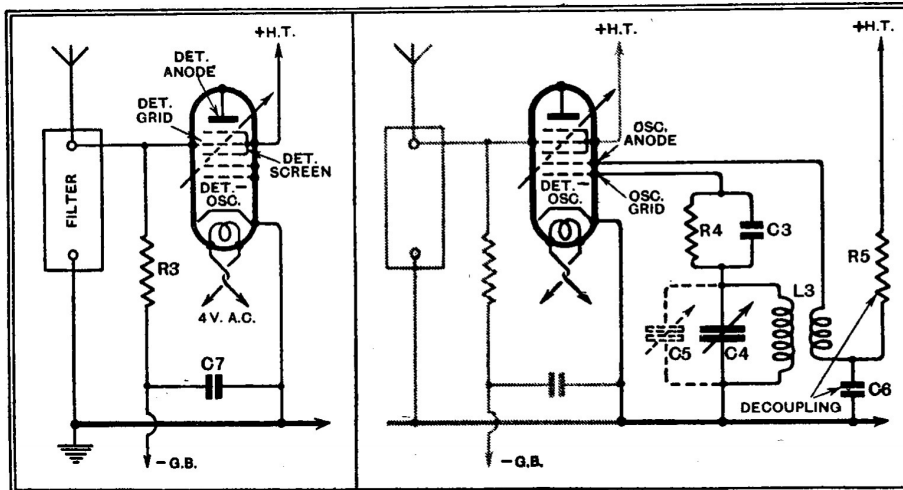


Fig. 1.—The input filter circuit.

Fig. 2.—Oscillator circuits of the frequency-changer valve.

ALTHOUGH the Single-Span receiver recently described in these pages is simpler than a conventional A.C. superheterodyne, the circuit diagram appears to be complicated unless considered in stages. A study of this series of dissected diagrams will explain the functioning of the new system from an essentially practical point of view.

Fig. 1.—Signals at all broadcasting wavelengths are applied to the detector grid of the frequency-changer valve through a special input filter; all lower wavelengths which might cause second-channel interference are cut off. Negative bias for anode-bend detection is applied through R3.

Fig. 2.—A tuned circuit covering wavelengths between about 100 and 170 metres (1,750-3,100 kc/s) is connected across the oscillator grid circuit of the valve, negative bias being produced by the action of R4 and C3. The oscillator anode circuit is completed through a reaction coil. Locally generated oscillations and those of the chosen wavelength from the aerial combine

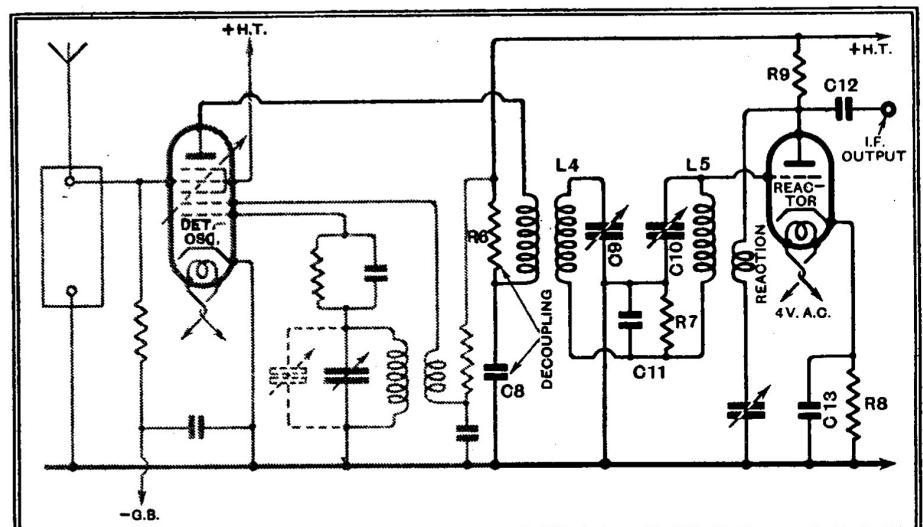


Fig. 3.—Intermediate-frequency impulses are applied to the reactor valve.

in the valve to produce a "beat" at nearly 190 metres wavelength (1,600 kc/s).

Fig. 3.—Signals of this new frequency are applied through the I.F. filter network to the grid of the reactor or buffer valve. Selectivity, and to a lesser extent sensitivity, are determined by the amount of reaction applied between grid and anode circuits of this valve.

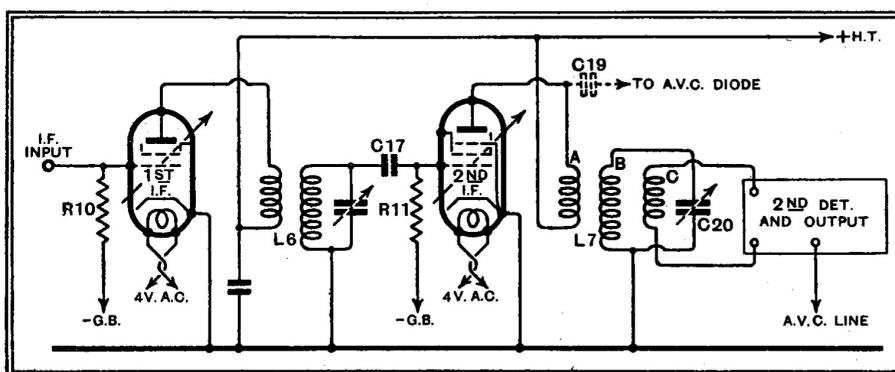
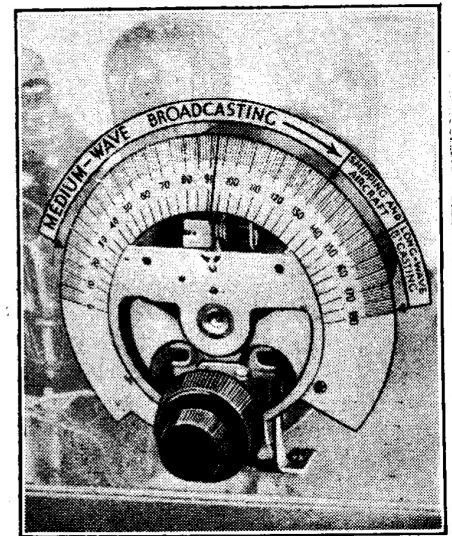


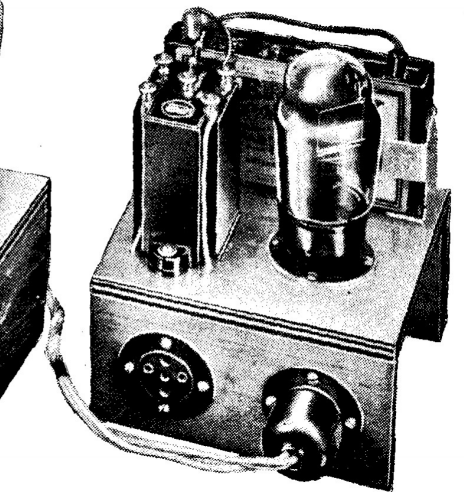
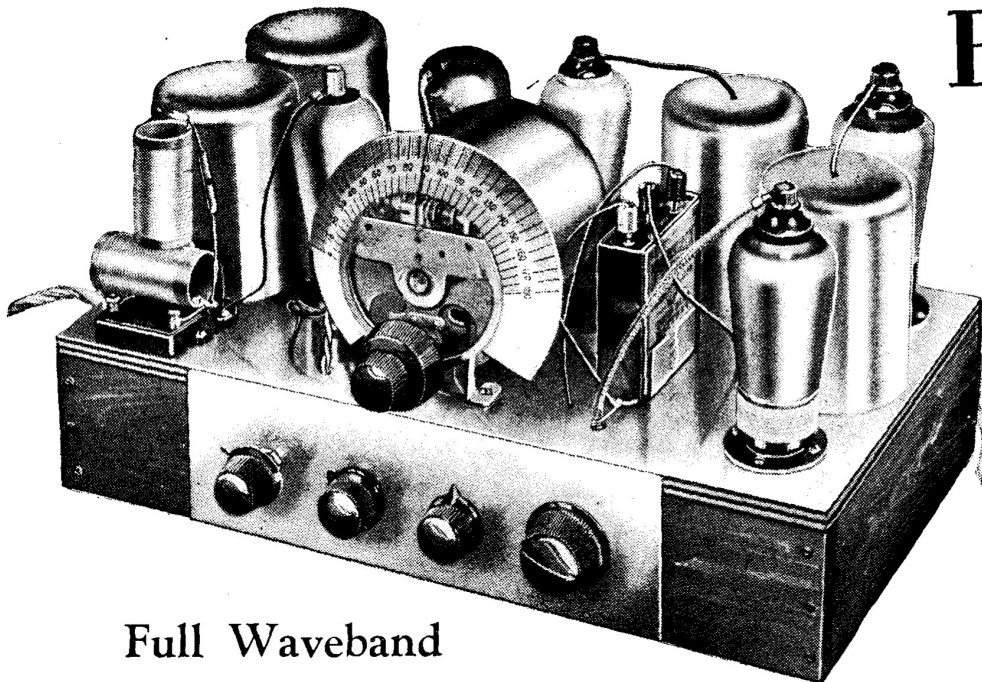
Fig. 4.—Intermediate-frequency amplifier and second detector-output connections.

Fig. 4.—The intermediate frequency output from the reactor valve is passed to a straightforward two-stage I.F. amplifier by resistance coupling, and after amplification, to a second detector and output stage of conventional design. Arrangements are made to feed back A.V.C. voltages to the grids of the detector-oscillator and the first I.F. amplifier.



A typical "Single-Span" tuning scale. Although the long-wave section may appear to be crowded, these stations actually have their full share of space.

The Battery Single-Span Receiver



Full Waveband

Coverage Without Ganging or Switching

SINGLE-SPAN tuning represents one of the most interesting receiver developments of recent years, and the principles underlying its operation were fully described in recent issues of *The Wireless World*.¹ The outstanding advantages of the new system are the absence of any ganging and the possibility of obtaining a tuning range wide enough to cover the 200-2,000 metres band in a single sweep of the variable condenser and without any necessity for coil changing. In addition, the absence of second channel interference and other forms of whistle generation render the system particularly adaptable to modern broadcasting conditions, while the introduction of variable selectivity leads to a further improvement in the performance obtainable.

The wide tuning range and absence of ganging are achieved by a modification of the now familiar superheterodyne. The use of an intermediate frequency higher than that of any received signal, together with an oscillator working on a frequency higher than the intermediate frequency, permits all frequencies lower than the intermediate frequency to be received with a single small coil and variable condenser in the oscillator circuit. In the Single-Span Receiver, for example, the intermediate frequency is 1,600 kc/s and the oscillator functions over a range of 3,100 kc/s to 1,750 kc/s, thus permitting signals between 1,500 kc/s (200 metres) and 150 kc/s (2,000 metres) to be received. This

alone would not give single-span tuning, for normal superheterodyne practice dictates that certain circuits must be tuned to the signal itself. The difficulty is overcome by the use of signal-frequency circuits so designed that they are responsive to all signals within the 150-1,500 kc/s range, but attenuate signals outside that range, and so prevent second channel interference.

The use of a high intermediate frequency is not in itself new, and it was used many years ago in the Infradyne receiver. For the process of frequency changing, however, this type of set aimed at using the sum of the signal and oscillator frequencies rather than the difference, with the result that a wide tuning range with a given coil and condenser was hardly possible, and signal frequency tuning was still necessary. As a result, the system offered little or no advantage over the ordinary superheterodyne and soon fell into disuse.

Advantages of a High I.F.

It is interesting to find, however, that a system employing an aperiodic aerial circuit and, therefore, more nearly akin to single-span tuning, was developed by von Kramolin as early as 1927, although he envisages the use of a fairly low intermediate frequency. In an example, he suggests the use of a frequency of some 500 kc/s for the I.F. circuits, with which reception can be obtained over a band of 1,500-550 kc/s, (200-550 metres) with an oscillator circuit tuning between 2,000 and

1,050 kc/s as the sole tuning control. Since the second channel range in 2,500-1,550 kc/s, it is theoretically possible to employ aperiodic signal frequency circuits and obtain freedom from second channel interference. The design of a suitable filter, however, would be a matter of considerable practical difficulty on account of the proximity of the receiving and second channel ranges.

The high intermediate frequency employed in Single-Span Receivers avoids difficulties of this nature and permits a tuning range covering both medium and

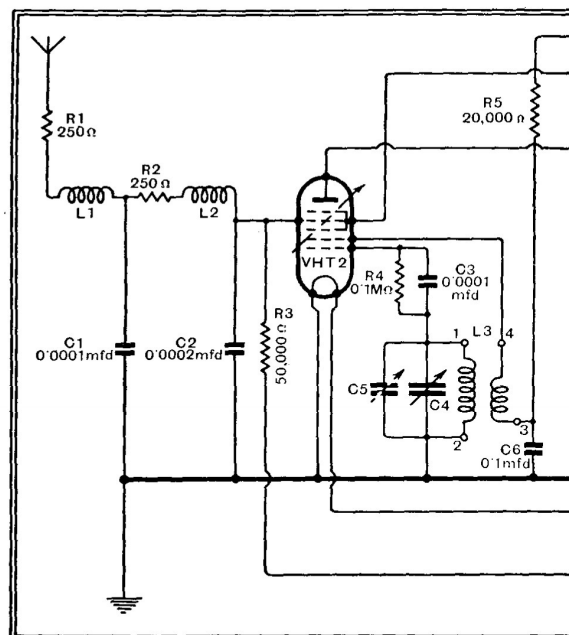


Fig. 1.—The complete circuit diagram of the receiver

¹ March 23rd, 30th, and April 6th, 1934.

long waves to be obtained. This alone, however, would not be sufficient to produce a successful receiver, and special design, not only of the aerial filter, but also of the I.F. circuits is essential to a satisfactory performance. The aerial filter must be as efficient as possible and give a substantially even response over the receiving range, but yet give a high degree of attenuation in the second channel region. In the I.F. circuits, the tuning coils and condensers must be designed for minimum losses and the ratio of inductance to capacity chosen for maximum selectivity rather than for optimum amplification. Furthermore, to obtain adequate selectivity for modern conditions it is necessary to employ reaction. By combining reaction with a special circuit arrangement and automatic volume control, it becomes almost entirely a selectivity control and has comparatively little effect upon the amplification.

Requirements for Battery Operation

The Single-Span Receiver² was built upon these lines and its performance well bore out the expectations based upon a study of the theoretical considerations. Single-span tuning, however, is by no means confined to a mains-operated set, and the principle is equally applicable to a battery receiver. The receiver described in this article is essentially the same as the earlier mains model, and the alterations which have been made are only those necessary for the different types of valves and those needed to preserve economy of anode current consumption, for no others have been deemed necessary or advisable.

The circuit diagram of the receiver appears in Fig. 1, and it will be seen that the first valve in the set is a heptode frequency-changer. The aerial filter, which permits all signals between 200 and 2,000

² The Wireless World, April 13th, 20th, 27th, 1934.

metres to be simultaneously applied to the control grid of the tetrode section of this valve while attenuating all signals outside this range, consists of the two coils L1 and L2 with the resistances R1 and R2 and condensers C1 and C2. The oscillator section, with which all tuning is carried out, comprises the coil assembly L3 with the tuning condenser C4 and the padding condenser C5.

THE principle of single-span tuning, in so far as it permits single-control operation without the use of ganged condensers, is a radical departure from accepted methods. Its further advantages of providing a very wide tuning range without the need for wave-band switching and of eliminating second channel whistles make it ideal for modern conditions. The principle is by no means confined to mains operated sets, and in this article will be found constructional details of a battery operated receiver capable of giving an outstanding performance

The intermediate frequency first appears in the tetrode anode circuit of this valve and preliminary selection is afforded by the pair of coupled tuned circuits L4 and L5, to the latter of which reaction is applied. The potentials developed across the trimming condenser C9 are applied to the grid of a triode valve which serves the dual purpose of providing reaction and of isolating the circuit to which reaction is

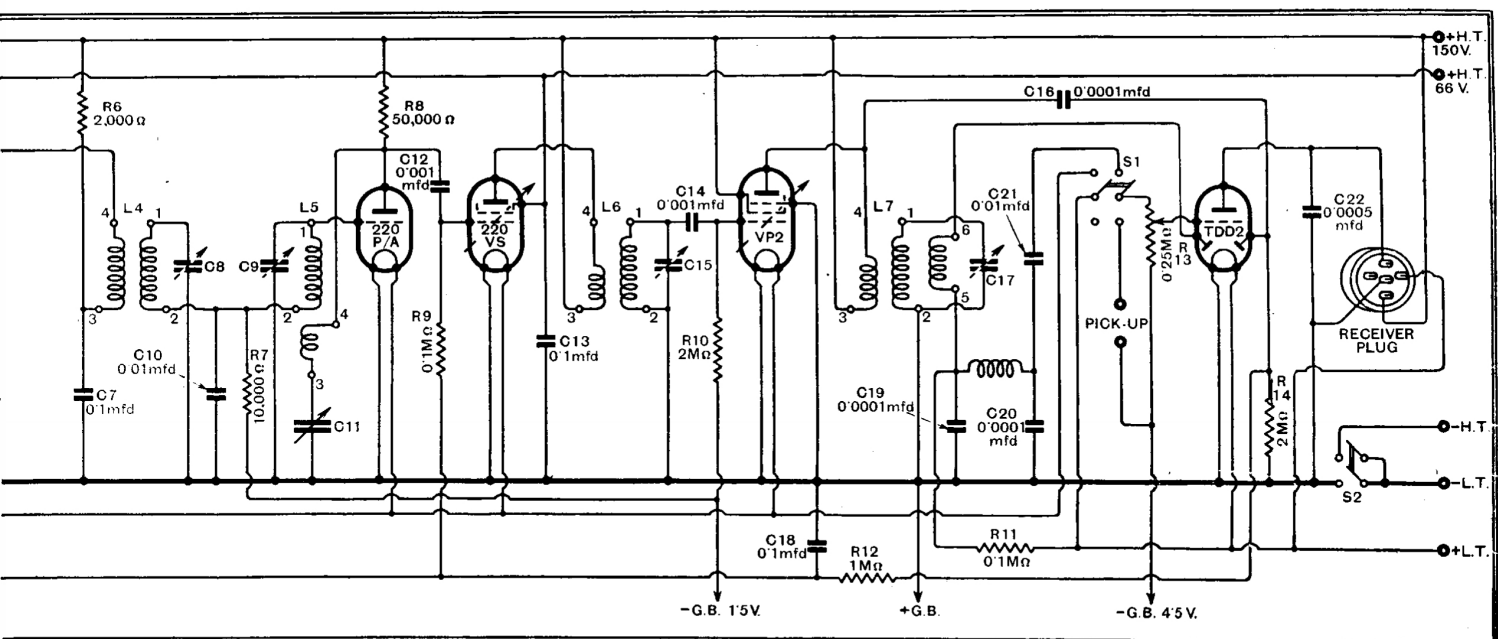
applied from the I.F. amplifier proper.³ If such isolation were not obtained it would be difficult to make any effective use of reaction.

This buffer valve is coupled to the first I.F. valve by a resistance-capacity coupling, and this I.F. valve, of the screen-grid type, is coupled to the second stage of amplification by a tuned transformer of 1-2 ratio. An H.F. pentode is used in the second stage and feeds another tuned transformer carrying three windings. The primary is connected in the I.F. valve anode circuit, the secondary is tuned, and the tertiary feeds the diode detector. This last valve in the receiver unit is a duo-diode-triode, and it is worthy of note that the two diodes have different characteristics. The detector diode is mounted round the negative limb of the filament, and functions normally, but the A.V.C. diode is mounted round the positive limb. This diode is fed by the 0.0001 mfd. condenser C16, and its load resistance R14 is returned to -L.T. As a result, the voltage drop along the detector diode and triode portions of the filament appears as a delay voltage in this diode circuit, and sufficient delay on A.V.C. is obtained without additional biasing.

The L.F. Circuits

A.V.C. is applied through the usual filter R12 and C18 to the control grids of the frequency changer and the first I.F. valves, which in the absence of any A.V.C. bias are operated at zero grid potential. This is permissible, since with the particular valves selected grid current does not start until the grid reaches an appreciably posi-

³ The use of a buffer valve is dealt with by F. M. Colebrook, B.Sc., in a paper entitled "A Study of the Possibilities of Radio-Frequency Voltage Amplification with Screen-grid and with Triode Valves," which appeared in *The Journal of the Institution of Electrical Engineers* for February, 1934.



unit of the Battery Single-Span Receiver. A heptode frequency-changer is employed, and a duo-diode-triode second detector valve provides delayed A.V.C.

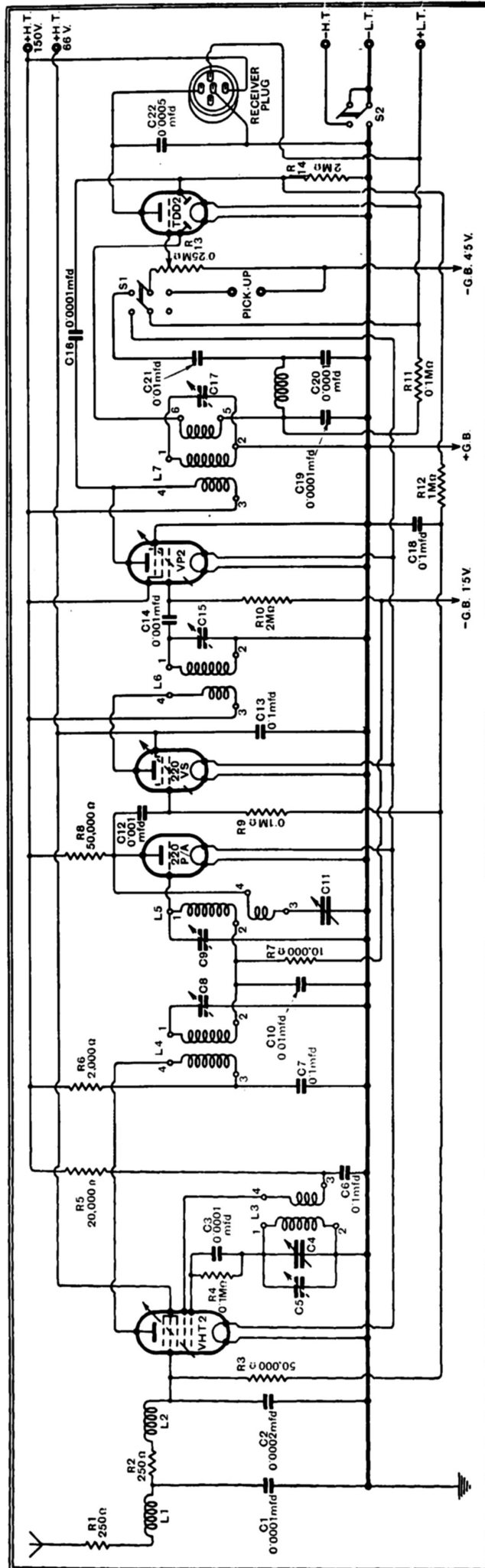


Fig. 1.—The complete circuit diagram of the receiver unit of the Battery Single-Span Receiver. A heptode frequency-changer is employed, and a duo-diode-triode second detector valve provides delayed A.V.C.

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- A diagram of a ring with a rectangular component attached to its top. The component has a circular feature on its left side and a protrusion on its right side. Four numbered circles are placed around the ring: 1 is at the top, 2 is on the right, 3 is at the bottom, and 4 is on the left.

The Battery Single-Span Receiver—

tive potential. The second I.F. valve is not controlled for A.V.C. purposes, and is given a fixed bias of -1.5 volts. It should be noted that this valve is designed to operate with a screen potential equal to the anode voltage.



A rear view of the receiver unit with the coil screens removed to show the internal arrangement of the transformers.

The output stage, the circuit of which appears in Fig. 2, is built as a separate unit, since this facilitates the employment of alternative equipment. The triode section of the duo-diode-triode in the receiver acts as the first stage L.F. amplifier both on radio and gramophone, and is coupled to the output valve by a 1-8 ratio push-pull transformer. The output valve is a double-pentode of the quiescent push-pull type, and gives an output adequate for most purposes when used with a sensitive type of loud speaker.

Constructing the Coils

In the interests of economy the apparatus has been designed for use with an H.T. supply of 150 volts, and it consumes a total current with no-signal of only 17 mA., an average of slightly under 3 mA. per valve. The same performance could only have been secured at a lower H.T. voltage by increasing the current consumption, with the inevitable result of a larger bill for H.T. battery replacements. In the interests of maximum economy the radio-gramophone switch is arranged to break the L.T. supply to the four early valves on gramophone, so that the total current consumption, both L.T. and H.T., is much less on gramophone than on radio.

The coils employed are identical with those used in the A.C. set, and the drawings given in this article need little amplification. L1 and L2 are both single layer coils and are supported by the wiring. L3 is bolted to the frame of the oscillator

tuning condenser, and care should be taken to see that both windings on this coil are in the same direction and that the connections are made correctly. If the winding direction of one coil, or the connections to one coil, be reversed, the heptode will not oscillate and no signals will be obtainable.

The basis of the other coils is the same, and is a single layer winding on a piece of $\frac{1}{16}$ in. diameter tubing; the differences between L4, L5, L6, and L7 are only in the primaries. L4 carries an overwound primary of 80 turns of wire, but L5 has no primary, although there are 15 turns of wire, wound on the main former at the end of the tuned winding, for reaction purposes. L6 is similar to L4, but the primary has only 40 turns. L7 carries an overwound primary of 60 turns, and a tertiary of the same number of turns wound over the primary. In every case adequate insulation between the windings is obtained by wrapping two layers of a fairly thin and hard paper round the previous winding. The tuned winding can in every case be secured by soldering the ends to tags fastened to the former; two layers of paper should then be wrapped round the coil at the low potential end, and the outer turn secured by a tiny blob of sealing wax at its two corners. One end of the wire for the primary should then be soldered to its appropriate tag and loosely

run on to the paper covering for the start of the primary. At this point it should be secured to the paper by a small blob of sealing wax. The primary may then be wound and the end again secured with sealing wax, the wire then being looped back to the appropriate lug.

These four I.F. coils are mounted on the trimming condensers by small brackets. The brackets are carried by the condenser terminals for the moving plates, and it will be found that the coil lug No. 1 in every case comes close to one of the terminals for the fixed plates, to which it should be joined by a stout wire, so giving additional rigidity. The condensers themselves are mounted on the screen bases by their one-hole fixing bushes. Care should be taken to see that the coils are correctly mounted on the condensers and that their terminal lugs are not too large, otherwise the lugs may foul the top of the screening can. Such a short-circuit would probably prevent reception, but it might only lead to a poor performance. It may, however, short-circuit the H.T. supply and damage the transformer primary concerned.

The remainder of the construction is straightforward and follows normal practice; it will be dealt with next week, therefore, together with the initial adjustments and some notes on the performance to be expected from the receiver.

The Radio Industry

AERIALITE, LTD., of Junction Mills, Whittington Street, Ashton-under-Lyne, are manufacturing several different types of aerial for fitting on cars, including models for the running board and the hood lining.

A very neat and compact Kabi "hum-balancing" potentiometer, no greater than a sixpence in diameter, has been introduced by F. W. Lechner and Co., Ltd., 61, Spencer Street, Clerkenwell, London, E.C.1.

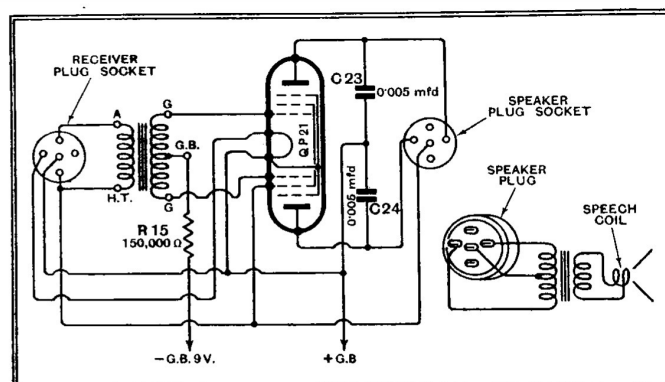


Fig. 2.—The circuit diagram of the output equipment which is built as a separate unit to facilitate modifications for special circumstances.

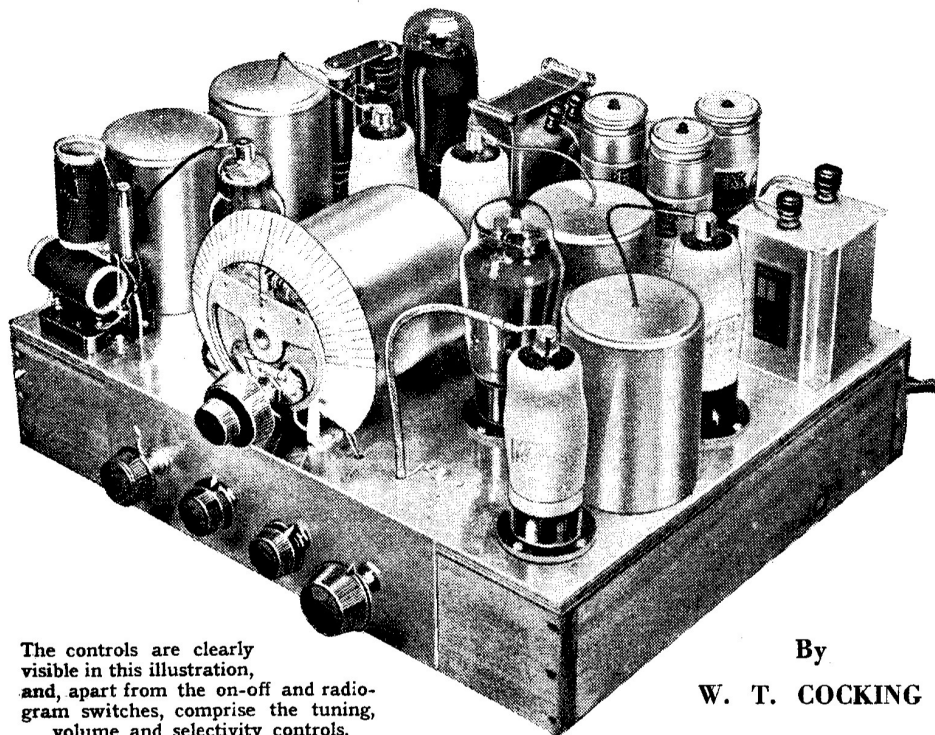
Steady progress is being made in the building of the new Cossor factory (the fifth), which will give employment to a thousand workers.

A new Hivac 2-volt battery H.F. pentode valve is described in a leaflet issued by the makers, the High Vacuum Valve Co., Ltd., 113-117, Farringdon Road, London, E.C.1.

A correction: Vortexion, 182, Broadway, Wimbledon, London, S.W.19. Style and address given last week was incorrect.

The Universal Single-Span Receiver

A Set for Operation
from Either A.C. or
D.C. Mains



The controls are clearly visible in this illustration, and, apart from the on-off and radio-gram switches, comprise the tuning, volume and selectivity controls.

By
W. T. COCKING

THE possessor of a direct-current lighting supply is often chary of investing in a mains-operated receiver lest it should be rendered useless by a change to alternating current. Most, if not all, D.C. supplies will eventually be changed to A.C., but in few cases can reliable information be obtained of the probable date of the change-over.

It is fortunate, therefore, that this state of affairs is no bar to the use of a mains-driven receiver, for it is readily possible to construct one which will operate with equal efficiency from either form of lighting supply. The "Universal" type of set is essentially similar to a D.C. mains receiver, and the valve heaters are all wired in series; a rectifier is included, however, so that a uni-directional H.T. supply may be obtained from A.C. mains.

The circuits of the receiver proper are essentially the same whatever method of power supply be adopted—the differences are of a minor order and due partly to the nature of the power supply, but more to the particular class of valve, the use of which is dictated by the method of feeding the set. In the case of an A.C. mains set, for instance, a wide range of valves is available and it is possible economically to employ a high H.T. voltage, so that a directly heated triode output valve becomes possible. With a battery supply, however, less efficient valves are available, and economy dictates that the anode current consumption be kept at a low figure; moreover, a quiescent type of output stage is now almost a necessity. The case of a D.C. mains receiver or the Universal type of set comes between the A.C. and battery classes. The valves available are as

efficient as those in the A.C. ranges, but the types are limited. In addition, the H.T. supply cannot exceed the mains voltage. No great limitation is placed on current, however, so that quiescent output stages are unnecessary, but the low voltage precludes the use of a triode output valve, and one is forced to employ a pentode.

The essential features of earlier single-span receivers have been retained in the

Universal Single-Span Receiver, and the changes which have been made are only those dictated by the different method of supply and the different valves employed. The essential features of single-span tuning—the absence of ganging, and coil switching, the full waveband coverage and freedom from second channel interference—are fully retained.

The complete circuit diagram appears in Fig. 1, and it will be seen that the valves are arranged as a heptode frequency-changer, followed by a triode buffer valve, two I.F. stages embodying H.F. pentodes and a duo-diode-triode which provides detection, delayed A.V.C., and first stage L.F. amplification. The output valve is a pentode, and a half-wave rectifier is provided for A.C. working. The valves are all rated to consume the same heater current of 0.2 ampere, and the heaters are connected in series. The heptode is the Micromesh 15.D.1, and its heater is rated at 13 volts; the other valves are Mazda and the HL.1320, the two VP.1321, and the

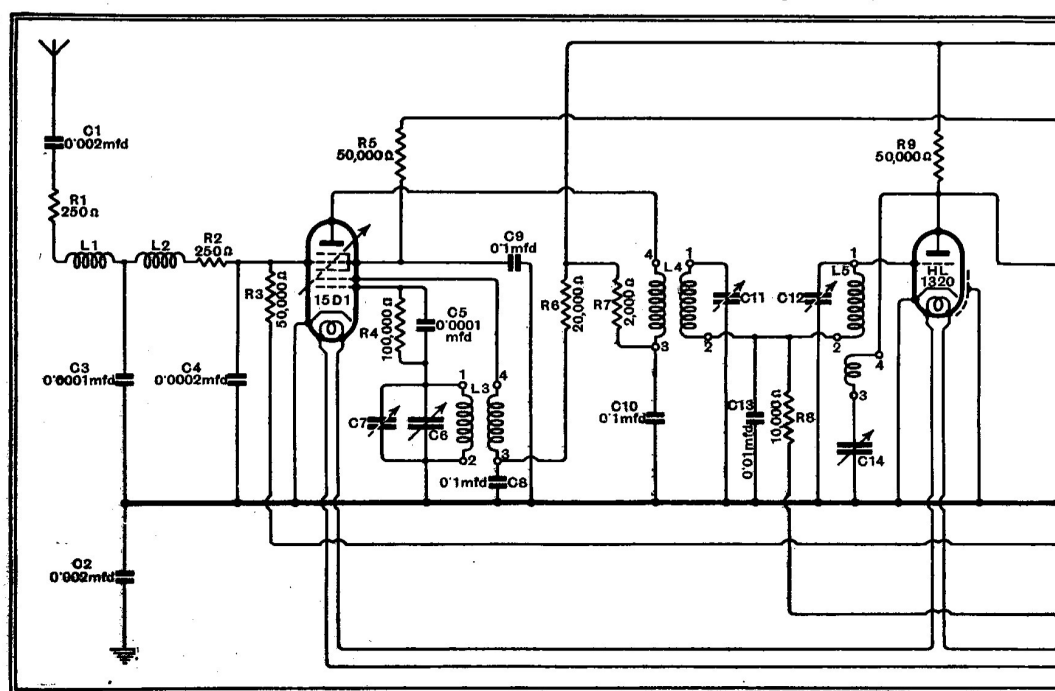


Fig. 1.—The complete circuit diagram of the new receiver shows that the essential features of the H.T. supply on A.C.

HL.DD.1320 are also rated at 13 volts. The Pen.3520, however, requires 35 volts and the U.4020 needs 40 volts.

The heaters, therefore, consume 140 volts at 0.2 ampere, so that on a 200 volts supply only 60 volts need be thrown away in a dropping resistance, for the 2 volts required by the dial lights can be ignored. The fixed portion of the resistance R21, therefore, is given a value of 300 ohms, and it dissipates only 12 watts. On 250 volts mains, however, a further 50 volts must be dropped; a portion of R21, having a resistance of 250 ohms, is included and provided with a tapping every 50 ohms for mains voltages between 200 volts and 250 volts. It will be seen, therefore, that R21 is actually a fixed resistance of 300 ohms in series with a tapped resistance of 250 ohms.

The aerial coupling circuit consists of the two coils L1 and L2, with the resistances R1 and R2 of 250 ohms each, the 0.0001 mfd. condenser C3 and the 0.0002 mfd. condenser C4. This filter passes frequencies between 150 kc/s and 1,500 kc/s, but greatly attenuates frequencies outside this range. Condensers C1 and C2 of 0.002 mfd. capacity are inserted in the aerial and earth leads in order to prevent any short-circuit between the mains and earth. It will be seen that no variable tuning is included in the aerial system, and that all frequencies within the receiving range are applied simultaneously to the tetrode control grid of the heptode valve.

A tuned circuit, however, is connected to the oscillator grid of this valve, and its tuning varied by the 0.00016 mfd. condenser C6 which forms the only tuning control. The frequency of the oscillations generated by the inner electrodes of

the heptode can be varied over a range slightly greater than 1,750 kc/s to 3,100 kc/s, so that the intermediate frequency of 1,600 kc/s can be produced from any desired station.

A transformer L4 of 1-1 ratio is connected in the tetrode anode circuit of the heptode and tuned to 1,600 kc/s. Coupled to this by a capacity coupling C13 is another tuned circuit L5, to which reaction

RECEIVERS for both A.C. mains and for battery operation embodying the single-span system of tuning have already been described in "The Wireless World," and in this article appear details of a model which functions equally well from either alternating or direct current. It will be remembered that the use of single-span tuning leads to the abolition of ganging and waveband switching, and renders second channel interference troubles non-existent. The present receiver, therefore, is of particular interest to those with D.C. mains.

can be applied from the triode buffer valve. This buffer valve is coupled to the first I.F. stage by a resistance-capacity coupling comprising the 50,000 ohms resistance R9, the 0.001 mfd. condenser C15, and the 100,000 ohms resistance R10. This particular arrangement is adopted in order that reaction may be applied to a circuit which is largely isolated from the others as far as stray couplings are concerned.

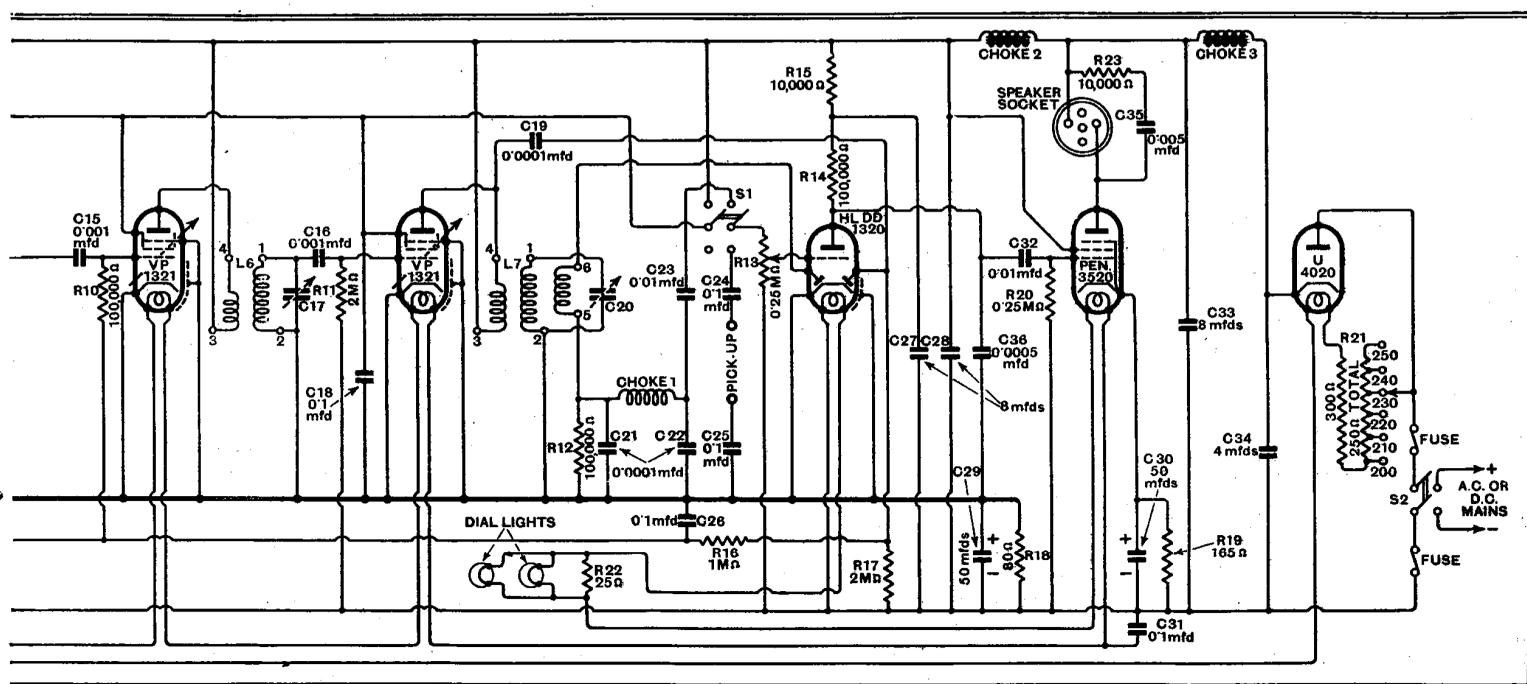
The L.F. Circuits

The first I.F. valve is coupled to the second by a 1-2 ratio transformer L6 with a secondary tuned to 1,600 kc/s, and the second stage is coupled to the detector by a transformer L7 of more complicated design. The tuned circuit is fed from a

primary, the ratio being 2-3, and a tertiary is included with a ratio of 3-2 from the tuned circuit. The detector diode is fed from this tertiary, and the usual filter comprising Chr and the two 0.0001 mfd. condensers C21 and C22 is included. The diode load resistance R12 is given a value of 100,000 ohms, and the L.F. potentials developed across it are applied to the triode grid through the 0.01 mfd. condenser C23 and the 250,000 ohms volume control potentiometer R13.

Resistance coupling is used between the triode and the output pentode, and de-coupling of the triode anode circuit is provided by the 10,000 ohms resistance R15 and the 8 mfd. electrolytic condenser C27. The output transformer primary is included directly in the pentode anode circuit, and is shunted by the 10,000 ohms resistance R23 in series with the 0.005 mfd. condenser C35 in order to maintain the correct load on the pentode and to prevent an excessive treble response.

The mains leads are taken first to the double-pole on-off switch S2, and then to a pair of fuses rated at one ampere. The current for the heater supply is then tapped off, and the remaining current passes through the half-wave rectifier. On a D.C. supply the rectifier acts as a simple resistance, but on A.C. it passes only alternate half-waves, and so gives a pulsating output. A 4 mfd. reservoir condenser C34 follows the rectifier and the current then passes through the first smoothing choke Ch3, where initial smoothing takes place in conjunction with the 8 mfd. electrolytic condenser C33. The anode of the output valve is fed from this point, but further smoothing is required for the screen of this valve and the early stages. This is provided by Ch2 and C28.



single-span tuning are retained. The valves all consume 0.2 ampere and their heaters are connected in series. The half-wave rectifier provides mains, and on a D.C. supply it protects the electrolytic condensers from damage.

The Universal Single-Span Receiver—

It will be noted that the smoothing condensers are all returned to negative H.T., which is not at the same potential as the earth line to which the cathodes of all the early valves are directly returned. Grid bias for the output valve is obtained by inserting a 165-ohms resistance R19, shunted by a 50-mfd. condenser C30 in its cathode lead—the lower end of this resistance and the grid leak R20 both being returned to negative H.T.

An 80-ohms resistance R18, shunted by a 50-mfd. condenser C29, is joined between the earth line and negative H.T., so that the latter point is about 2.5 volts negative with respect to the earth line. The grid return leads of all the early valves are returned, either directly or through A.V.C. resistances, to negative H.T., so that they all have the same initial bias of 2.5 volts.

The heptode and the first I.F. valve are both controlled for A.V.C. purposes, and the A.V.C. bias is obtained from the second diode in the duo-diode-triode. This diode is fed from

the last I.F. transformer primary through the condenser C19. Its load resistance R17 of 2 megohms is returned to negative H.T., so that a delay of 2.5 volts is obtained. When the signal input to the detector exceeds 2.5 volts, therefore, rectification

to negative H.T., the value of which depends upon the signal strength. This potential is applied as additional bias to the two controlled stages through the usual filter circuit R16 C26.

When the set is tuned to a certain signal the bias on the two controlled valves is thus the initial bias plus a figure which depends on the signal strength. When a stronger signal is tuned in the detector

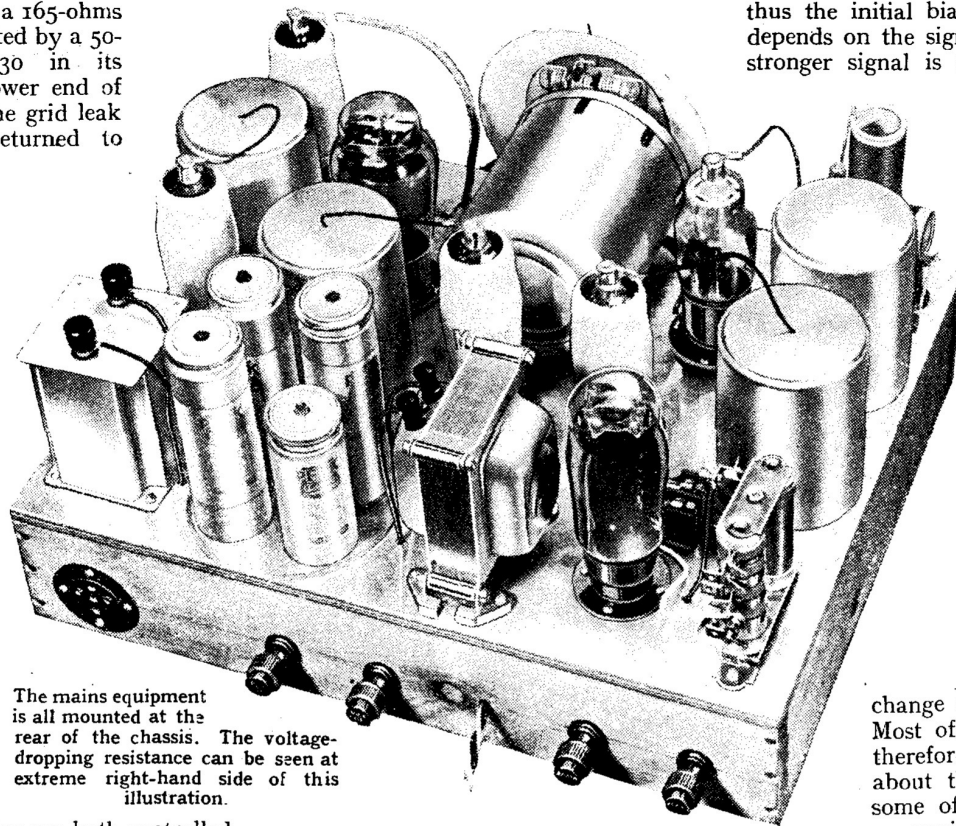
input and the A.V.C. bias both increase, so that the total bias on the controlled valves rises and the amplification of these stages consequently falls. The net result is that although the detector input rises with increased signal strength in the aerial, it rises less than it would do if all valves were operated with a fixed bias, and quite large changes in aerial input are possible with little or no

change in the audible output. Most of the stronger stations, therefore, can be tuned in at about the same volume, and some of the effects of fading are avoided.

The valves selected for use in the I.F. stages are rated for operating with their screen grids at the same potential as their anodes, so that a screen-feed potentiometer becomes unnecessary. The heptode, however, requires a screen potential of only some 100 volts, and this is obtained by feeding it through the 50,000-ohms resistance R5. One pole of the radio-gramophone switch S1 is arranged to break the screen circuits on gramophone in order to prevent any possibility of radio signals breaking through. The other pole of this switch changes the connection of R13 from C23 to one of the pick-up terminals. It will be noted that 0.1-mfd. condensers C24 and C25 are inserted in the pick-up leads in order to isolate this component from the mains.

The Mains

This point may require a little explanation. In any D.C. mains or Universal receiver the circuits of the set are in direct connection with the supply mains, for it is not possible to employ a transformer as in a purely A.C. set. Now, one pole of the mains is almost invariably earthed at the supply station, so that one of the mains leads is some 200-250 volts above or below earth. In many cases the negative H.T. line of the receiver will be at about the same potential as earth, but in many others it will be 200-250 volts different.



The mains equipment is all mounted at the rear of the chassis. The voltage-dropping resistance can be seen at extreme right-hand side of this illustration.

occurs in the A.V.C. diode, and this diode acquires a potential negative with respect

LIST OF PARTS

After the particular make of component used in the original model, suitable alternative products are given in some instances.

- | | |
|--|---|
| 1 Variable condenser, 0.00016 mfd., C5 Polar Type "E" | 1 Mains resistance, 300 ohms, plus 250 ohms, tapped every 50 ohms, R21 Watmel P25 |
| 1 Dial, Slow motion type Polar Micro-drive semi-circular | 1 Resistor, 25 ohms, R22 Claude Lyons F.W.25 |
| 2 Bulbs, 0.06 amp. Bulgin Type "H" | 1 L.F. choke, Ch3 Wearite H.T.11 |
| 1 H.F. choke, Ch1 Bulgin H.F.8 | 1 L.F. choke, 32 henrys, Ch2 Bulgin L.F.15 |
| (Kinva, Wearite) | (Bulgin, Davenset, Ferranti, Sound Sales, Varley, Wearite) |
| 4 Microcondensers, 100 mufds., C11, C12, C17, C20 Eddystone 900 | 1 Tapered volume control potentiometer, 250,000 ohms, R13 Claude Lyons Type 250 M-T |
| 1 Compression condenser, 100 mufds., C7 Colvern | (Ferranti, Magnum, Rothermel) |
| 1 Electrolytic condenser, 4 mids., C34 Peak Type "W" | 2 Valve holders, 5-pin Clix Chassis Mounting Standard Type |
| 3 Electrolytic condensers, 8 mids., C27, C28, C33 Peak Type "W" | 6 Valve holders, 7-pin Clix Chassis Mounting Type |
| 1 Electrolytic condenser, 50 mids. 15 volts, C29 Peak Type D.54 | 1 Rotary Q.M.B. D.P.D.T. Switch, S1 Claude Lyons 2163 |
| 1 Electrolytic condenser, 50 mids. 25 volts, C30 Peak Type D.52 | 1 Rotary Q.M.B. D.P.S.T. Switch, S2 Claude Lyons 2161 |
| 8 Fixed condensers, 0.1 mfd., C8, C9, C10, C18, C24, C25, C26, C31 Peak Type "M" | 1 Reaction condenser, slow-motion, 0.0002 mfd., C14 Polar Type QJ |
| 3 Fixed condensers, 0.01 mfd., C13, C22, C32 Peak Type "M" | (Eddystone) |
| 1 Fixed condenser, 0.005 mfd., C35 Peak Type "M" | 4 Coil screens, 3 1/2 x 2 1/2 in. diam. Mains Power Radio Type CS1 |
| 2 Fixed condensers, 0.002 mfd., C1, C2 Peak Type "M" | 1 Coil screen, 4 x 3 1/2 in. diam. Colvern |
| 2 Fixed condensers, 0.001 mfd., C15, C16 Peak Type "M" | (Goltone) |
| 1 Fixed condenser, 0.0005 mfd., C36 Peak Type "M" | Materials for Coils: |
| 4 Fixed condensers, 0.0001 mfd., C5, C19, C21, C22 Peak Type "M" | 12 in. Paxolin tube, 1 in. diam. Wright & Weaire |
| 1 Fixed condenser, 0.0001 mfd., C3 Graham-Farish Bakelite Case Type | 2 1/2 in. Paxolin tube, 1/2 in. diam. Wright & Weaire |
| 1 Fixed condenser, 0.0002 mfd., C4 Graham-Farish Bakelite Case Type | Quantity No. 32, 36 and 38 D.S.C. wire, |
| (Dubilier, Graham-Farish, T.C.C., T.M.C.Hydra, Telsen) | or 1 Set of Coils. |
| 1 Resistance, 80 ohms, R18 Watmel Hy-watt | 4 Knobs Bulgin K6 |
| 1 Resistance, 165 ohms, R19 Watmel Hy-watt | 1 5-pin Plug Bulgin P.3 |
| 2 Resistances, 250 ohms, R1, R2 Watmel Hy-watt | (British Radio Gramophone Co., Goltone) |
| 1 Resistance, 2,000 ohms, R7 Watmel Hy-watt | 1 Baseboard twin fuseholder with 1 amp. fuses Bulgin F.11 |
| 3 Resistances, 10,000 ohms, R8, R15, R23 Watmel Hy-watt | (Belling-Lee) |
| 1 Resistance, 20,000 ohms R6 Watmel Hy-watt | 4 Ebonite shrouded terminals, A. E. Pick-up (2) Belling-Lee Type "B" |
| 3 Resistances, 50,000 ohms, R3, R5, R9 Watmel Hy-watt | 5 Valve cap connectors, thimble type Clix |
| 4 Resistances, 100,000 ohms, R4, R10, R12, R14 Seradex | 2 Lengths screened sleeving Harbros |
| 1 Resistance, 250,000 ohms, R20 Seradex | 4 ozs. No. 20 tinned copper wire, 8 lengths Systoflex, wood, flex, etc. |
| 1 Resistance, 1 megohm, R16 Seradex | Plymax baseboard, 12 x 15 x 3/4 in. Peto-Scott |
| 2 Resistances, 2 megohms, R11, R17 Seradex | Screws:— |
| Dubilier, Erie, Ferranti, Graham-Farish, Claude Lyons, Seradex) | 4 1/2 in. No. 4 R/hd.; 18 1/2 in. No. 4 R/hd. |
| | 3 1/2 in. No. 6B.A., with metal threads and nuts and washers. |
| | Loudspeaker, with transformer to give primary Impedance of 4,400 ohms. Rola F7-PM29 |
| | Valves:—Mazda, 1 HL.1320, 1 HL.DD.1320, 2 VP.1321, 1 Pen.3520, 1 U.4020; Micromesh, 1 15.D.1. |

The Universal Single-Span Receiver—

Condensers in the aerial, earth, and pick-up leads are essential, therefore, in order to avoid any possibility of short-circuiting the mains, for either the aerial or the pick-up might accidentally become earthed. Moreover, without these condensers, a shock might be found on handling the connections.

It must not be forgotten, however, that all metal objects in the set itself are connected directly with the mains. These include not only the metal-covered chassis but also the coil screens and the metallising of the valves themselves. Care should be taken, therefore, not to come into contact with any metal part of the set when it is switched on. It is recommended,

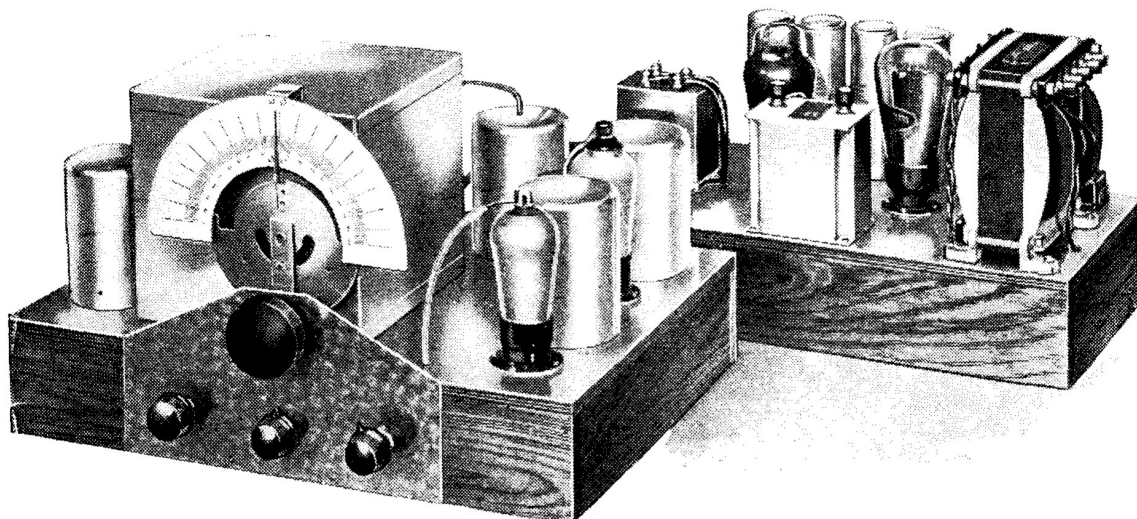
therefore, that once the initial adjustments have been performed, the set be included in a cabinet. One point which is often overlooked is to see that the grub-screws in the control knobs are deeply counter-sunk, and the metal pointer supplied with the reaction condenser C14 should not be used.

It should not be thought that a Universal set is in any way dangerous. It is perfectly safe provided that the proper precautions be taken, but as these precautions are unnecessary with the usual type of A.C. set, they are not always fully realised, and it has been deemed advisable to go into the matter at some length.

(To be concluded.)

Olympic S-S Six

A New Single-Span Receiver for Distant Reception



To be Fully Described in Aug. 10th and 17th Issues

THE single-span system of tuning is now well established as a definite advance on older methods inasmuch as it eliminates ganging and waveband switching and so greatly simplifies both the construction and adjustment of a receiver. The set to be described in forthcoming issues of *The Wireless World* is of high sensitivity and possesses a much higher degree of selectivity than earlier single-span receivers. Six tuned circuits are used, and the combination of reaction with automatic volume control gives variable selectivity, and so permits the quality of reproduction to be always as high as possible, consistent with the conditions of interference prevailing on a particular station.

With minimum selectivity, a condition used chiefly for local reception, the overall frequency response is flat within some 3 db. from 40 cycles to 10,000 cycles and an output of about 3.5 watts can be obtained. The receiver, therefore, is as suitable for local reception as for distant listening.

Both quality and selectivity are unaffected by the wavelength to which the set is tuned, with the result that the excessive sideband cutting of long-wave stations, which is so common, is not present in this receiver. This is chiefly noticeable by the increased brilliance of reproduction of long-wave stations.

Mains hum proved inaudible in all tests and background hiss could only be heard on the weakest stations. Both sensitivity and selectivity proved adequate for all normal purposes, and complete freedom from second channel and kindred forms of interference was found.

LIST OF PARTS

After the particular make of component used in the original model, suitable alternative products are given in some instances.

RECEIVER UNIT

- | | |
|--|------------------------------|
| 1 Variable condenser, 0.00016 mfd. | Polar Type "E" |
| 1 Dial, Slow-motion type | Eddystone 973 |
| 1 Slow-motion condenser, 0.0002 mfd. | Polar "Q.J." |
| (Eddystone) | |
| 1 Potentiometer, 250,000 ohms | Claude Lyons S.T.250 |
| (Ferranti, Magnum, Rothermel) | |
| 1 Rotary D.P.D.T. switch | Claude Lyons 2163 |
| 1 Valve holder, 7-pin | W.B. Baseboard Type |
| 3 Valve holders, 7-pin | Clix Chassis Mounting Type |
| 1 Valve holder, 9-pin | Clix Chassis Mounting Type |
| 1 Compression condenser, 100 mmfids. | Colvern |
| 6 Microcondensers, 100 mmfids. | Eddystone 900 |
| 4 Fixed condensers, 0.0001 mfd. | T.C.C. Type "M" |
| 1 Fixed condenser, 0.0001 mfd. | T.C.C.34 |
| 1 Fixed condenser, 0.0002 mfd. | T.C.C.34 |
| 3 Fixed condensers, 0.001 mfd. | T.C.C. Type "M" |
| 2 Fixed condensers, 0.01 mfd. | T.C.C. Type "M" |
| 9 Fixed condensers, 0.1 mfd. Tubular, 350 volts D.C. working | T.C.C.250 |
| (Dubilier, Graham-Farish, Peak, T.M.C. Hydra, Telsen) | |
| 2 Electrolytic condensers, 50 mfd. 12 v. working | T.C.C.501 |
| (Dubilier, Telsen) | |
| 1 Resistance, 100 ohms | Graham-Farish "Ohmite" |
| 2 Resistances, 250 ohms | Graham-Farish "Ohmite" |
| 4 Resistances, 2,000 ohms | Graham-Farish "Ohmite" |
| 3 Resistances, 10,000 ohms | Graham-Farish "Ohmite" |
| 2 Resistances, 50,000 ohms | Graham-Farish "Ohmite" |
| 3 Resistances, 100,000 ohms | Graham-Farish "Ohmite" |
| 2 Resistances, 1 megohm | Graham-Farish "Ohmite" |
| 2 Resistances, 2 megohms | Graham-Farish "Ohmite" |
| 1 Resistance, 4,000 ohms | Graham-Farish "Ohmite" |
| 1 Resistance, 6,000 ohms | Graham-Farish "Ohmite" |
| 1 Resistance, 6,000 ohms | Graham-Farish "Ohmite" |
| (Dubilier, Eric, Ferranti, Claude Lyons, Seradex, Watmel) | |
| 4 Resistance holders, horizontal type | Graham-Farish |
| 1 6-way Connector | Bryce |
| 1 5-pin Plug | Bulgin P.3 |
| (British Radio Gramophone Co., Goltone) | |
| 1 5-way Cable, with twin 70/36 leads | Harbros |
| (Goltone) | |
| 6 Knobs | Bulgin K.6 |
| 4 Ebonite shrouded terminals, A, E, Pick-up (2) | Belling-Lee Type "B" |
| 2 Valve cap connectors, thimble type | Clix |
| 6 Coil screens, 3½ x 2½ in. diam. | Mains Power Radio Co. G.S.1. |
| 1 Coil screen, 4 x 3½ in. diam. | Colvern |
| (Goltone) | |
| 1 Screening box, 6½ x 6½ x 6 in. | Magnum |

- Materials for Coils:**
 16 in. Paxolin tube, 1 in. diam. Wright & Weaire
 2½ in. Paxolin tube, ¾ in. diam. Wright & Weaire
 Quantity No. 32, 36 and 38 D.S.C. wire,
 or 1 Set of Coils.
 2 Lengths screened sleeving
 (Goltone) Harbros

4 ozs. No. 20 tinned copper wire, 10 lengths Systoflex, wood, etc.

Plymax baseboard, 12 x 16 x ¾ in. Peto-Scott

Aluminium front plate Peto-Scott

Screws:—

20 ¼ in. No. 4 R/hd.; 8 ¾ in. No. 2 R/hd.; 18 ¾ in. No. 4 R/hd.; 16 ¾ in. No. 4 R/hd.; 6 ¾ in. No. 4 R/hd., all with nuts and washers.
 2 ¾ in. No. 6 B.A. with metal threads and nuts and washers.

Valves:—1 Ferranti H4D; 1 Mazda AC/TP; 2 Cossor MVS/Pen.; 1 Osram or Marconi MX40.

POWER UNIT

1 Mains transformer, primary 200 to 250 volts 50 cycles; secondaries, 350-0-350 volts, 100 mA., 4 volts, 2.5 amps. centre-tapped; 4 volts, 2 amps. centre-tapped; 4 volts, 6 amps. centre-tapped

Rich & Bundy Type 239
 (Davenset, Parmeko, Sound Sales, Vortexion, Wearite)

1 L.F. transformer, 1:3 Tolsen DR3

1 Smoothing choke, 15 henrys, 100 mA. Bulgin L.F.21
 (Davenset, Parmeko, Sound Sales, Varley, Wearite)

1 Fixed condenser, 0.5 mfd. Tubular, 350 volts D.C. working T.C.C.250

1 Fixed condenser, 0.005 mfd. T.C.C. Type "M"

1 Electrolytic condenser, 4 mfd. 440 volts working T.C.C.802

4 Electrolytic condensers, 8 mfd. 440 volts working T.C.C.802

1 Electrolytic condenser, 50 mfd., 50 volts working T.C.C.521
 (Dubilier, Graham-Farish, Peak)

1 Resistance, 100 ohms Graham-Farish "Ohmite"

1 Resistance, 140 ohms Graham-Farish "Ohmite"

1 Resistance, 5,000 ohms Graham-Farish "Ohmite"

1 Resistance, 10,000 ohms Graham-Farish "Ohmite"

1 Resistance, 20,000 ohms Graham-Farish "Ohmite"

1 Resistance, 1,500 ohms Graham-Farish "Ohmite"

(Dubilier, Eric, Ferranti, Claude Lyons, Seradex, Watmel)

1 Valve holder, 5-pin Clix Chassis Mounting Standard Type

1 Valve holder, 7-pin Clix Chassis Mounting Type

1 Twin safety fuseholder with 1 amp. fuses Belling-Lee 1033

(Bulgin)

1 5-pin Plug Bulgin P.3

(British Radio Gramophone Co., Goltone)

Loud speaker: 2,500 ohm field W.B. "E.M.2"

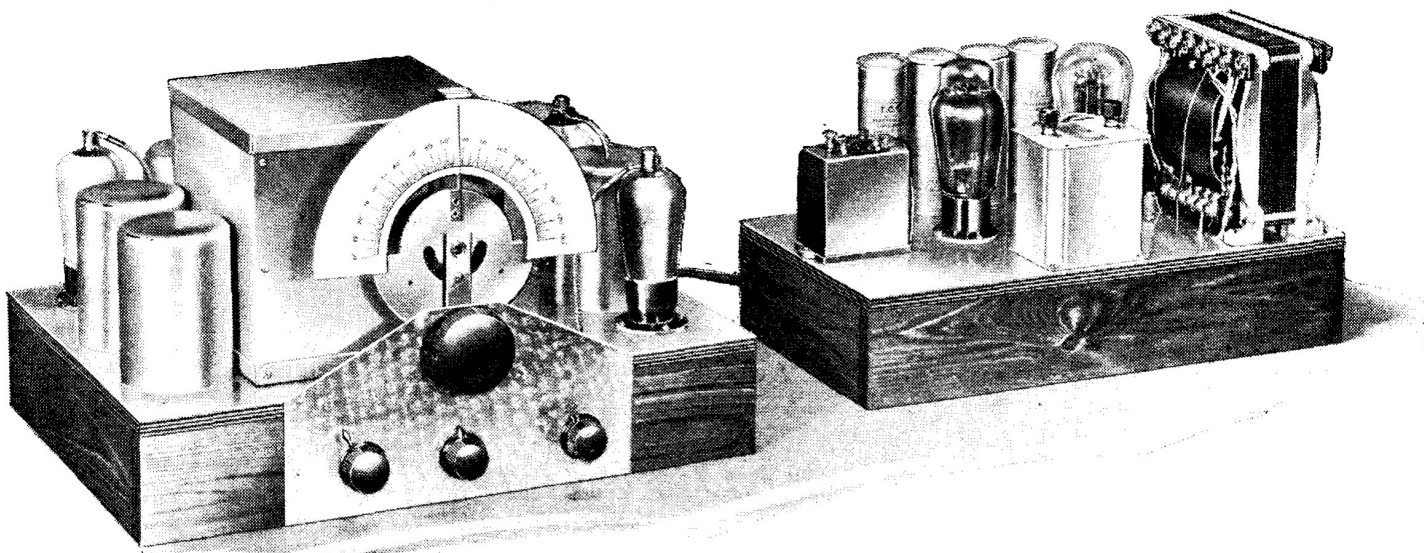
Quantity No. 20 tinned copper wire, 4 lengths Systoflex, wood, etc.

Plymax baseboard, 8 x 15 x ¾ in. Peto-Scott

Screws:—

24 ¼ in. No. 4 R/hd.; 6 ¾ in. No. 4 R/hd., all with nuts and washers.

Valves:—1 Osram or Marconi MU12, 1 Mazda AC/2/Pen.



Olympic S-S Six

A Selective High Quality Set for Distant Reception

By W. T. COCKING

THE single-span system of tuning is of particular interest to the constructor because it relieves him of all ganging difficulties while still permitting single-control tuning to be obtained. The receiver described in this article is both more sensitive and more selective than other designs, while the high standard of reproduction associated with single-span receivers is fully retained.

THE various methods by which increased selectivity can be obtained at the high intermediate frequency employed with single-span tuning were discussed in recent issues of *The Wireless World*,¹ and it was shown that an increase in the number of tuned circuits was the most satisfactory solution of the problem. Now, although it is readily possible to add tuned circuits to a receiver without increasing the number of valves employed, and it is also possible to add stages of amplification without using a greater number of tuned circuits, neither course is wholly satisfactory, and the best results are secured when tuned circuits and valves are added together. If the aim be to secure the maximum possible selectivity from a given number of tuned circuits, then ideally they should be separated from one another by valves. If many circuits be employed, this calls for a large number of valves, and in order to maintain stability and to keep the total amplification within reasonable limits, each stage need give only a small gain. Although ideal, a course of this nature is ruled out on the grounds of expense.

The other extreme is to obtain as high a degree of amplification as possible from

each stage, and to include the tuned circuits in twos, threes, or even fours, coupled together in the intervalve couplings. Coupled circuits, however, are both less efficient and give lower selectivity than the same number of circuits separated by valves, so that to maintain reasonably high amplification the circuits must be coupled fairly tightly, and this leads to poor selectivity. Compromise between the conflicting factors of cost and technical requirements is thus called for, and in the New Single-Span Receiver an increase is made in both the number of tuned circuits embodied and in the number of effective stages of amplification.

Six tuned circuits are used and arranged as two coupled pairs and two single circuits, with three stages of amplification in addition to the buffer stage, which provides reaction and greatly increases the selectivity. There are thus four effective valves at the intermediate frequency, but only three are actually used, for the first two stages are combined in a single envelope. Advantage is taken of the triode-pentode valve, originally developed as a frequency changer, but used here to combine the functions of a buffer valve and a

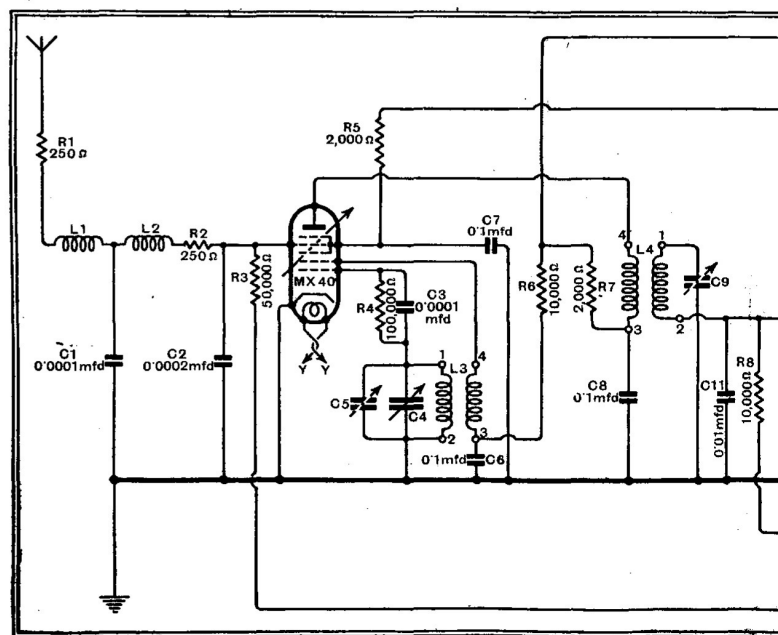


Fig. 1.—The complete circuit diagram of the receiver unit shows the

¹ *The Wireless World*, July 20th and 27th, 1934.

first stage I.F. amplifier—functions which it fulfils admirably.

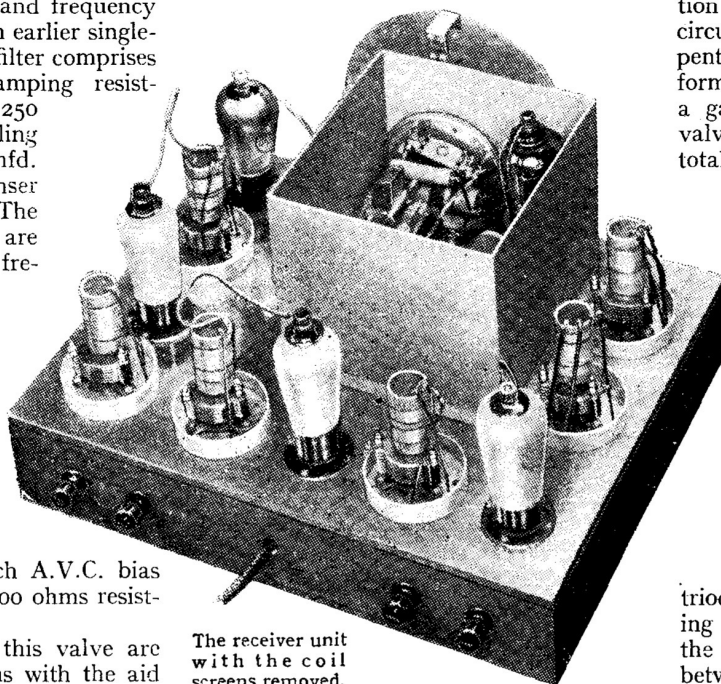
The Frequency Changer

Fig. 1 shows the complete circuit diagram of the receiver unit, and it will be seen that the aerial circuit and frequency changer are unchanged from earlier single-span receivers. The aerial filter comprises L1 and L2, the two damping resistances R1 and R2, of 250 ohms each, with the coupling condenser C1 of 0.0001 mfd. and the terminating condenser C2 of 0.0002 mfd. The characteristics of the filter are such that it freely passes frequencies between 150 kc/s and 1,500 kc/s, but greatly attenuates frequencies outside this range, so preventing second channel interference. The frequencies passed by this filter are applied to the control grid of the tetrode section of the heptode frequency-changer, to which A.V.C. bias is applied through the 50,000 ohms resistance R3.

The inner electrodes of this valve are used to generate oscillations with the aid of the coil assembly L3. The tuned circuit is connected to the oscillator grid, which is maintained at its correct operating potential by the flow of grid current through the 100,000 ohms resistance R4. The reaction coil is joined to the oscillator anode which derives its H.T. supply through the 10,000 ohms resistance R6. The oscillator frequency is controlled by the variable condenser C4, having a maximum capacity of 0.00016 mfd. and tuning over a range of 1,750-3,100 kc/s to permit reception over the 150-1,500 kc/s

band (2,000-200 metres). This condenser forms the sole tuning control, and the parallel padding condenser C5 is merely for the purpose of securing the requisite tuning range.

The intermediate frequency output of the frequency changer is applied to a pair



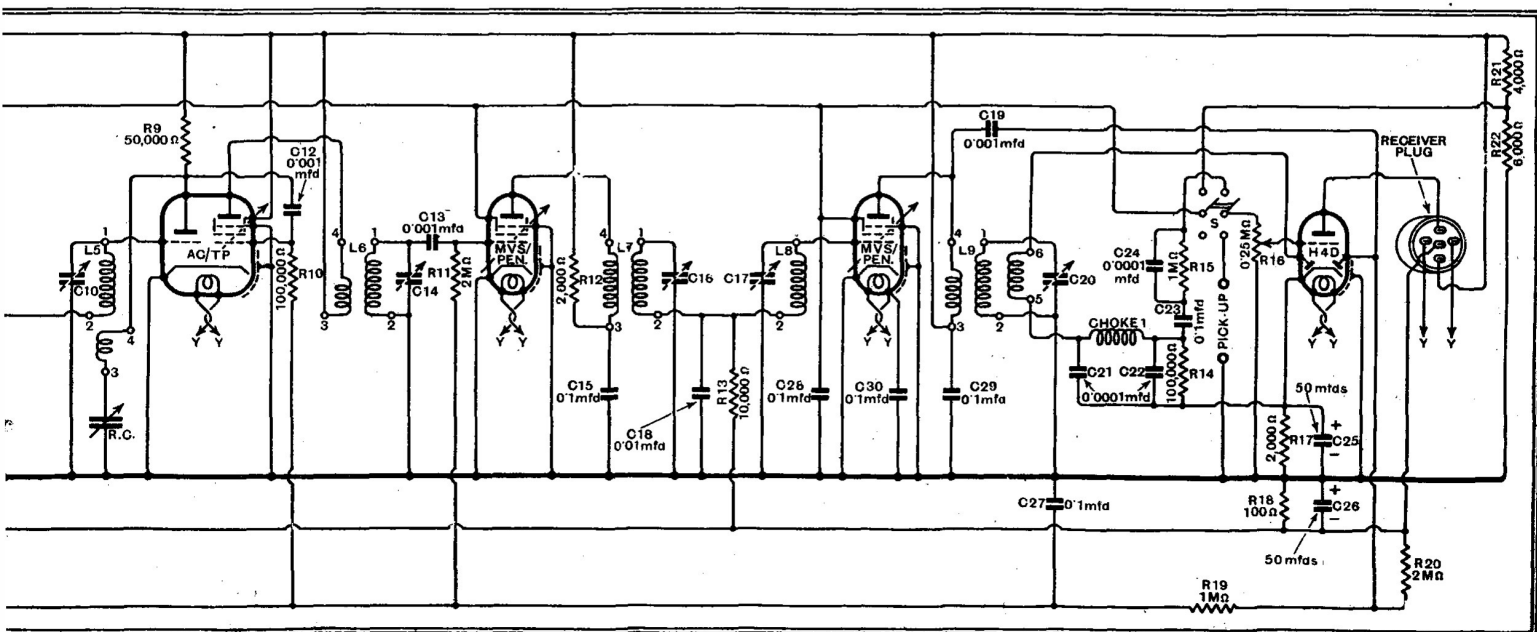
The receiver unit with the coil screens removed.

of loosely coupled circuits. The first circuit consists of L4 and C9 tuned to 1,600 kc/s, the circuit being fed from a primary having the same number of turns as the secondary. The second circuit, L5C10, is also tuned to 1,600 kc/s, and is coupled to the first by the 0.01 mfd. condenser C11. The potentials developed across C10 are applied to the triode section of the triode-pentode, and reaction is applied from its anode circuit to the tuned circuit L5C10.

Resistance coupling is used between the triode and pentode sections of this valve, for the chief function of the buffer is to isolate as far as possible the tuned circuits which follow it from the one to which reaction is applied, and which precedes it. The coupling is formed by the combination of R9, R10 and C12, and the tuned circuit L6C14 is coupled to the coil in the pentode anode circuit, thus giving a transformer of 1.2 ratio. The buffer valve gives a gain of 1.5 times, and the first I.F. valve an amplification of 126.5 times; the total gain afforded by the triode-pentode is thus $1.5 \times 126.5 = 190$ times.

The Detector

The second I.F. stage is an H.F. pentode and is coupled to the third stage by a pair of coupled circuits, the primary being a transformer of 1.1 ratio. The gain obtained here is consequently less, for the coupled circuits give an efficiency of under 50 per cent.; in spite of this, however, an amplification of forty times is obtained. The last stage is coupled to the duo-diode-triode by means of a transformer L9 carrying three windings. The ratio between the primary and secondary is 1.1.5, and between the secondary and tertiary it is 1.5.1. The detector diode is fed from the tertiary, and the usual H.F. filter Ch1, C21 and C22 is included. The diode load resistance R14 is given a value of 100,000 ohms in order to maintain the upper register, and the L.F. potentials developed across this are applied through the 0.1 mfd. condenser C23 to the network R15, C24, R16. R16 is the manual volume control and functions on both radio and gramophone; it has a value of 250,000 ohms. R15 of 1 megohm and C24 of 0.0001 mfd. form a tone-corrector in



fundamental tuning system of single-span remains unchanged. six I.F. tuned circuits are embodied.

Advantage is taken of the triode-pentode valve to obtain increased amplification and

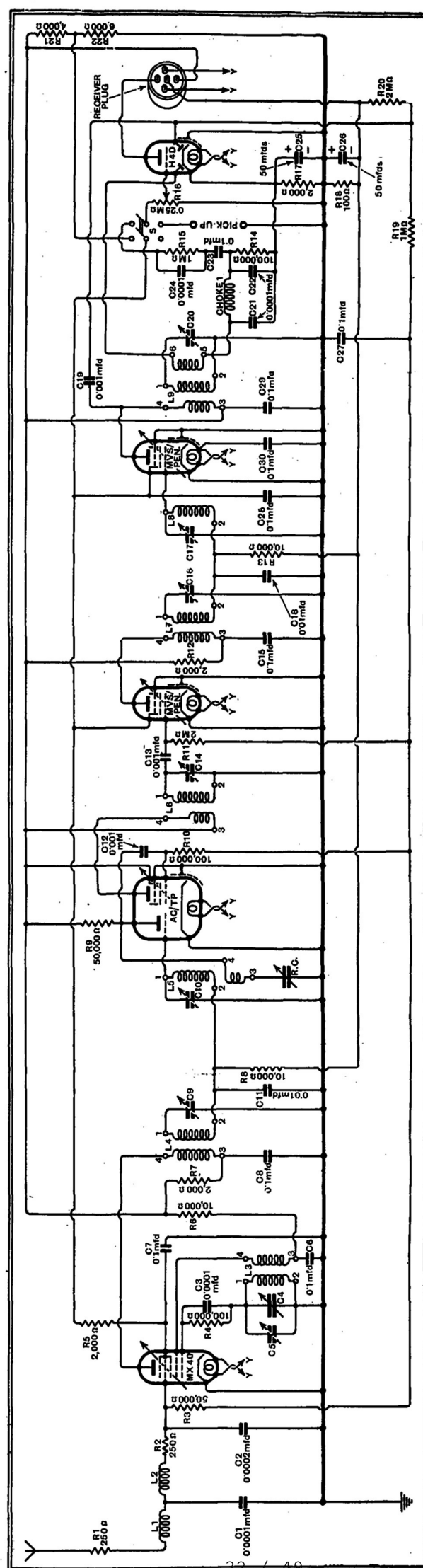


Fig. 1.—The complete circuit diagram of the receiver unit shows the fundamental tuning system of single-span remains unchanged. Advantage is taken of the triode-pentode valve to obtain increased amplification and six I.F. tuned circuits are embodied.

Olympic S-S Six—

conjunction with R16. At low and medium frequencies C24 has little effect, and R15 and R16 form a potential divider, so that only about one-fifth of the detector output

and the load resistance R20 is returned to negative H.T.; the delay voltage is thus equal to the sum of the voltage drops along R17 and R18. The A.V.C. bias developed across R20 is applied to the controlled

the locally generated signal, and to adjust the input to give a certain output across the loud speaker terminals. The frequency of the signal is then varied by a small known amount, and the input increased to give the same output as at resonance. The ratio of input off-resonance to input at resonance is plotted for a number of different frequencies, and the curves of Fig. 3 are obtained.

Broadcasting stations are usually spaced by 9 kc/s, and we see from curve A that a station 9 kc/s off-resonance would have to be 3.2 times as strong as one at resonance to give the same output. This is not a high order of selectivity, but it is intended that the receiver be operated in this condition only for local reception when the wanted station is itself much stronger than any transmission on a nearby wavelength. The sideband cutting with this degree of selectivity is not high, and a 10,000 cycles note is reduced only to about 27 per cent. of its original value. This loss is easily corrected, and the overall frequency response curve of Fig. 4 shows the results obtained; from 40 cycles to 10,000 cycles the response is even within ± 3 db. It is possible to obtain, therefore, an exceptionally high standard of reproduction in local reception.

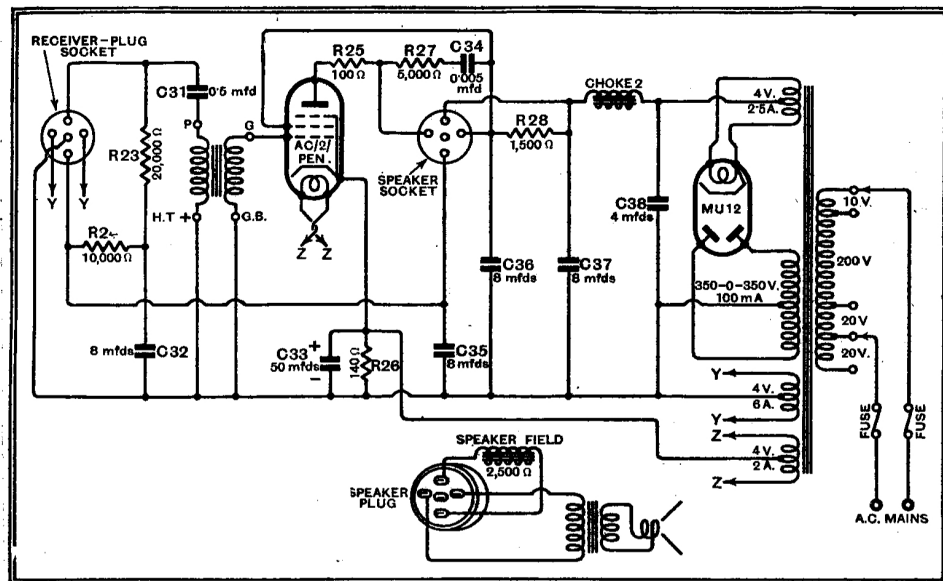


Fig. 2—Provision is made in the power unit for energising the field of a loud speaker, the winding being so connected that it functions as a smoothing choke.

appears across R16. At high frequencies, however, C24 has a reactance moderate compared with the resistance of R16, and nearly the full detector output appears across R16.

Negative grid bias for the triode L.F. amplifier is derived from the voltage drop across R17. The initial bias for the early stages, however, is obtained by making the earth line of the set, to which the cathodes are returned, positive with

grids through the usual filter R19C27.

The coupling between the L.F. stage and the output valve is by means of a resistance-fed transformer of 1-3 ratio (Fig. 2). The coupling resistance R23 is given a value of 20,000 ohms, and decoupling is provided by the 10,000 ohms resistance R24 in conjunction with the 8 mfd. electrolytic condenser C32. The output pentode is one of high efficiency, rated for an output of about 3.5 watts, and it is biased by the voltage drop along R26, which is shunted by a 50 mfd. condenser C33.

The mains and smoothing equipment follow standard practice, and need no explanation.

Provision is made for energising a speaker field of 2,500 ohms resistance, and it is, in fact, employed as a smoothing choke. Electrolytic condensers are used throughout for smoothing, and the rectifier is of the indirectly heated type.

Through the combination of six tuned circuits and reaction, variable selectivity of a high order is obtained, and exceptionally good quality of reproduction can be secured.

The selectivity obtained with reaction at minimum is shown by curve A of Fig. 3. The curve was obtained with the aid of a standard-signal generator, the procedure being to tune the receiver to resonance with

Variable Selectivity

When reaction is applied, the selectivity is very greatly increased. It is difficult to give definite figures for selectivity obtained in this way, for the amount of reaction

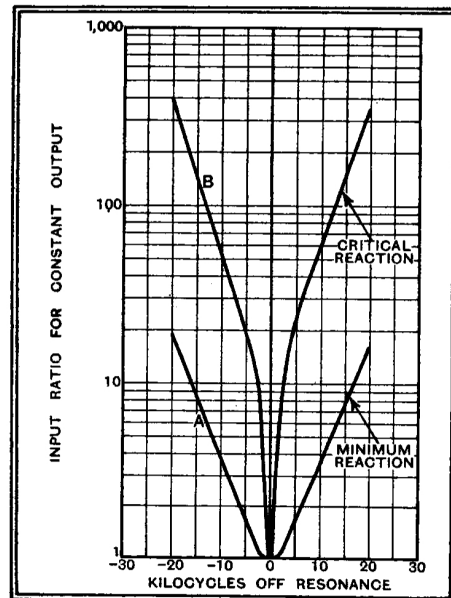
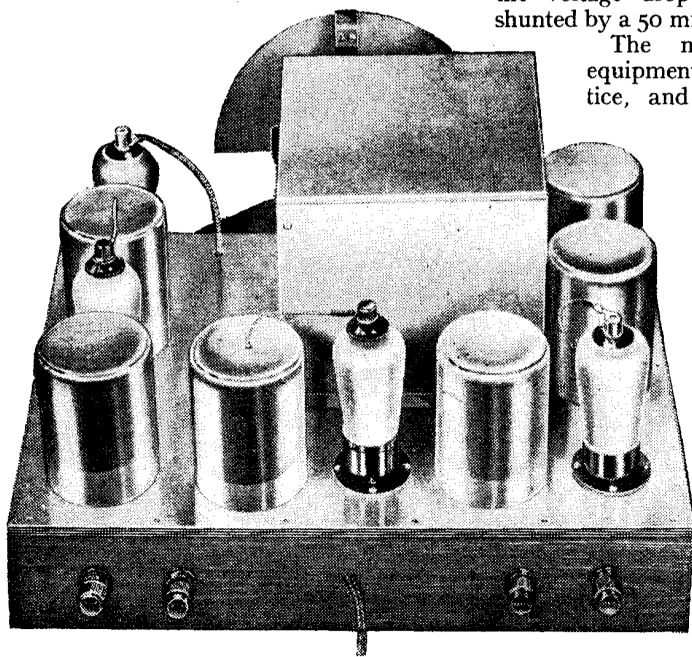


Fig. 3.—These curves show the selectivity obtainable with the new receiver both with minimum and with critical reaction. With other degrees of reaction, the curves obtained would be between these extremes.

which can be used with stability depends in some degree upon the A.V.C. bias applied to the controlled valves, and hence upon signal strength. Curve B of Fig. 3 represents the case of critical reaction with a weak signal, so that the A.V.C. bias is zero. Somewhat greater selectivity is possible on a stronger signal. The great improvement in selectivity obtainable as a

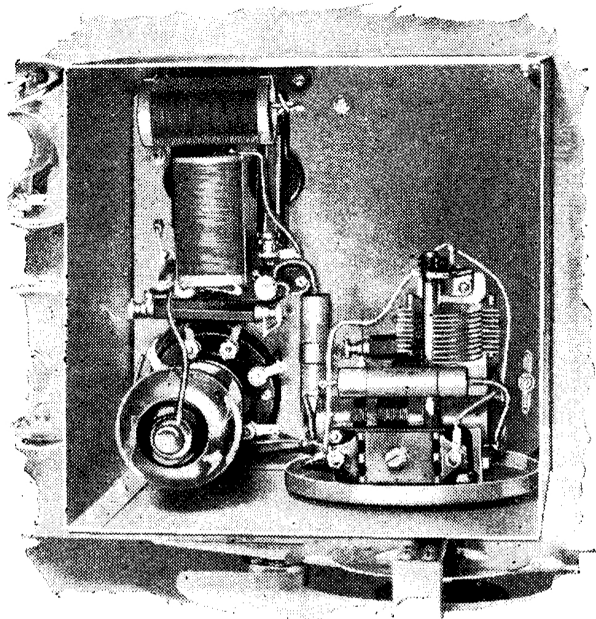


A rear view of the receiver. The triode-pentode can be seen on the extreme right.

respect to negative H.T. through the insertion of the 100 ohms resistance R18 between earth and negative H.T. The A.V.C. diode is fed from the primary of L9 through the 0.001 mfd. condenser C19,

Olympic S-S Six—

result of the use of reaction is readily apparent, for a signal 9 kc/s off-resonance must be over forty-five times as strong as one at-resonance to give the same output.



The frequency-changer and aerial filter are included in a large screening box and the arrangement of parts is clearly shown here. The oscillator screen has been removed.

Even then the curves do not tell the whole story, for they represent only the selectivity afforded by the tuned circuits, and do not show the gain in freedom from interference afforded by the demodulation of a weak signal by a stronger which occurs with a linear detector. Whatever the degree of selectivity, this effect comes into play to reduce interference, but it increases with any growth in selectivity, and so accentuates the difference between the curves of Fig. 3.

When much reaction is used, there is naturally a good deal of sideband cutting, with the result that the high-frequency response falls off. This is actually advantageous rather than otherwise, for on the weak signals for which high selectivity is needed it is essential to reduce the high-frequency response if heterodyne interference and sideband splash are not to prove prohibitive. In addition to increasing the selectivity, the application of reaction increases the sensitivity by some 21 times. Unless the set be tuned to a weak signal, however, it will be found that an increase

in reaction has little or no audible effect on the volume, for the greater sensitivity is offset by the higher bias applied by the A.V.C. system to the controlled valves.

It may be remarked at this point that the apparent selectivity of the receiver depends not only on the true selectivity but also on the sensitivity. At first, therefore, the spread of the local station may seem rather great, particularly if the set be tried in the daytime or at some other time when the signals on nearby channels are weak. If the set be operated at night, however, when distant stations increase greatly in strength, it will be found readily possible to receive stations free from interference which are working with quite a small frequency separation from the local. This is more easily seen from Fig. 5, which shows the selectivity curves replotted to illustrate the actual aerial input required to maintain constant output for a particular setting of the manual volume control. With critical reaction, an input of 71 microvolts will give the same out-

put as an input of 1,500 microvolts without reaction, when the circuits are tuned to the same frequency as the signal. At frequencies different from resonance, however, reaction in itself makes little difference.

Suppose we wish to receive a station giving 1,500 microvolts in the aerial, and

THE LIST OF PARTS

A full list of component parts required to build this receiver, together in some instances with suitable alternatives, will be found on page 110.

that there is an interfering transmission giving the same aerial voltage on a frequency 20 kc/s lower than that of the wanted signal. Now we can obtain adequate volume without reaction, but the output from the interfering station will be 1/19.35 times that of the wanted signal. It may still be audible, therefore. If we increase reaction to the limit, the output from the unwanted station is unchanged, but the input required from the wanted station is only 71 microvolts. This station can thus be 1/21 times its former strength with the same interference. The station will, however, remain at 1,500 microvolts, so that the increased detector input will result in A.V.C. reducing the sensitivity. This reduction will not be to quite 1/21 times, but it applies to all signals equally, so that instead of the interfering transmission giving an output of 1/19.35 times that of the wanted station, it gives an output of $1/19.35 \times 21 = 1/406$ times, and the interference becomes inaudible.

It is particularly to be noted that if

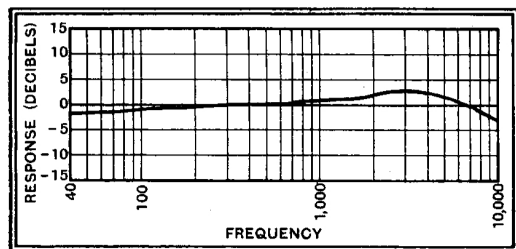


Fig. 4.—The overall frequency response of the receiver shows that at 40 cycles the loss is under 2 db, while at as high a frequency as 10,000 cycles it is only 3 db. There is a slight rise at 3,000 cycles, but this does not exceed 2.5 db. The curve was taken with reaction at minimum.

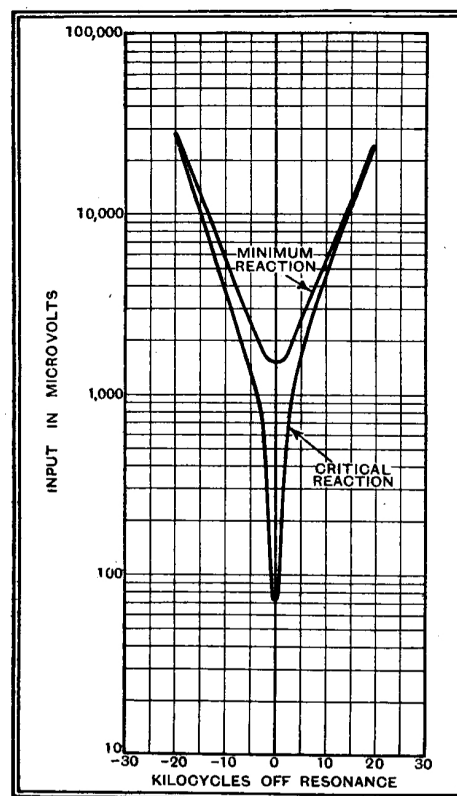


Fig. 5.—These curves show the input necessary for constant output at various frequencies on either side of resonance. It should be noted that the use of reaction has little effect except at resonance.

the set is not tuned to a station the application of reaction will not reduce interference from a station to which the set is not tuned. Increasing reaction certainly increases the sensitivity and sharpens the resonance curve, but this does not affect the output from a neighbouring station until a carrier is tuned in which will operate the automatic volume control system and so reduce the sensitivity.

(To be concluded.)

1934 OLYMPIA RADIO SHOW

THURSDAY, AUGUST 16 TO
SATURDAY, AUGUST 25

11 a.m. to 10 p.m. daily

TWO FURTHER SPECIAL SHOW NUMBERS OF "THE WIRELESS WORLD"

AUG. 17: GUIDE TO THE SHOW

An illustrated and classified review of new and representative exhibits. A full list of exhibitors, with a special "Stand Finder" pictorial plan. Instructions for assembling and wiring the new Olympia S-S Six Receiver.

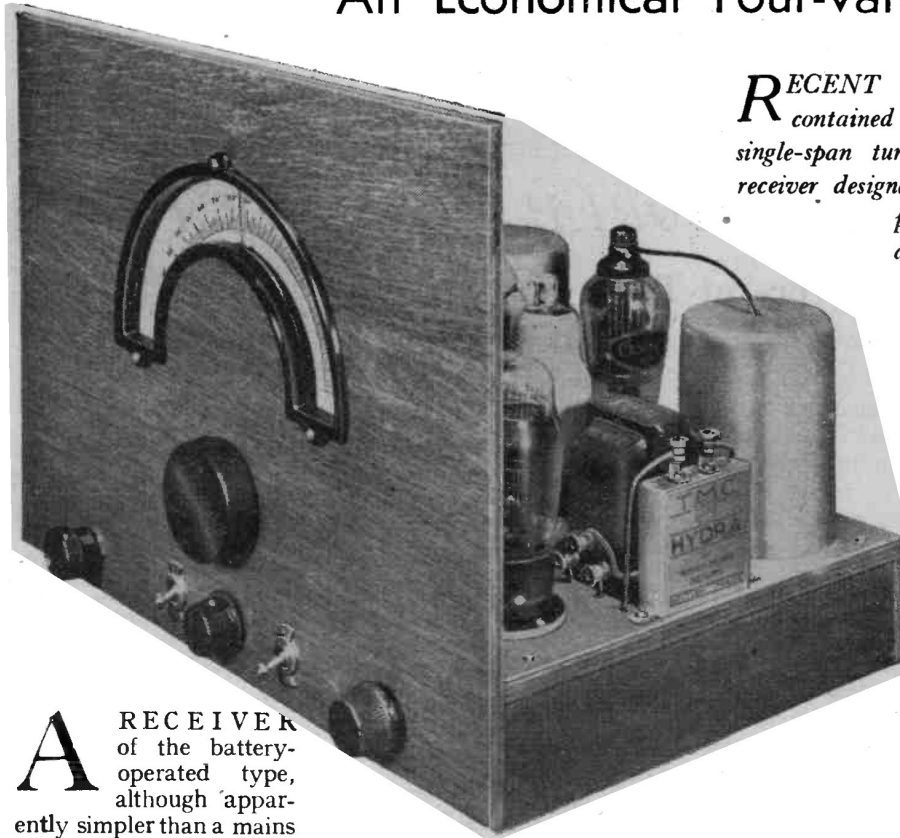
AUG. 24: COMPLETE SHOW REPORT

A complete stand-to-stand illustrated report compiled by the technical staff of *The Wireless World* at Olympia. This issue will provide a full record of the Show and will be a complete reference for the coming season.

The Wireless World

New Single-Span Battery Four

An Economical Four-valve Superhet Receiver



RECENT articles in "The Wireless World" have contained details of the latest developments in single-span tuning, which have been embodied in a receiver designed for economical battery operation. The points of special importance are the new aerial filter and a novel reaction system.

By W. T. COCKING

A RECEIVER of the battery-operated type, although apparently simpler than a mains model, may set its designer an even more difficult problem, for not only are the valves available less efficient but the power consumption must be kept very small if the operating costs are not to be prohibitive. Even in these days of quiescent output systems it is rarely feasible to provide as large an output as that commonly associated with even the smaller class of mains set. It is not difficult, however, to obtain an output in the region of 1,000 milli-

watts while still preserving economy, and although the purist will justly demand a considerably greater output for the finest reproduction, it is sufficient for a high standard of quality, provided that it is not wasted by the use of an inefficient type of loud speaker.

The two chief quiescent output systems are Class "B" and QPP, and with them it is possible economically to obtain maximum outputs of roughly 2,000 milliwatts

and 1,000 milliwatts respectively. Although not excessive, the current consumption of the former is the greater, simply because it gives a greater output. Experience with the two systems shows that it is difficult to obtain as good reproduction with Class "B" as with QPP, particularly at low volume levels, and the distortion is often most noticeable on the transient sounds of the piano. It is easy to see the reason for this when it is remembered that the two systems are essentially the same as far as the anode circuit of the output valve is concerned, and are consequently likely to be on a par as regards distortion at this point. The essential difference lies in the input, for grid current is permitted to flow in Class "B" working but not in QPP. Grid current necessarily means that the preceding stage distorts, and although this distortion can be kept at a low value at the expense of anode current consumption or amplification, or both, it cannot be completely eliminated. It is theoretically possible so to arrange matters that the distortion introduced by the driver valve balances that caused by the output valve, but it is extremely difficult to arrange this

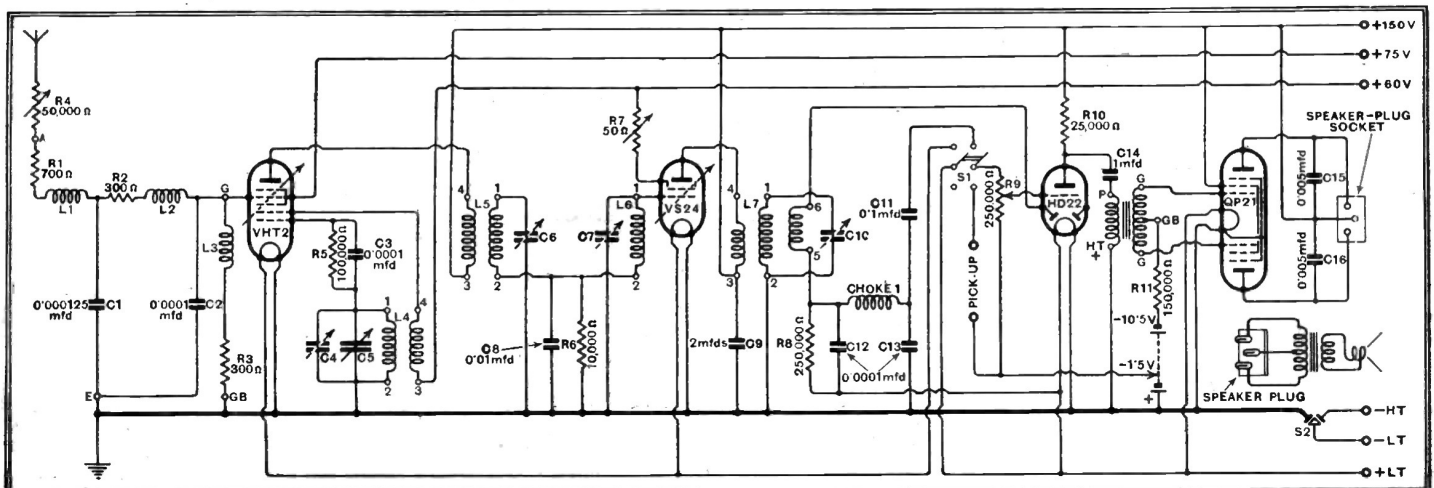


Fig. 1.—The complete circuit diagram of the new receiver shows that reaction is controlled by the variable resistance R7.

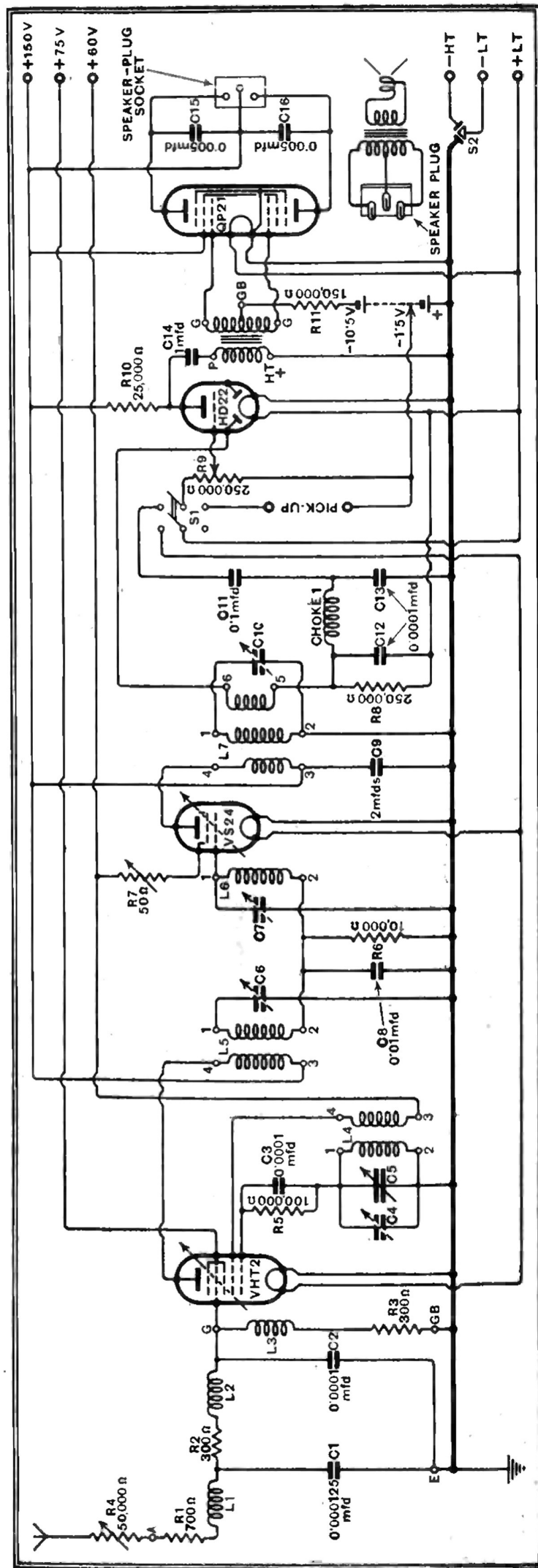


Fig. 1.—The complete circuit diagram of the new receiver shows that reaction is controlled by the variable resistance R7.

New Single-Span Battery Four—

satisfactorily in practice, so that we must conclude that in its present form Class "B" is less desirable than QPP from the quality viewpoint.

The LF Equipment

We decide, therefore, to employ a quiescent push-pull output stage and with one of the double pentode valves, such as the QP21, an output of some 900 milliwatts is obtainable with an HT supply of 150 volts, and the quiescent current consumption is no more than 6 mA. When operated with its correct load impedance such a stage is capable of giving very good reproduction. It is necessary, however, to take precautions against parasitic oscillation, for should this occur it will result in serious distortion. Unlike the Class "B" stage, it is usually easy to prevent parasitic oscillation with QPP, and the insertion of a resistance of 150,000 ohms in the lead to the centre-tap on the input transformer is very effective. This resistance is shown as R11 in Fig. 1, and the only other precaution needed is the use of by-pass condensers C15 and C16 across each half of the output transformer primary. With these simple precautions parasitic oscillation is a most unlikely occurrence.

The maximum input required by such a stage is 21 volts peak, so that it is necessary to feed it through a high ratio transformer. The component employed has a ratio of 1-8 and is resistance-capacity fed from the preceding stage by the 25,000 ohms resistance R10 and the 1 mfd. condenser C14. This stage is the triode section of a duo-diode-triode, and it need give an output of no more than 2.625 volts peak. The valve itself gives an amplification of 12.6 times and consumes 1.5 mA. with -1.5 volts grid bias. The LF volume control R9 is included in its grid circuit and functions on both radio and gramophone, while the switch S1 permits the change over to be made.

On gramophone S1 breaks the filament circuit of the two early valves so that they consume no anode or filament current and interference from broadcasting is avoided. The fidelity obtained on gramophone is governed largely by the LF transformer, and the overall response curve of the purely LF equipment is shown by the dotted curve of Fig. 2. At

50 c/s the response falls by about 8.5 decibels and this is advantageous in that it prevents the output stage from being overloaded by frequencies which cannot be reproduced at audible strength unless the maximum available output greatly exceeds 1 watt. At high frequencies the response is substantially flat up to 5,000 c/s and falls only 11 db. at 10,000 c/s.

Turning now to the radio side of the equipment, the LF valve derives its input from the output of one of the diodes which functions as a detector. The diode is fed with the modulated carrier by a winding on the coil assembly L7, having one half the number of turns of the tuned winding. The load resistance R8 is given a value of 250,000 ohms and the by-pass condenser C12 is of 0.0001 mfd. capacity. A filter comprising the HF choke Ch1 and the 0.0001 mfd. condenser C13 is included to restrict HF currents to their proper circuits, and the coupling to the LF valve is completed through the 0.1 mfd. condenser C11.

The preceding stage consists of a variable-mu valve which is operated at a fixed bias of zero volts. This is permissible with a battery valve since grid current does not flow until the grid potential is appreciably positive with respect to negative LT. The coupling between the valve and the diode detector comprises a three-winding transformer L7, on which the

and tertiary, which feeds the diode, also gives the greatest amplification, but poor selectivity. The best compromise is reached with a ratio of 1-2, and with this a stage gain of 58.5 times can be obtained with good selectivity.

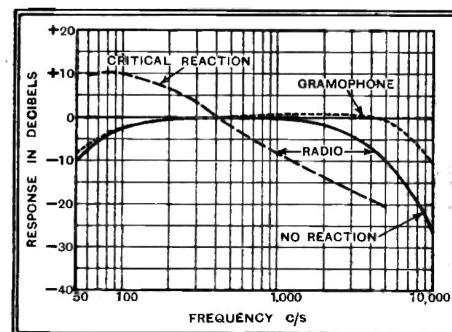
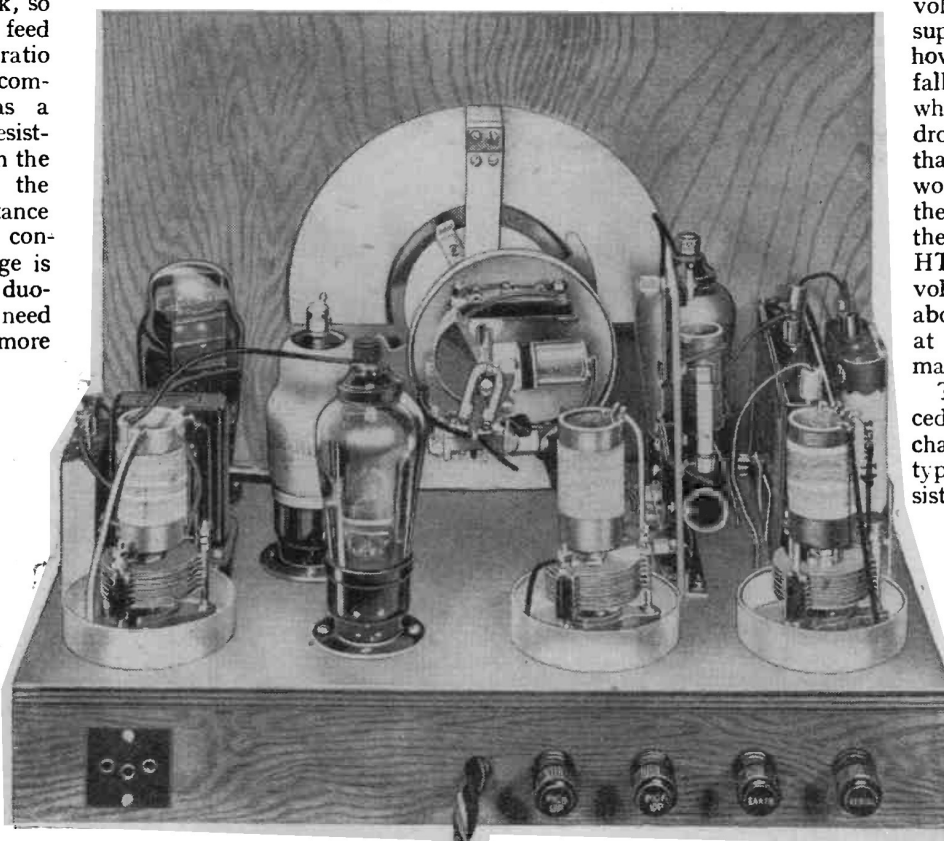


Fig. 2.—The fidelity curves of the complete receiver are shown here for both gramophone and radio.

The amplification obtainable, of course, depends on the operating potentials of the IF valve, and it was found that the greatest amplification for a given anode current consumption is obtained by using a high anode voltage with zero grid bias. The full HT supply of 150 volts is accordingly applied to the anode, and with this the optimum screen potential from the point of view of amplification is about 70 volts. By using a screen supply of some 56 volts, however, the amplification falls by only 9 per cent., whereas the anode current drops by 59 per cent., so that the saving is well worth while. Actually, the screen is operated from the 60-volts tapping on the HT battery, for the true voltage will soon fall to about 56 volts and remain at this figure for the major portion of its life.

The IF valve is preceded by a frequency-changer of the heptode type, the coupling consisting of two coupled tuned circuits of band-pass form, but actually loosely linked for the sake of selectivity. The first circuit L5 is a transformer of 1-1 ratio, since the AC resistance of the heptode is fairly high, and the second, L6, is a single coil. The circuits are tuned by the two air-dielectric trimming condensers, C6 and C7 respectively, and the coupling is provided by the common capacity C8 of 0.01 mfd., the 10,000 ohms resistance R6 being included so that there is a conductive path between the grid and the filament of the IF valve.



A rear view of the set with the coil screens removed.

basic winding is the tuned secondary. Since the IF valve is of fairly high AC resistance a 1-1 ratio between primary and secondary gives the best amplification and is satisfactory from the selectivity viewpoint. A 1-1 ratio between the secondary

condensers, C6 and C7 respectively, and the coupling is provided by the common capacity C8 of 0.01 mfd., the 10,000 ohms resistance R6 being included so that there is a conductive path between the grid and the filament of the IF valve.

New Single-Span Battery Four—

The intermediate frequency is 1,600 kc/s, so that to receive signals in the range of 150 kc/s to 1,500 kc/s (2,000-200 metres) the oscillator need tune over the range of 1,750 kc/s to 3,100 kc/s only. This can be covered by a small variable condenser in conjunction with a single coil, so that waveband switching is unnecessary. The tuned winding of the oscillator coil assembly L₄ is included in

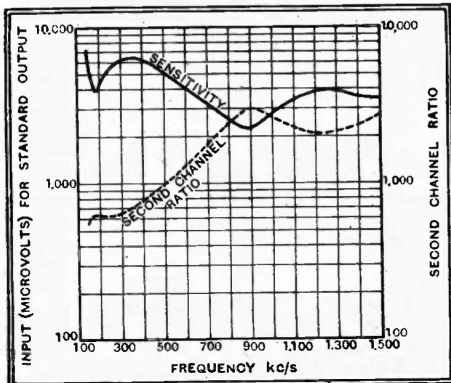


Fig. 3.—The sensitivity and second channel ratio are shown by these curves. The use of reaction increases the sensitivity over ten times.

the oscillator grid circuit, and tuning is carried out by the 0.00016 mfd. condenser C₅, the adjustable condenser C₄ being for the purpose of obtaining the correct minimum capacity. The oscillator anode circuit includes the reaction coil, which is coupled very tightly to the tuned winding in order to secure maximum conversion conductance. The oscillator anode itself is operated at about 60 volts, and the grid lead includes a 100,000 ohms resistance R₅ in order to obtain the correct operating potential. The heptode screen is taken to a 75-volts tapping, and the anode is run from the full 150 volts, these potentials having been found to give the best performance with the valve selected.

Second Channel Interference

Owing to the use of a high intermediate frequency, second channel interference from any station within the tuning range is an impossibility, and it can only occur from stations on wavelengths below 100 metres. It is permissible, therefore, to dispense with signal frequency tuning, thus making the oscillator condenser C₅ the only tuning control and eliminating any need for ganging. An aerial filter which passes the required range of frequencies and cuts off others may be used, therefore, and the development of a new type of filter was described in a recent issue of *The Wireless World*.¹ It is essentially a band-pass type of filter, and the values of L₁, L₂, C₁, C₂, R₁ and R₂ are selected for an even response over the range of 550 kc/s to 1,500 kc/s, with a sharp cut-off at higher frequencies. The response over the range of 150 kc/s to 280 kc/s, the long waveband, is maintained

through the agency of R₃ and the coil L₃.

The sensitivity obtainable with a receiver of this type is quite constant with frequency save for two factors—the variation in efficiency of the aerial filter and the change in effective stage gain of the frequency-changer. The latter is quite small, but it falls off a little at the lower frequencies, with the result that the shape of the sensitivity curve differs somewhat from the curve of the filter alone. The carrier input, modulated 30 per cent. at 400 c/s, for the standard output of 50

LIST OF PARTS

- 1 Aerial filter (R₁, R₂, R₃, C₁, C₂, L₁, L₂, L₃)
or set of parts comprising:
2 Paxolin tubes, 1/2 in. dia. x 1 1/2 in. long
1 bobbin (see text)
2 resistances, 300 ohms, 1 watt
1 resistance, 700 ohms, 1 watt
1 condenser, 0.000125 mfd. } Accurate to within plus
1 condenser, 0.0001 mfd. } or minus 5 per cent.
Quantity No. 38 DSC and 42 DSC wire
Mounting board, brackets, etc.
- 3 IF coils, L₅, L₆, L₇
or 3 Paxolin tubes, 1/2 in. dia. x 1 1/2 in. long
Quantity No. 32 DSC and 36 DSC wire
- 1 Oscillator coil assembly, L₄
or 1 Paxolin tube, 1/2 in. dia. x 2 1/2 in. long
Quantity No. 36 DSC wire
(Goltone)
- 1 Variable condenser, 0.00016 mfd., C₅
Polar Type "E"
Eddystone 973
- 1 Tuning dial
Eddystone 973
- 1 Compression condenser, 0.0001 mfd., C₄
Colvern
- 3 Variable condensers, 0.0001 mfd., C₆, C₇, C₁₀
Eddystone 900
- 3 Knobs
Bulgin K6
- 3 Screening cans, 2 1/2 in. dia. x 3 1/2 in. height
Goltone R9/321
(Mains Power Radio)
- 1 Screening can, 3 1/2 in. dia. x 4 1/2 in. height
(Colvern) Goltone R9/322
- 1 Variable resistance, 50,000 ohms, R₄
(Bulgin, Colvern, Watmel)
- 1 Variable resistance, wire-wound, 50 ohms, with knob,
R₇
Kabi—F. W. Lechner & Co., Ltd.,
61, Spencer Street,
London, E.C.1.
- 1 Tapered volume control potentiometer, 250,000 ohms,
R₉
Ferranti Type "PC"
(Claude Lyons, Magnum, Rothermel)
- Resistances:
1, 10,000 ohms, 1 watt, R₆,
1, 25,000 ohms, 1 watt, R₁₀
1, 100,000 ohms, 1 watt, R₅
1, 150,000 ohms, 1 watt, R₁₁
1, 250,000 ohms, 1 watt, R₈
(Bryce, Dubilier, Ferranti, Graham Farish, Claude
Lyons, Polar-NSF, Watmel)
- Fixed condensers:
1, 0.1 mfd. tubular, C₁₁ TMC Hydra T24
1, 0.01 mfd. tubular, C₈ TMC Hydra T17
2, 0.005 mfd. tubular, C₁₅, C₁₆ TMC Hydra T15
3, 0.0001 mfd. tubular, C₃, C₁₂, C₁₃ TMC Hydra T3
1, 1 mfd., C₁₄ TMC Hydra 25
1, 2 mfd., C₉ TMC Hydra 25
(Dubilier, Graham Farish, Peak, Polar-NSF, T.C.C.,
Telsen)
- 2 Valve holders, 5-pin Clix Chassis Mounting
Standard Type
- 2 Valve holders, 7-pin Clix Chassis Mounting Type
(Goltone)
- 1 Screened HF choke, Ch1
Bulgin HF8
(Wearite)
- 1 QPP transformer, ratio 1:8
Lissen LN5306
(Graham Farish, Multitone)
- 1 QMB toggle switch, DPDT, S1
Bulgin S89
- 1 QMB toggle switch, 3-point, S2
Bulgin S87
- 1 Speaker plug and socket, 3-way
Belling-Lee 1119
- 4 Ebonite shrouded terminals, A., E., Pick-up (2)
Belling-Lee "B"
Bryce
- 1 Connector, 6-way
- 1 Battery cable, 6-way, with terminals and spade ends
Goltone R59/472
- 5 Wander plugs, 2 GB+, 1 GB-, 1 GB-1, 1 GB-2
Clix "A"
- 1 GB battery, 4 1/2 volts
- 1 GB battery, 9 volts
- 2 GB battery clips
Bulgin No. 2
- 1 HT battery, 150 volts
- 1 LT accumulator, 2 volts
- 1 length Screened sleeving
Goltone
- 1 oz. No. 22 tinned copper wire, 6 lengths Systoflex,
wood, etc.
- Wood panel, 1 1/2 in. x 10 1/2 in.
- Plymax baseboard, 9 x 14 x 1/2 in. Peto-Scott
- Screws: 20 1/2 in. No. 4 R/hd.; 20 1/2 in. No. 4 R/hd.;
4 1/2 in. No. 4 R/hd.; 1 1/2 in. No. 6BA with nut
and washers.
- Valves: 1 Ferranti VHT2; 1 Osram or Marconi VS24;
1 Osram or Marconi HD22; 1 Osram or Mar-
coni QP21
- Loud speaker with universal or QPP transformer
W.B.PMS2 Stentorian
C.A.C. Cabinets, Ltd.
- Cabinet

milliwatts is shown by the solid line curve of Fig. 3. This is without reaction, and the effect of using regeneration is merely to reduce the input needed for standard output by a factor constant for all signal frequencies. Using reaction, the input need be only one tenth to one twentieth of the figures indicated by the curve.

The dotted curve of the same figure shows the second channel ratio, that is, the number of times an interfering station must be stronger than the wanted one for it to give the same output. The ratio varies between 500 times and 3,000 times, and as the wanted station will usually be itself much stronger than any which could cause interference, it can be seen that the possibility of second channel interference has virtually been eliminated.

The adjacent channel selectivity depends entirely upon the IF circuits, and although it is only of a moderate order when reaction is not employed, it is unusually high for the modest number of tuned circuits employed and the high frequency at which they operate. When reaction is used, however, the selectivity is enormously increased and becomes adequate for general distant reception. This is well brought out by the curves of Fig. 4, which show the selectivity both with and without reaction.

The Fidelity Curves

When reaction is not used the fidelity is the same as on gramophone, save for a slight loss of bass (about 1.5 db.) due to the coupling from the diode, and for some reduction in the high frequency response, caused partly by losses in the detector circuit and partly by sideband cutting. The results obtained are shown by the full-line curve of Fig. 2, and it can be shown that for good reproduction up to some 6,000 c/s a curve of this shape is correct, owing to the tendency of the loud speaker in conjunction with the pentode type out-

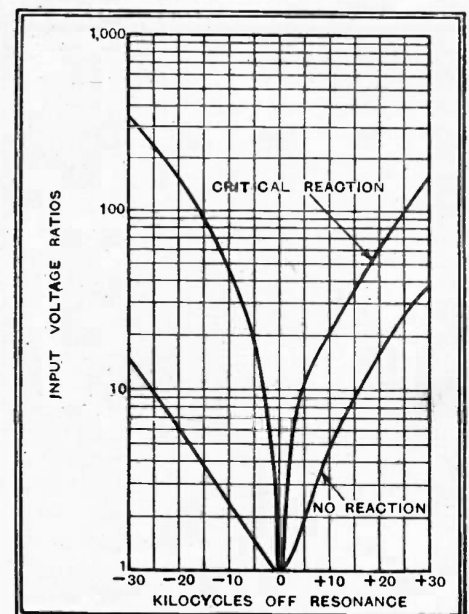


Fig. 4.—The selectivity, both with and without reaction, can be seen from these curves.

¹ *The Wireless World*, November 16th, 1934.

New Single-Span, Battery Four—

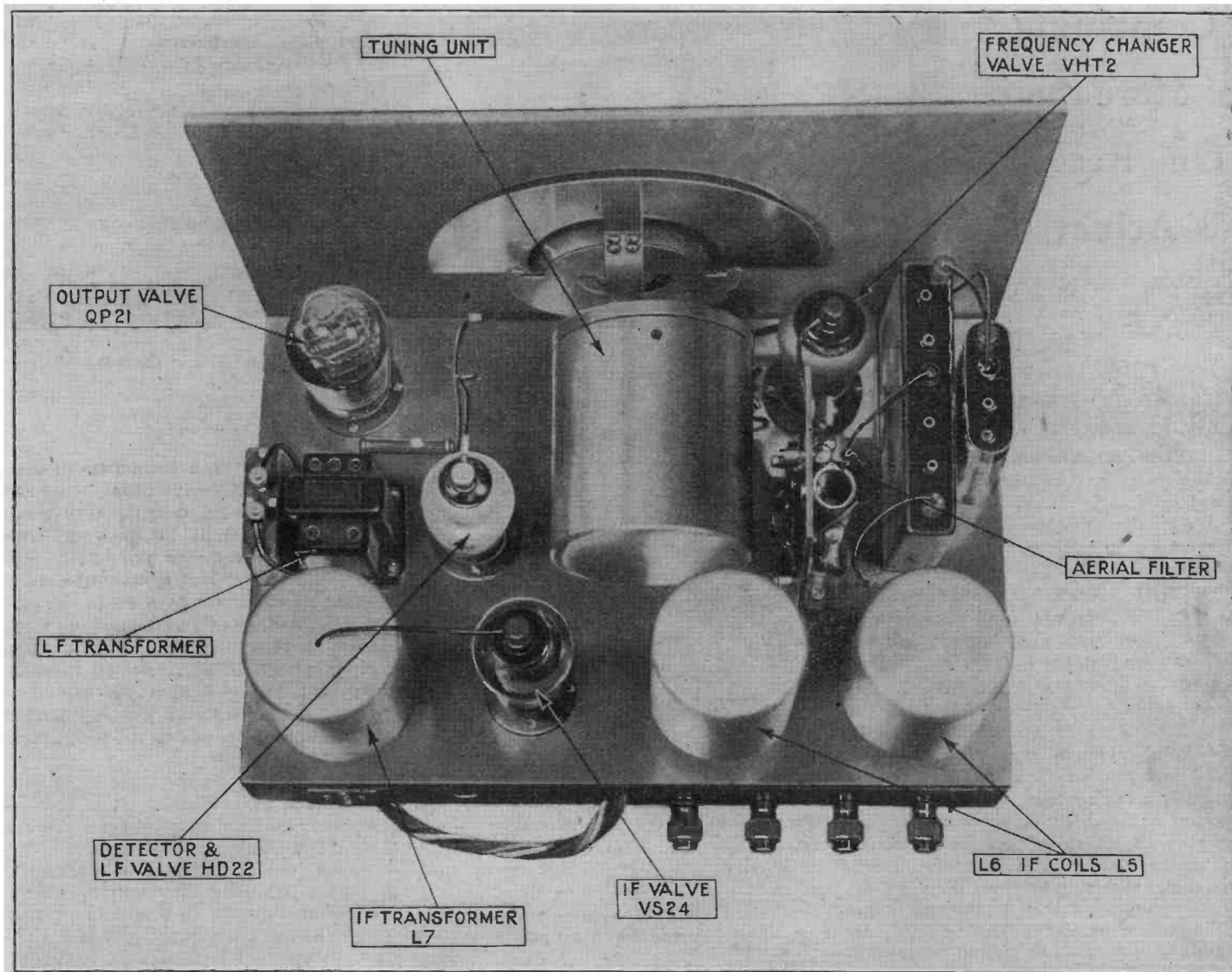
put stage to accentuate the upper register. The response on gramophone is actually too good and will often have to be reduced in the manner indicated later.

The use of reaction increases sideband cutting, and so the high frequency response deteriorates as shown by the dash-line. The apparent increase in the bass is due to 400 c/s being taken as the zero level. In general, it will rarely be necessary to use as much reaction as this, and the use of only a moderate amount of

of the required range, for even the smallest neutralising condenser is much too large. If the screen grid is not at earth potential as far as HF currents are concerned, however, its effectiveness as a screen is reduced, with the result that the apparent control grid-anode capacity is increased. It becomes possible, therefore, to obtain reaction effects by the simple expedient of inserting an impedance in the screen-circuit.

A variable resistance, R7 in Fig. 1, is thus included in the screen lead and makes

a battery receiver, and simple diode AVC proved ineffective in controlling the fading of a weak station and incapable of preventing overloading by a strong signal. The difficulty is due in part to the inherent delay in the AVC diode of a battery duodiode-triode and partly to the particular value of the normal detector input in this receiver. A pre-detector volume control for use chiefly in local reception is included, therefore, and takes the form of a 50,000 ohms variable resistance R4 included in the aerial lead.



The positions of the chief components in the receiver can be clearly seen in this illustration.

reaction will give a better fidelity curve. It can be seen, however, that reaction may be employed not only for the purpose of increasing the sensitivity and selectivity, but also as a tone-control.

The method by which reaction is obtained is unusual but very effective. It is well known that feed-back occurs through the grid-anode capacity of a valve, and that it will cause instability if it be sufficient. It would, therefore, be theoretically possible to obtain reaction simply by connecting a variable condenser between the grid and the anode of the IF valve. This fails in practice owing to the impossibility of obtaining a condenser

a very simple and effective reaction control. The value of *resistance* required for self-oscillation is some 60 ohms. All wire-wound variable resistances of normal construction possess some inductance, however, so that a lower value suffices to produce oscillation. Indeed, the resistance is really of less importance than the inductance, so that in this particular position it is essential to employ the specified component.

It may be remarked at this point that AVC is not fitted, since it was found impossible to devise a method which would prove of any practical advantage. Amplified AVC is really out of the question in

LIVING LESS DANGEROUSLY

SPEAKING at a recent meeting of the Association of Supervising Electrical Engineers, Mr. W. Lang, M.I.E.E., dealt with the gradual evolution of the safety measures advocated in the I.E.E. Regulations for the Electrical Equipment of Buildings. According to Mr. Lang, the regulations were originally framed mainly with a view to avoiding fire risks and consequent damage to property. It is only comparatively lately that the risk of danger from electric shock has been taken seriously into account, and it may be that too much stress has been laid on this aspect of the subject, and that the precautions required are unnecessarily elaborate.

Forschungsbericht zum Wireless World- Single Span-Receiver 1934, übersetzt: Edi, 2024 (Originaltext unten)

Forschungsabteilung, Arbeiten durchgeführt von

Herrn C.R. SMITH, R. PARSONS; S. MARTINGELL. ZUSAMMENFASSUNG.
EINLEITUNG. BERICHT Nr. G.O10 Seriennummer 1934/25 KOMMERZIELLE
EMPFÄNGER VON 1934.

August 1934. Zeichnungsnummern G.O10.1 bis G.O10.6

Dieser Bericht gibt Aufschluss bezüglich Musterempfängern kommerzieller Herstellung, die von der Forschungsabteilung seit der Ausstellung Drahtloser Empfangsgeräte Geräte im Jahr 1933 getestet wurden.

Dieser Empfänger, obwohl er streng genommen kein kommerzieller Empfänger ist, wird in diesem Bericht der Vollständigkeit halber aufgenommen, da er einige neuartige und interessante Konstruktionsmerkmale aufweist.

Der Empfänger ist vom Superhet-Typ und kann als Bausatz für den Heimbau erworben werden. Er besteht aus einem Heptoden-Frequenzumsetzer, zwei ZF-Stufen, einer Doppel-Dioden-Triode mit automatischer Lautstärkeregelung, einer Trioden-Ausgangsstufe und einer Ventil-Gleichrichter.

Das Hauptmerkmal dieses Empfängers ist die Verwendung einer Zwischenfrequenz von 1600 Kilohertz. Dadurch liegen alle Quellen von Spiegelfrequenzen außerhalb des Rundfunkbands, und ein einfacher Tiefpassfilter im Antennenkreis, dessen Durchlaßkurve bei etwa 1500 kHz abfällt, gewährleistet praktisch vollständige Freiheit von dieser Art von Interferenz.

Ein weiterer Vorteil der Verwendung einer so hohen Zwischenfrequenz liegt darin, dass ein einziger Bereich auf dem lokalen Oszillator-Tuner (1750 kHz bis 3100 kHz) ausreicht, um alle Wellenlängen von 200 bis 2000 Metern zu empfangen. Die Verwendung eines Tiefpassfilters im Antennenkreis anstelle des konventionellen abgestimmten Kreises ermöglicht die Herstellung eines selektiven und empfindlichen Empfängers mit nur einem abgestimmten Kreis, ohne Wellenbandumschaltung und mit konstanter Selektivität bei allen Wellenlängen.

Ein weiteres neuartiges Merkmal des Empfängerdesigns ist die Verwendung von Rückkopplung in einem Empfänger mit automatischer Lautstärkeregelung. Durch Rückkopplung der Zwischenfrequenz und somit Einengung der Durchlaßkurve wird die Selektivität ohne nennenswerte Erhöhung der Signalstärke bei Sendern erzielt, die stark genug sind, um die automatische Lautstärkeregelung zu betreiben.

Ein nach dem „Wireless World“-Design hergestellter Empfänger, der mit einem „Senior R-K“-Lautsprecher verwendet wurde, lieferte eine sehr gute Wiedergabequalität, sowohl hinsichtlich Frequenzgang als auch Linearität.

Durch die Rückkopplung konnte die Selektivität auf sehr bequeme Weise erhöht werden. Es wurden keine Unannehmlichkeiten beim Abstimmen festgestellt, da das gesamte Wellenband von 200 bis 2000 Metern von einer einzigen Skale abgedeckt wurde.

Es konnten keine Spiegelfrequenzen beobachtet werden, aber mit Hilfe eines Wellenmessers/ Prüfgeneratorss konnten einige unerwünschte Schwebungen erzeugt werden.

Zum Beispiel konnte durch Einstellen des Wellenmessers so, dass die Wellenmesserfrequenz plus Londoner Regionalfrequenz der Zwischenfrequenz entspricht, ein schwacher Überlagerungston auf allen Stationen erzeugt werden.

Wiederum war es bei voller Verstärkung des Empfängers möglich, das Londoner Regionalprogramm zu hören, wenn auf 270 kHz abgestimmt wurde. Da die Frequenz von London National minus London Regional 272 kHz ergibt, wird angenommen, dass beide Effekte auf Kreuzmodulation an der ersten Röhre aufgrund fehlender Antennenabstimmung zurückzuführen sind.

Es handelt sich jedoch nicht um bemerkenswerte Fehler und sie sind vergleichsweise unbedeutend.

Die Empfindlichkeit des Empfängers ist jedoch gering, wenn man die Anzahl der verwendeten Ventile berücksichtigt, und das interne Rauschniveau bei schwachen Stationen ist ziemlich hoch.

Der Empfänger leidet tatsächlich unter dem Fehlen eines abgestimmten Antennenkreises.

Die automatische Lautstärkeregelung ist zufriedenstellend.

Research Department.

REPORT No. G.010

9th August, 1934.

Serial No. 1934/25

Work carried out by
Messrs. C.H. SMITH,
R. PARSONS,
S. MARTINGELL.

Drawing Nos. G.010.1
to G.010.6.

COMMERCIAL RECEIVERS OF 1934.

SUMMARY.

This report gives information regarding sample receivers of commercial manufacture which have been tested by this Department since the 1933 Wireless Exhibition.

(11) "WIRELESS WORLD" "Single Span" Receiver. This receiver, although not strictly speaking a commercial receiver, is included in this report for convenience, since it contains some novel and interesting design features.

The receiver is of the superheterodyne type, and may be obtained as a kit of parts for home construction. It consists of a heptode frequency changer, two I.F. stages, a double diode triode giving automatic volume control, a triode output stage and valve rectifier.

The main feature of this receiver is the use of an intermediate frequency of 1600 kilocycles. By virtue of this, all normal sources of second channel interference lie outside the broadcast band, and a simple low pass filter in the aerial circuit cutting off at about 1500 k.c. gives practically complete freedom from this source of interference. A further advantage from the use of such a high intermediate frequency lies in the fact that a single range on the local oscillator tuner (1750 k.c. to 3100 k.c.) serves to receive all wavelengths from 200 to 2000 metres. The use of a low pass filter in the aerial circuit in place of the conventional

tuned circuit enables a selective and sensitive receiver to be made having only one tuned circuit, no waveband switching and constant selectivity at all wavelengths.

A further novel feature of the design of the receiver is the use of reaction in a receiver having automatic volume control. By reacting at the intermediate frequency and so altering the response curve, the effect of variable selectivity is obtained without appreciable increase in signal strength on stations powerful enough to operate the automatic volume control.

frequency plus London Regional frequency equals intermediate frequency, a weak heterodyne note could be produced on all stations. Again, with the receiver at full gain it was possible to hear the London Regional programme when tuned to receive a station on 270 k.c. Since the frequency of London National minus London Regional equals 272 k.c., it is presumed that both these effects are due to cross modulation in the first valve due to lack of aerial tuning. They are, however, not noticeable faults, and are comparatively unimportant. The sensitivity of the receiver is,

A receiver constructed on these lines according to the "Wireless World" design, when used with a Senior R-K loudspeaker, was found to give very good quality of reproduction with zero reaction, both as regards frequency response and linearity. By operating this control selectivity could be increased in a very convenient manner. No inconvenience in tuning was experienced due to the whole waveband from 200 to 2000 metres being covered by a single dial.

No second channel interference of the normal type could be observed, but by the aid of a wavemeter a few spurious beats could be produced. For example, by setting the wavemeter so that wavemeter

however, low having regard to the number of valves used, and the internal noise level on weak stations is rather high. The receiver, in fact, suffers from the absence of an aerial tuned circuit.

The automatic volume control is satisfactory.

SINGLE-SPAN TUNING. A system of superheterodyne reception in which there is no variable tuning in the signal frequency circuits. The circuit between the aerial and the first valve consists of a filter which passes all frequencies comprising the whole range of wavelengths to be received; for instance, in a broadcast receiver all frequencies corresponding to wavelengths from 200 to 2,000 metres (1,500 to 150 kc.) are passed with more or less equal strength, whereas higher frequencies are cut off.

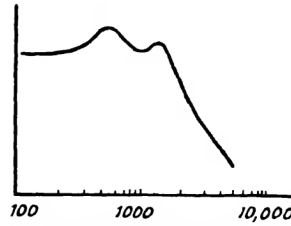
As in an ordinary superheterodyne receiver, local oscillations are made to interact with the signal frequency oscillations to produce a beat frequency after rectification by the first detector. But this beat frequency is higher than the highest signal frequency received, not lower as in the case of an ordinary superheterodyne.

One of the main advantages of the system is that it requires a single variable "tuning" condenser only, namely that in the oscillator circuit, the necessity for ganged condensers being eliminated altogether. Secondly, no switching is necessary to change from medium to long waves, the whole wavelength range being covered by the single range of oscillator frequencies.

The use of the single tuning condenser is made possible by the high supersonic frequency employed, namely 1,600 kc. per second or more. With this "intermediate" frequency the oscillator would work over the range from 1,750 to 3,100 kc. to cover the complete 200 to 2,000 metre wavelength band, and this requires a maximum to minimum capacity ratio of 3:14 only.

Second channel interference would occur from stations operating over the frequency range of 3,350 to 4,700 kc. if the aerial coupling to the first valve were efficient over that range. For this reason the cut-off should occur at about 1,500 kc. per sec., and filter circuits are designed to this end. The passing of signal frequencies below the useful range is immaterial and the aerial filter circuit can conveniently be in the form of a "low pass" one. But owing to the nature of the aerial circuit itself a symmetrical low pass filter is impossible and

a compromise has to be effected. This takes the form of the well-known band-pass filter used for tuning purposes, but the coupling between the units is made



SINGLE-SPAN TUNING. Fig. 1. Response curve of coupled aerial circuits.

Courtesy of "The Wireless World"

sufficiently tight to give a peak separation in the double-hump resonance curve of about 800 kc., one peak occurring at about 400 kc. and the other at about 1,200 kc. The type of response curve obtained with such an arrangement, using capacity coupling, is shown in Fig. 1.

A practical circuit arrangement is given in Fig. 2, which shows the essential aerial filter circuit, and the frequency-changer valve of the heptode type. The resistances R_1 and R_2 are included to reduce the peaks of the double-hump band-pass filter characteristic.

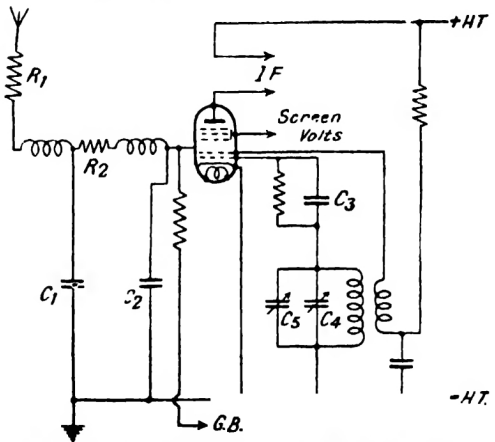


Fig. 2. Simplified diagram showing arrangement of filter and connexions to frequency-changer valve. Courtesy of "The Wireless World."

The oscillator condenser C_4 is the only one used for tuning, C_5 being a pre-set condenser only. Normal band-pass filters may be used in the 1,600 kc. intermediate frequency circuits and other refinements may be added, according to normal practice. The diagrams are by courtesy of "The Wireless World," to whom the system is due. The single-span tuning principle was not developed and its possibilities remain largely unexploited.

A Three-valve Single Span

A SELECTIVE CIRCUIT FOR THE EXPERIMENTER

By F. J. Shipgood, A.M.I.P.R.E.

WITH the present overcrowding of stations on the broadcast bands, the design of a receiver of adequate selectivity becomes a problem. Whether a T.R.F. or superhet be used, it is usually necessary to employ two tuned circuits with the attendant twin-gang condenser, trimmers and, in the case of the superhet, padders.

A simple yet selective receiver is provided by a variation on an old idea, the single-span.

The principle of the single-span is to use an aperiodic R.F. stage so that all signals available in the aerial circuit are presented at the grid of a first detector or frequency-changer. The anode circuit is tuned to some intermediate frequency, and a local oscillator is arranged to beat with the wanted signal so as to produce the I.F.

The early single span used a high value of I.F. in order to discourage second channel interference and to reduce the ratio of the two extreme oscillator frequencies. For example, if the receiver was required to tune from 150 kc/s to 1,500 kc/s, a ratio of 10 : 1, with an I.F. of, say, 1,500 kc/s, the extreme oscillator frequencies were 1,650 kc/s and 3,000 kc/s, a ratio of less than 2 : 1. Thus the tuning was well within the span of a 200 pF tuning condenser. The disadvantage of using the high I.F. was the loss of adjacent channel selectivity, and a large number of I.F. stages were necessary.

In order to utilise standard components a compromise was made, and using an I.F. of 465 kc/s and a 300 pF midget air dielectric variable condenser, the tuning range was found to be 600 kc/s to 3 Mc/s.

The Circuit

The circuit shows the aerial connected directly to the grid of a 6K8, and an untuned coil placed between grid and chassis. The remainder of the valve circuit is conventional. A grid-tuned series-fed Meissner forms the local oscillator circuit, and the usual value of decoupling, self-bias and automatic bias components are used. The I.F. transformer (the only one) in the anode circuit is coupled to the grid of a leaky-grid detector, and this is resistance-capacity coupled to a 6V6 output stage.

The circuit was required originally for a bedside receiver and the sensitivity was adequate for this purpose. The main thing was that its tuning was razor-sharp and the Light Programme on 247 m. and the Home Service on 261 m. were easily separated.

Increased Sensitivity

To increase the sensitivity there is a choice of methods. The obvious one involves an additional I.F. amplifier—a 6B8 could be employed as such, one of the diodes being used as the detector. A reaction coil may be wound on the I.F. transformer,

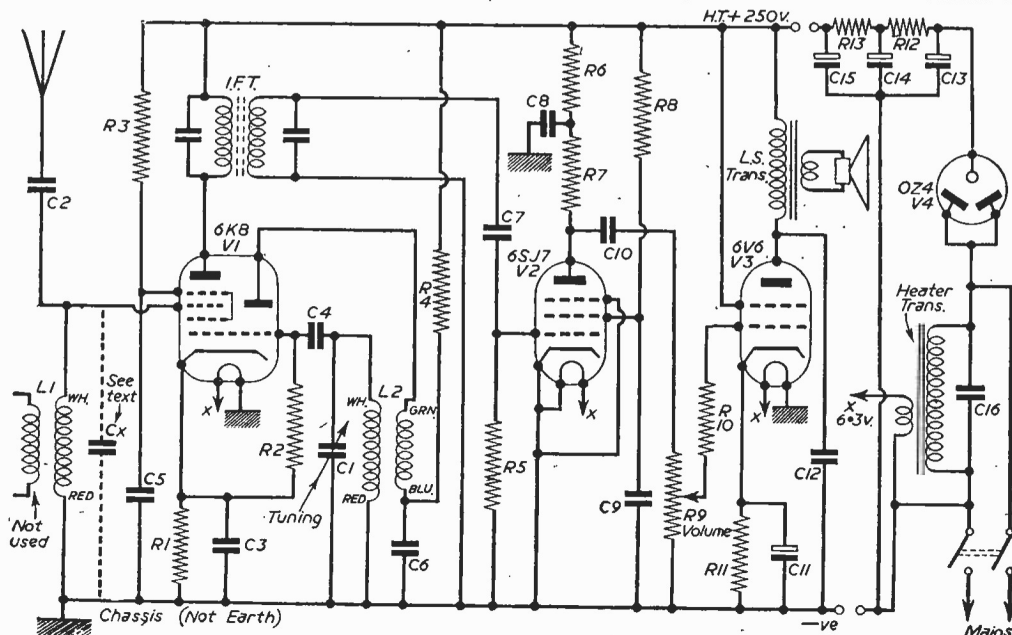


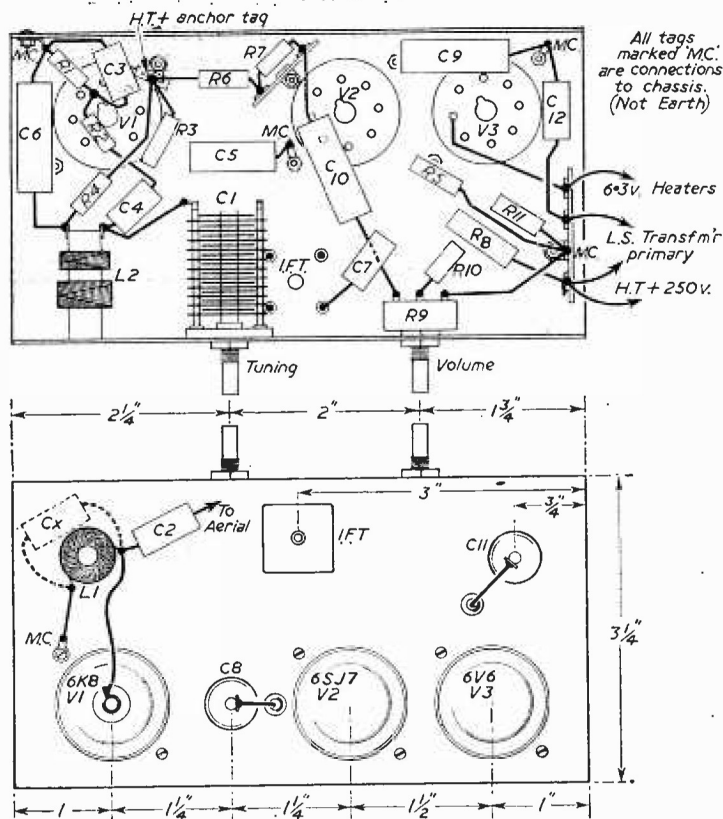
Fig. 1.—Theoretical circuit of the receiver.

although this will prove difficult if a midget type transformer is used. Both of these methods further increase the selectivity.

However, the simplest method is another compromise. The R.F. coil is tuned to

Power Supply

The power pack consisted of a '6-volt filament transformer and 0Z4 cold cathode rectifier, both anodes strapped for half-wave rectification, two 500 ohm 2 W resistors and three high capacity electrolytic conden-



Figs. 2 and 3.—Top and bottom chassis details.

some optimum point by a small preset trimming condenser. For instance, a 50 pF trimmer tuned in 208 metres and gave greatly increased gain on 194 m., 247 m. and 261 m., that is, Third, Light and Home programmes, in the area in which the receiver was tested—North Shields.

The inclusion of more than the usual capacity made the 50 c/s mains hum practically inaudible.

If, as in this case, the mains is connected to chassis, remember that the earth, if used, and aerial must be connected via suitable isolating condensers, say 0.005 μ F.

Stylus Testing Service

PLANS to set up dealer "needle clinics" where sapphire styli may be regularly inspected and, where necessary, replaced are announced by Philips Electrical Limited.

Many record collectors go to great lengths to preserve their records by correct storage, cleaning, etc. It is often found, however, that insufficient attention is paid to the stylus which, in spite of the extreme lightness of the modern pick-up, is subjected to considerable pressure at the very small surface of

the tip actually in contact with the record. Apart from this fair wear and tear, a sapphire needle can easily be damaged by mishandling; this, as well as doing harm to the records, may well cause distortion in reproduction.

To enable dealers to offer an efficient needle inspection service, Philips are now able to supply them with a special needle-testing microscope. This has a rotatable platform with two pick-up holders which permit of an immediate comparison between the stylus under inspection and an unused one.

The needle microscope (Type AG7004) is offered to dealers on a non-profit basis at a price of £6 net.

COMPONENT LIST

CONDENSERS

- C1—300 pF variable.
- C2—0.005 μ F
- C3—0.01 μ F
- C4—50 pF
- C5—0.1 μ F
- C6—0.1 μ F
- C7—300 pF
- C8—0.5 μ F
- C9—0.5 μ F
- C10—0.1 μ F
- C11—25 μ F 25 v.
- C12—500 pF
- C13—16+32 μ F
- C14—Electrolytic
- C15—(16+32 μ F) (in parallel)
- C16—0.01 μ F

RESISTANCES

- R1—330 Ω , 1/2 W.
- R2—47 K, 1/2 W.
- R3—22 K, 1/2 W.
- R4—33K, 1/2 W.
- R5—1 Meg, 1/2 W.
- R6—47 K, 1/2 W.
- R7—250 K, 1/2 W.
- R8—100 K, 1/2 W.
- R9—1 meg. potentiometer
- R10—33 Ω , 1/2 W.
- R11—240 Ω , 1/2 W.
- R12—500 Ω , 2 W.
- R13—500 Ω , 2 W.

VALVES

- V1—6K8GT V2—6SJ7G
- V3—6V6GT V4—074

COILS

- I.F.T.—465 kc/s midget
- L1—Weymouth HA3
- L2—Weymouth HO3

SUNDRIES

- Nuts, bolts, grommets, tags, etc.
- 4 Octal Valve Holders
- Loudspeaker and Transformer.

Beginner's 200-1600m. Superhet

A SIMPLE THREE-
VALVE SET FOR
A.C. MAINS
OPERATION ONLY

By F. G. Rayer

A RECEIVER of the type described here has the great advantage that no aligning difficulties arise, because the aerial circuit is 'aperiodic'. Only the oscillator is tuned, the usual paddler being omitted so that a coverage of about 1,965 to 650 kc/s is obtained with the .0005 μ F variable condenser. This allows reception on a continuously-tuned band of 150 to 185 kc/s, or about 200 to 1,600 metres, so that no separate long-wave band is required for the 1500 metre Light Programme transmitter. Further to simplify the circuit, a type of detector is employed which will easily operate the loudspeaker direct, thereby avoiding any separate A.F. stage, and associated components and wiring. This arrangement gives results approaching those obtained from a diode detector followed by an A.F. output stage, but is simpler. Further components are eliminated by the absence of A.V.C., and by using a common

dropper for screen grids
and oscillator anode.

The circuit, shown in Fig. 1, is thus much less complicated than that of the usual superhet. It has a very good degree of adjacent-channel selectivity, interference of this nature which is troublesome on T.R.F. circuits being absent. The 25K potentiometer provides on/off switching, so that there is no hiss in all. It is important to note that the valve bias resistor is much smaller than would be the case for normal superhets. If other output valves are used, this stage is also essential, but critical.

Oscillator Coil

A standard medium-wave oscillator coil with separate windings is satisfactory, or it may be wound as shown in Fig. 2. A $\frac{1}{2}$ in. dia. former, with dust-iron core, is required, and both windings are in the same direction, and of 34 s.w.g. D.S.C. wire. Each winding is in a compact pile.

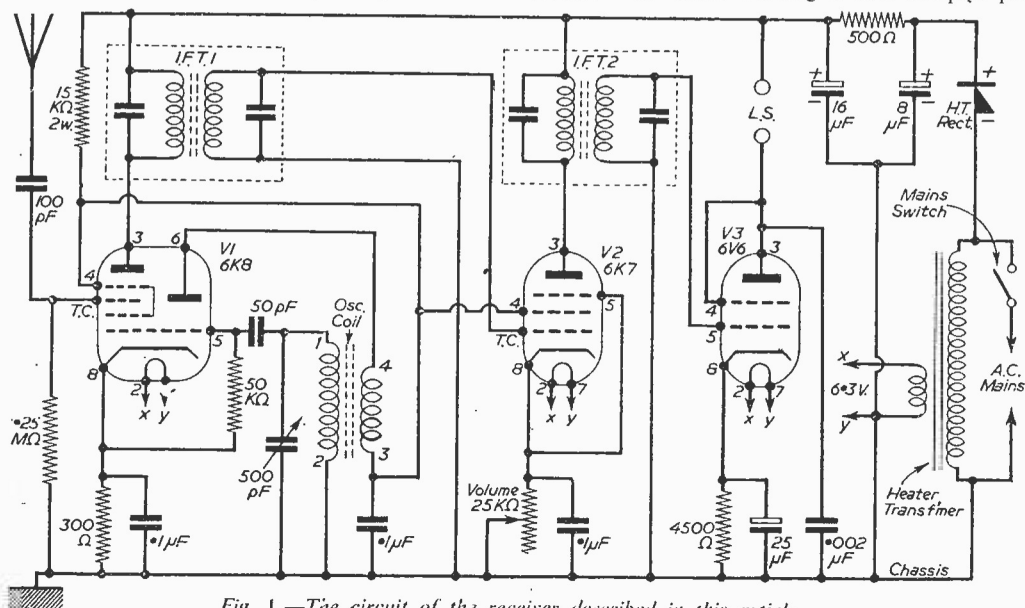


Fig. 1.—The circuit of the receiver described in this article.

with about $\frac{1}{4}$ in. clear space between them. An adhesive such as Durofix will hold the ends secure. The leads may be taken directly to the various components in the receiver, or may be soldered to the tags usually provided on this type of former. The larger winding should be so situated that when the core is screwed right in it is centrally placed in the winding. If the winding is too far from the core the higher wavelengths will not be reached.

Chassis Construction

Exact dimensions are not very important, but a chassis about 10 in. $\times$ 5 $\frac{1}{2}$ in. will be satisfactory. A suitable chassis can easily be purchased ready made. Alternatively, it may be constructed by bending 2 in. runners on a piece of 18 s.w.g. aluminium 10 in. $\times$ 9 $\frac{1}{2}$ in., or by screwing 2 in. wooden runners to a sheet 10 in. $\times$ 5 $\frac{1}{2}$ in.

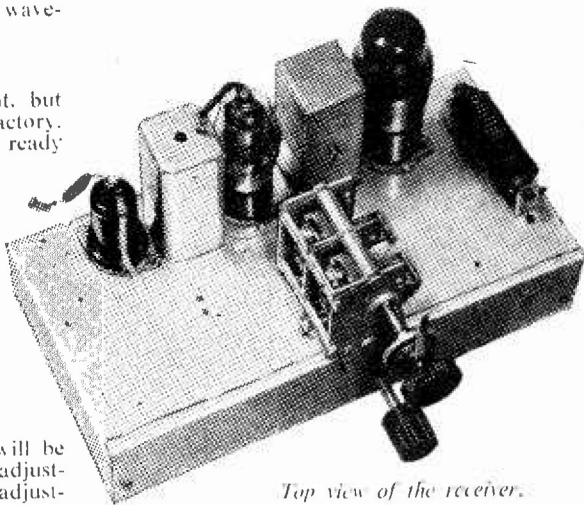
The components are positioned as in Fig. 3. If a tuning condenser is to be obtained, the two-gang type is recommended, because it will be readily obtainable at low cost from surplus stores. It will also prove convenient if the effect of tuning the aerial circuit is at some future date investigated.

Any pair of 465 kc/s I.F. transformers will be satisfactory, with top or side trimmers or adjustable cores. If the transformers have side adjustment, they are positioned so that the cores may be reached from the back of the receiver.

Short leads are required at the frequency-changer grid cap, to avoid hum, and the 100pF condenser should be of mica type. Only a very short aerial wire is necessary.

The tuning condenser frame must be in contact with the chassis. A simple form of reduction

drive, with pointer, is required, ready-made dials with stations or wavelengths marked not being suitable. If circumstances make it unnecessary to tune into the long-waveband, the simplified circuit may still be retained, but the usual oscillator paddler (normally 500pF) may be included. This will reduce coverage to the medium-waveband only.



Top view of the receiver.

Chassis Connections

All other wiring appears in Fig. 4, points marked "M.C." being taken to tags securely bolted to the chassis. Connecting wire of about 20 s.w.g., with lengths of insulated sleeving, will be convenient.

If I.F. transformers with leads are fitted, a

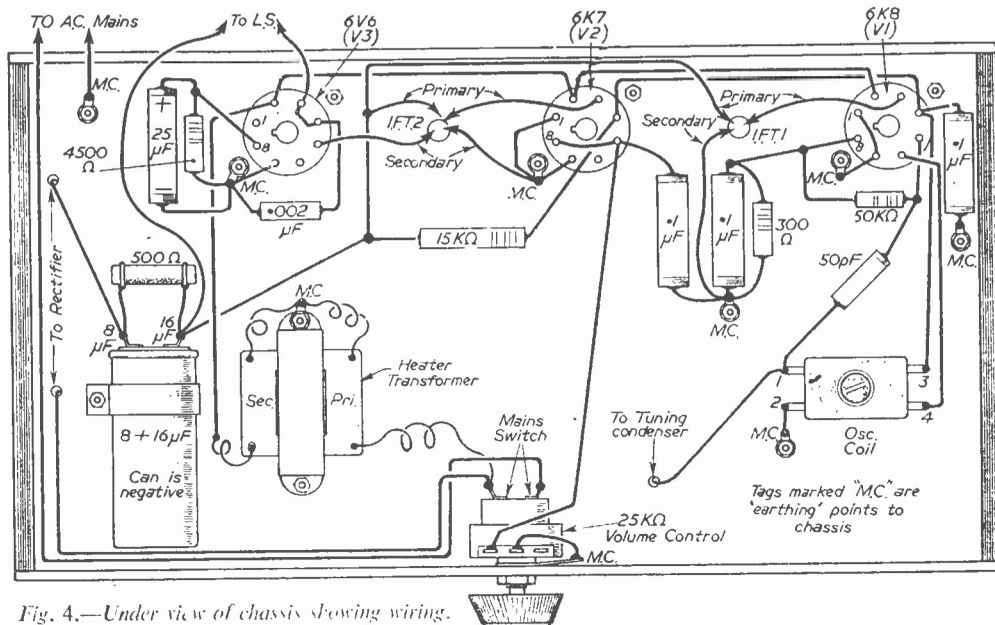


Fig. 4.—Under view of chassis showing wiring.

single $\frac{1}{16}$ in. hole under each transformer will suffice. Other transformers may have projecting tags, and a clearance hole for each tag will then be necessary. With the first transformer, the primary goes to 6K8 anode and H.T. positive. The secondary is taken to 6K7 grid cap and chassis, the latter tag or lead normally being marked as the A.V.C. connection. The second transformer similarly has its primary wired to 6K7 anode and H.T. positive. The secondary is usually marked for diode and diode-load connections. If so, the "diode" lead is taken to the 6V6 grid, and the "diode-load" lead to chassis.

If a small smoothing choke is to hand, this can replace the 500 ohm resistor. As the valves consume only 1.05 amp., sufficient current is available to operate a 6.3v. dial or indicator bulb wired in parallel with the heaters.

To reduce chances of shocks if the chassis is touched it is worth while taking the "Neutral" main to the chassis, and to use a non-reversible plug. The receiver should also be totally enclosed in an insulated cabinet with control spindles, bushes, and knob set-screws out of reach. With suitably shaped knobs it will only be necessary to see that the set-screws are short, or to insert a little insulating compound into the set-screw holes after tightening.

Adjustments

These are very simple, but will nevertheless considerably influence results. A station should

either direction. If such is the case, all the trimmers (or cores) should be adjusted until this is no longer necessary.

The set can be lined up with equal success at any intermediate frequency within the limits tunable by the transformers. It is not necessary to employ any particular frequency. Due to the manner in which the F.C. stage operates, any station higher or lower in frequency than the oscillator frequency, to the extent of the I.F. selected, will be received. If a local station on the second channel chances to interfere with some

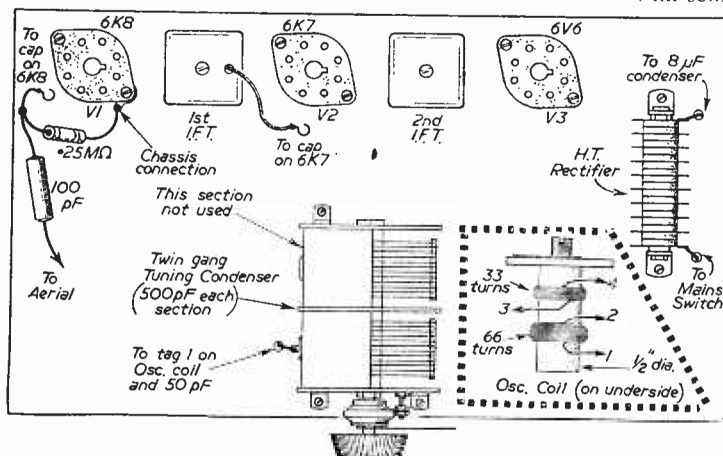


Fig. 3.—Top of chassis layout and inset (Fig. 2) the oscillator coil.

other transmitter, this can be corrected by re-aligning the I.F. transformers at a slightly different frequency.

In some circumstances modulation hum may be troublesome. If so, it can usually be reduced by wiring a .05 μ F 750v. condenser from rectifier negative to chassis. If some modulation hum remains, the aerial lead in Fig. 1 can be taken to a dual-wave H.F. choke returned to the chassis, and a further aerial-isolating condenser of .0001 μ F to .001 μ F added for the aerial. The need for this depends upon local conditions, and especially upon any stray mains leakage to the aerial or lead-in.

COMPONENT LIST

Two 465 kc/s I.F. transformers.
.0005 μ F tuning condenser with reduction drive and knob.
300 ohm, 4,500 ohm, 50 K, and .25 megohm $\frac{1}{2}$ -watt resistors.
500 ohm 1-watt resistor. 15 K. 2-watt resistor.
50 pF and 100 pF mica condensers. .002 μ F condenser.
Three .1 μ F condensers.
25 μ F 25 v. bias condenser.
8 μ F plus 16 μ F 350 v. smoothing condensers.
25 K. potentiometer with switch. Knob.
6.3 v. 1 $\frac{1}{2}$ amp. heater transformer.
250 v. 60 mA metal rectifier.
M.W. oscillator coil.
6K8, 6K7 and 6V6 valves.
Three octal valholders.
Chassis about 10in. x 5 $\frac{1}{2}$ in.

be tuned in, the volume control being set to a low level. The I.F. transformer trimmers or cores are then adjusted for maximum signal strength. It is essential that an insulated blade, such as can be made from a piece of ebonite rod, be used for this adjustment. No trimmer (or core) should be at the limit of its adjustment in

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Edited by F. J. CAMM

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