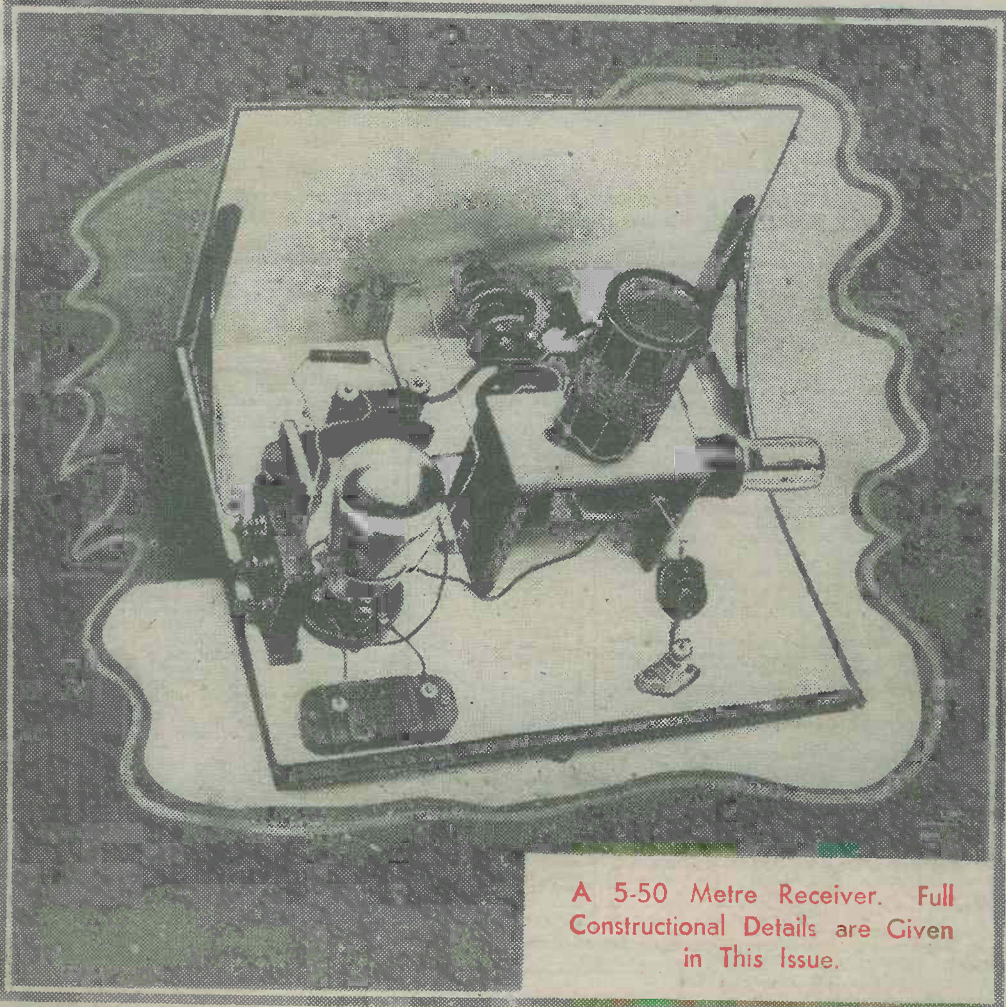
WIDE-BAND COUPLING CIRCUITS

Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

Vol. 22 No. 476 NEW SERIES FEBRUARY, 1946



A 5-50 Metre Receiver. Full Constructional Details are Given in This Issue.

Practical Wireless

and PRACTICAL TELEVISION

14th YEAR OF ISSUE

EVERY MONTH

VOL. XXII. No. 476. FEBRUARY, 1946

Editor F. J. CAMM

COMMENTS OF THE MONTH. BY THE EDITOR

The Component Shortage

A FEW months ago we complained that our readers were unable to obtain replacement parts for British receivers and that it was practically impossible to obtain replacements for American receivers. We do not recant those criticisms in spite of a letter which we have received from the Board of Trade taking us to task for having made them. If the Board of Trade needs any confirmation of the accuracy of our remarks, it can be provided from the files of letters received from readers of this journal. These letters not only indicate that it is almost impossible to obtain American valves, electrolytic condensers, and similar parts, but also that American receivers seem more prone to breakdown than British receivers. In other words, a satisfactory method of adapting American receivers designed to operate on 110 volts for operation on English voltages of 200-250 volts has not yet been found. The resistance cord has many defects, not the least of which is its liability to damage, and also that the resistance does not remain constant. There is also the risk of fire.

Some of the letters we have received indicate that readers have spent months writing round to almost every likely source of supply after they have tried their dealer, who in turn has tried the wholesaler. It is somewhat naïve, therefore, for the Board of Trade to suggest that readers should place their orders with the retailers from whom the sets were purchased, and that the wholesaler who supplied them should pass his order to the distributor "who will then deliver the necessary components or suitable equivalents." We ourselves have tried the two main distributors who handle the receivers imported under Government auspices from America during the war. We asked them to supply certain of the components which our readers have been endeavouring to obtain. Each of these distributors told us that these components are quite unobtainable and would remain unobtainable for some months to come.

American Receivers

FROM our own records we were, of course, able to trace in some cases English alternative equivalents, but the demand for these as replacements for English receivers has been so enormous that none can be spared as replacements for American receivers.

We mention these points because readers who may be considering the purchase of an American receiver should do so in the knowledge that if it goes wrong they may be kept waiting for many months before spares may become available.

It can be said that some of the American receivers are quite satisfactory whilst they work, but that they do not last for anything like the same period as English receivers. We know of many cases of English receivers which have been in daily use for over ten years without replacement or repair of any sort. We do not know of one American receiver that can equal this. The answer is, of course, that American receivers are adapted for our mains, and are not designed for them, and an adaptation can never be so good as a correctly designed article.

Not that the component shortage is peculiar to American components. A large proportion of our correspondence is concerned with tracing sources of supply of components, not only for home-constructed receivers, but also for commercial receivers. Most manufacturers have closed down their technical query and service departments and their customers have turned to us for help. We, too, are suffering from acute staff shortage and the position has not been eased, although the war has been over for over eight months, due to the Government's pugnacious adherence to the absurd Bevin demobilisation scheme which was based on an arithmetical system of inverted logic, born in ignorance and somewhat spitefully administered. It has not taken into consideration the consumer needs of the home market, and whilst manufacturers owing to shortage of material and labour have not been enabled to make new goods, it has prevented the replacement of components which would keep existing apparatus in reasonable working order.

According to Sir Stafford Cripps, this state of affairs is going to continue for some time. Almost everything we make must be sent abroad to the countries which have been "liberated" from their coalition with Hitler.

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The Editor will be pleased to consider articles of a practical nature suitable for publication in "Practical Wireless." Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed: The Editor, "Practical Wireless," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

Owing to the rapid progress in the design of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

ROUND THE WORLD OF WIRELESS

"Blue Train" in Jerusalem

IN view of the heavy volume of telegraphic traffic arising in Palestine, Cable and Wireless, Ltd. have transferred a mobile wireless unit from Italy to Jerusalem to supplement the cable circuit from Haifa (connected with Jerusalem by Government landline) via Cyprus, Alexandria, Malta and Gibraltar to London.

This "Blue Train"—equivalent to the Army's "Golden Arrow" train—is capable of handling up to 40,000 words a day and is available to carry all classes of traffic.

Equipment is being shipped to enable the unit to transmit and receive pictures by wireless.

The "Blue Train" is manned by 10 Cable and Wireless 'Telcom" staff, under Mr. C. F. Furmston-Evans, Engineer-in-charge.

Tokio and Bangkok Wireless Communications

CABLE AND WIRELESS, LIMITED, have opened wireless telegraph circuits with Tokio (Government and Ordinary Press traffic only) and Bangkok (all classes of traffic). Full ordinary telegraph rates are 1s. 11d. per word to Bangkok—as before the war—with proportionate charges at reduced rates for Code, Deferred and Press messages. The Ordinary Press rate to Tokio is 8d. per word.

Radio relay towers are being used in a new communications system in the United States. Automatic, unattended radio towers are symbols of one of the most significant advances in communications in modern times. These towers may ultimately replace thousands of miles of telegraph and telephone lines in America. Our illustration shows a radio antenna of a tower on the roof of the 24-storey Western Union building.

B.I.R.E. Meetings

AT a meeting of the British Institution of Radio Engineers (Scottish Section), held at Heriot Watt College, Chamber Street, Edinburgh, on December 11th, a paper on "Ultra-high Frequency Techniques" was read by Professor M. G. Say, Ph.D., M.Sc.

Another paper on "A Review of Industrial Electronics" was read by J. Hare (Associate) at a meeting of the North-eastern Section held at the Neville Hall, Westgate Road, Newcastle-on-Tyne, on December 12th.

Far East Telegraphic Communications

COLOMBO, capital of Ceylon, is to-day the principal centre of telegraphic communications between London and the Occupation forces in the SEAC and Far East areas.

The Cable and Wireless, Ltd. office in Chatham Street, Colombo, with its peacetime complement of staff considerably augmented by Telcom personnel and locally trained junior operators, is operating 13 circuits as indicated in the diagram on opposite page; wireless with London, Shanghai, Chungking, Hong Kong, Rangoon —where the Company's "Blue Train" mobile wireless unit is operating—Singapore, Soerabaya, Batavia, and Padang; cables with Penang, Alexandria and London. In addition, two teleprinter circuits are connected with the Naval Office.

During November the staff in Colombo handled more than a million words including hundreds of thousands of words in Press telegrams.

Studio Opera

MONTHLY productions of opera by the Music Productions Department are planned. Listeners have already heard Weinberger's "Schwanda the Bagpiper," conducted by Stanford Robinson. On December 2nd, Mascagni's well-known "Cavalleria Rusticana" was broadcast by the B.B.C. Theatre Orchestra and Chorus. Stanford Robinson conducted; H. Proctor-Gregg wrote the narration. The two were jointly responsible for production. The cast included Edna Hobson as Santuzza, the young peasant girl, Tudor Davies as the peasant, Turiddu, also Winifred Lancaster, George Hancock, and Gladys Ripley.

The production on December 19th of Borodin's "Prince Igor" was a notable event for it was conducted by Sir Thomas Beecham, who is identified with many memorable performances of this work. This was the first time that Sir Thomas has conducted an opera in a B.B.C. studio. "Prince Igor" is best known to the general public for the Polovtsian Dances but its brilliance spills over into love-music, and scenes both comic and tragic. Indeed, the whole work glows and glitters. "Prince Igor" by Borodin ranks among the finest of national operas.

On January 30th, 1946, the opera will be Puccini's "Tosca," under the baton of Stanford Robinson. Founded on Sardou's tragedy "Tosca," first produced in Rome in January, 1900, it is a powerful story of passion and revenge, with music to match the theme. Studio opera has gained a strong hold on the ear of the musical public, and during the war years there were some outstanding productions, including

Nautical training is part of the future programme of the National Association of Training Corps for Girls, who are leasing a small island in Poole Harbour as a national training centre. Our illustration shows members of the G.T.C. receiving instruction in telegraphy.

"Hansel and Gretel," "Tales of Hoffmann," "Il Seraglio," "La Traviata," "The Barber of Seville," "Eugene Onegin." Other important operatic works will be heard in the New Year.

New General Manager for Britannic

MR. F. D. SMITH has been appointed General Manager of Britannic Electric Cable and Construction Company, Limited. Previously Mr. Smith was Works Manager of Aero Engines, Limited, Kingswood.

Prior to that he had extensive experience in South America, where he was employed in various capacities by the Telephone Trust, Limited, Venezuela Telephone Company and International Telephone and Telegraph Company.

Swedish Wireless Engineers to Study British System

THREE members of the Swedish Directorate of Telegraphs are to visit London during January to study the British oversea system controlled by Cable and Wireless, Limited, who operate a direct photo-telegraph circuit with Stockholm.

The party will comprise Mr. S. A. Gejer and Mr. K. J. T. Ekstrom, engineers of the Board of Swedish Telegraphs, and Mr. G. T. A. Widlund, Superintendent of the Stockholm Radio Centre.

The visitors are expected to arrive on January 11th.

Wireless for the Blind

THIS year's Christmas Day appeal for the British "Wireless for the Blind" Fund was broadcast by Mr. Christopher Stone in the B.B.C. Home programme.

The appeal was not made last year for a curious reason. Radio manufacturers whose plant had been wrecked by flying bombs could not supply sets, so the Fund could not spend its cash in hand. It was decided to waive the broadcast.

That was the first Christmas Day without its "wireless for the blind" appeal since the series was started in 1929 by Mr. Winston Churchill. The National Institute says that 71,000 sets have been given to blind listeners by the Fund.

Braille "Annuals"

BLIND people had their usual Braille "annuals" this Christmas, thanks to paper economies at the N.I.B. works during the past 12 months. They included a Christmas Annual, an almanac, a pocket diary, Scripture Text Calendar, the Scripture Union Portions, and a 1946 diary in two sizes.

New Transmitter for Moscow

IT is reported from the U.S.S.R. that a powerful new transmitter has been completed in Moscow, and is now working on 360.6 metres.

New Eire Station

THE Eire Government is to erect a high-power short-wave broadcasting station of modern type, which will probably be in operation early this year.

Wireless Receiving Licences

THE approximate numbers of wireless licences issued during the year ended October 31st, 1945, are as follows:

Region	Number
London Postal	1,768,000
Home Counties	1,285,000
Midland	1,399,000
North Eastern	1,536,000
North Western	1,346,000
South Western	832,000
Welsh and Border	585,000
Total England and Wales	8,751,000
Scotland	982,000
Northern Ireland	151,000
Grand Total	9,884,000

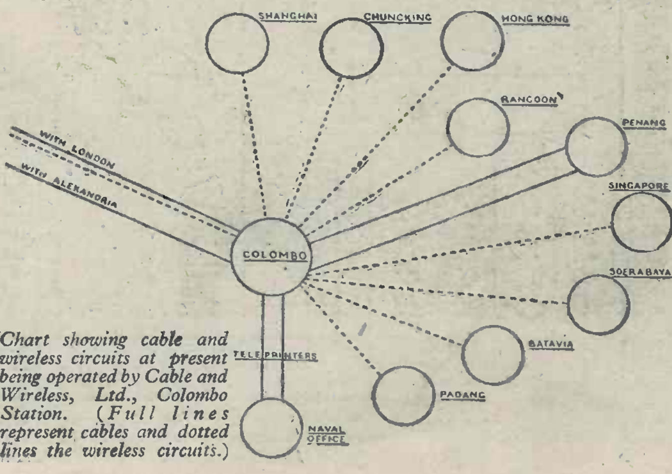
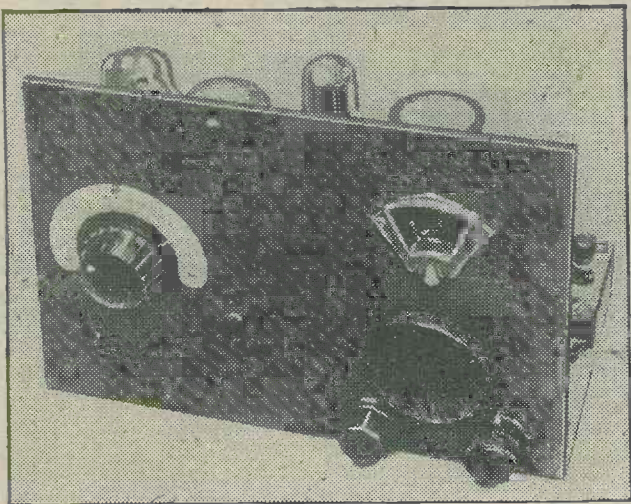


Chart showing cable and wireless circuits at present being operated by Cable and Wireless, Ltd., Colombo Station. (Full lines represent cables and dotted lines the wireless circuits.)

A Compact S.W. Three

Constructional Details of a Compact Set for S.W. Operation

By "LONGDON"



Front view of the S.W. Three

THIS receiver is a good example of a compact chassis layout for S.W. operation and gives very good results upon wavelengths from 10 to 100 metres. All-metal construction is used with advantage, for the use of a metal panel removes the possibility of hand-capacity effects, while the chassis gives a much neater and more compact layout than would a baseboard. The panel arrangement shown in the above photograph gives a convenient operating position for tuning and reaction controls when searching for DX stations.

The circuit is shown in Fig. 1. Two R.C.C. stages follow the detector, and the output stage is a pentode. This gives sufficient amplification for speaker reception of the more powerful stations in America, Africa and the Near East. Although Australian stations have been received at sufficient speaker volume to be clearly audible in a large room, it is best to use 'phones for DX listening with a receiver of this type. With a speaker signals may be completely missed when tuning unless the operator is very careful. The L.F. amplification is ample for 'phones, of course, and in most cases the volume control will require to be turned to something less than maximum.

In the detector stage plug-in coils are used so that any waveband may be tuned. A .0001 mfd. pre-set reduces aerial damping, and in addition coils with an aerial-coupling winding are used so that tuning is reasonably sharp. Direct tuning with a slow-motion drive is used, but if band-spreading is wanted this can be added as explained later.

Constructing the Receiver

Fig. 2 shows the top of the chassis. A manufacturer's chassis 4in. by 9in. is used. It should be about 1½in. deep, as if it is too shallow there will not be room for the potentiometer used for L.F. gain, unless the latter is a midget component. For the panel a stout sheet of metal 6in. by 9in. is wanted, although plywood with foil glued to the rear could be used instead.

The panel is secured to the right of the chassis by the fixing bushes of the on/off switch and potentiometer. A small bolt secures the left side of the panel. When the panel has been drilled and fitted in position a stout panel bracket is added as shown in Fig. 2. There is not

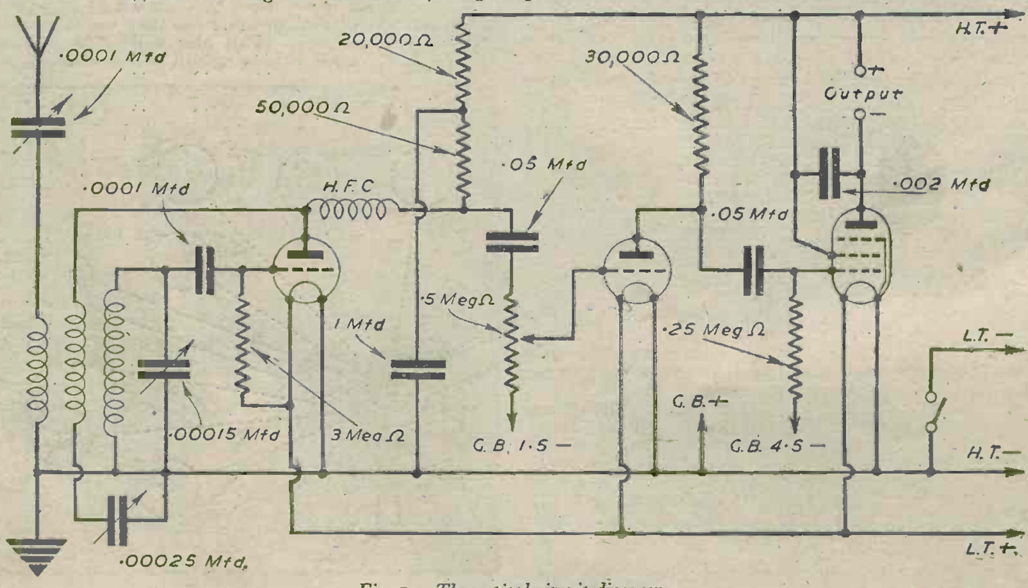


Fig. 1.—Theoretical circuit diagram.

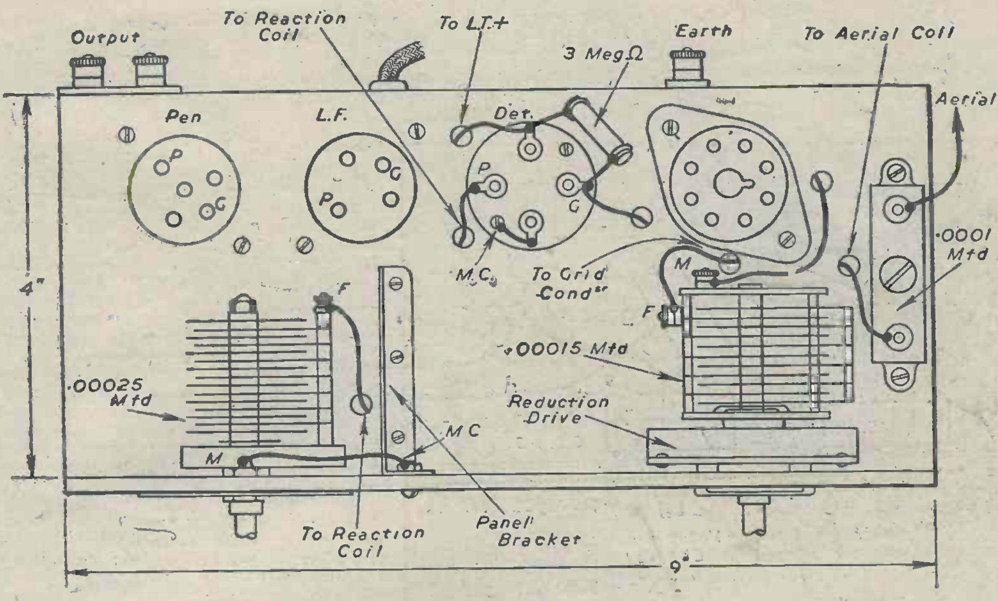


Fig. 2.—Top of chassis layout.

room for two brackets, and one near the centre will amply brace the panel to prevent tuning alterations due to pressure upon the control knobs bending the panel when operating. The bracket is fixed by bolts, and they should be tight to secure good electrical connection.

The .0001 mfd. pre-set in series with the aerial lead-in is mounted about ¼in. above the chassis to decrease the capacitance to earth via the chassis. No aerial terminal is employed, the lead-in being taken directly to the pre-set. The remaining terminal of the pre-set is connected to the aerial coupling winding of the coil. The earth terminal is in contact with the rear runner of the chassis.

The tuning condenser and drive are fitted to the right as shown, and the reaction condenser to the left. The latter has a fairly large knob, complete with pointer and scale, and the condenser should be smooth and free in operation. To make the earth-return certain a lead is taken from the tag contacting the moving vanes to a bolt holding the panel bracket.

L.F. and output valveholders are normal paxolin types, secured below the chassis. The detector valveholder is a low-loss baseboard type bolted to the top of the chassis. The one filament is connected to the chassis; the other to the L.T. plus line of the other valves. The plate is connected to the H.F.C. and reaction coil. The grid-leak is above the chassis, and the last lead from the detector passes through a hole to the grid-condenser.

A lead is also taken from the moving-vanes terminal of the tuning condenser directly to the coil holder, as shown in Fig. 2. This provides a shorter earth-return than that via the chassis and panel and helps the receiver to tune to a low minimum wavelength.

Sub-chassis wiring is depicted in Fig. 3. The output terminals are insulated from the chassis. All the battery leads pass out through a hole in the rear runner. All the resistors and small condensers can be suspended in the wiring in the approximate positions shown. The 1 mfd. decoupling condenser is bolted to one side runner. The H.F.C. should be kept as far from the chassis as possible and should not need supporting if the leads to it are short and of stout wire.

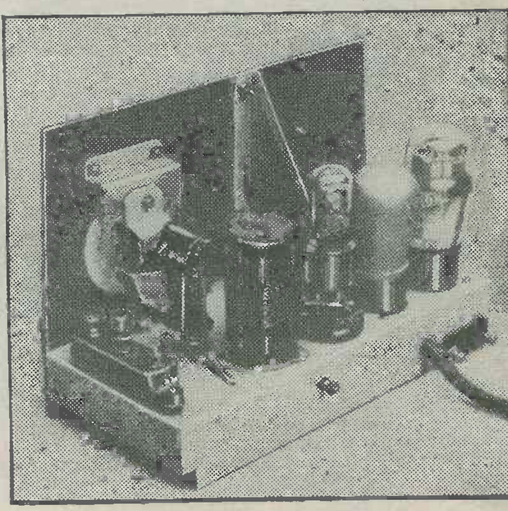
The detector grid-condenser is also kept away from the chassis, and the leads from it pass through fairly large holes in the chassis. All wires passing through the chassis must be insulated.

It must be noted that the volume control spindle is in contact with the chassis and panel, so if this component is of the type having the spindle connected internally to the slider, insulating washers must be added. Failure to attend to this will result in complete lack of signals, and the constructor might be at a loss to find the fault.

One contact of the on/off switch is connected to the chassis. The L.T. minus lead is taken to the other.

Notes on Operation

If 'phones are being used, they should be connected in the correct polarity, or otherwise they will eventually become demagnetised. (This also applies to moving-iron speakers, but not to moving-coil 'phones or speakers.)



Rear view of the S.W. Three.

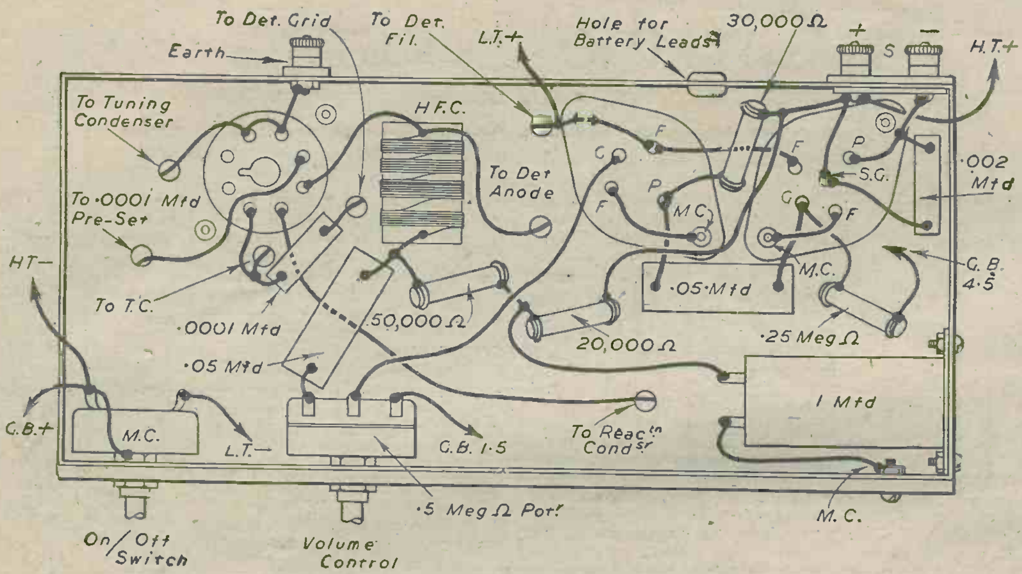


Fig. 3.—Sub-chassis wiring diagrams.

A coil should be inserted, and the volume-control set to a mid-way position. With the set switched on, turn the reaction condenser until a breathing noise is heard, indicating that the detector is upon the point of oscillation. Tuning carefully, stations will now be received. As the receiver is tuned the reaction control will need to be slightly readjusted to maintain the detector in a sensitive condition. In addition, the volume-control may be used as needful to decrease or increase L.F. amplification.

In the afternoon there should be no difficulty in receiving various American transmissions on 16 metres. The frequencies around 19 metres should be used later, and 25-metre frequencies will prove more lively for this continent during the early dark hours. Some Far East stations can usually be heard on the 25- and 31-metre bands during the afternoon. Attention to the 41- and 49-metre bands during evening and early night will provide reception of African and Far East stations. Australian stations can usually be heard best in the early morning, and sometimes also in the afternoon on the 25-metre band.

When the user has become familiar with operation, stations will be received with ease. As a guide, it is recommended that the beginner study the reports of reception often given in the "Readers' Letters" pages, as these give details of times and wavelengths used.

The aerial should not be too long, and should be well clear of surrounding objects. If oscillation cannot be maintained upon some frequencies, then the .0001-mfd. pre-set must be opened out to a lower capacitance.

If bandspreading is wanted, then the .00015 mfd. tuning condenser should be replaced by one of approximately .00001 mfd. The .00015 mfd. component is then fixed between the reaction and tuning controls, with a knob and scale upon the panel. In this case, the larger (or bandset) condenser is left at definite positions and the smaller (or bandspread) used for tuning.

LIST OF COMPONENTS

- .0001 mfd. pre-set.
- .00015 mfd. short-wave tuning condenser.
- .00025 mfd. short-wave tuning condenser.
- .0001, .002, two .05 and 1 mfd. fixed condensers.
- 20,000, 30,000 and 50,000 ohm resistors; .25 and 3 megohm resistors.
- .5 megohm potentiometer.
- Premier 6-pin coils for frequencies required and chassis holder for same.
- Low-loss 4-pin baseboard holder; 4-pin and 5-pin chassis holders.
- Small rotary on/off switch.
- Good quality reduction dial.
- Manufacturer's chassis, 9in. by 4in. by 1½in. deep.
- Metal sheet 9in. by 6in. for panel.
- Strong panel-bracket; knobs, etc.
- Short-wave high-frequency choke.
- Valves: Osram HL2/K, HL2, and Cossor 220HPT (or similar types).

B.S.R.A.

WE have received a copy of the November-December issue of the Bulletin of the British Sound Recording Association, which has recently resumed publication. Among its contents is a list of recently elected members, and a selection of helpful replies from the Association's Information Bureau dealing with various recording-reproduction topics. With the return of several of the B.S.R.A.'s officers to London, many developments in the activities of the Association are planned for 1946. A leaflet outlining the objects and work of this organisation can be obtained from the Hon. Tech. Secretary, D. W. Aldous, British Sound Recording Association, BCM/BSRA, London, W.C.1.

Query Service

WILL readers please note that our query service is discontinued until further notice and that we cannot make any exceptions until our staff return from the Services.

Subscriptions

WILL readers please address all letters relating to subscriptions and back issues to The Publisher, George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2, and not to the Editor.

Blueprints

Orders for blueprints should be addressed to the Blueprint Dept., address as above.

On the Beam–3

Continued from Last Month, this Article Describes the Aircraft Receivers Used for Standard Beam Approach—a Radio Aid for Landing Aircraft in Conditions of Poor Visibility.

IN considering the general circuit arrangement of the main-beacon receiver, it is necessary also to take some note of the marker receiver details. This is because the output from the second detector of the main receiver is fed into the grid circuit of the marker receiver through the volume control fitted on the pilot's control panel.

Thus, the output valve of the two-valve marker receiver serves as an audio amplifier for both receivers, and performs the function of an audio mixer stage.

Fig. 1 gives a schematic layout of the valves, the valve types being indicated. From this it will be seen that of the six valves in the main receiver, V6 is provided for the sole purpose of operating the kicker meter. The remainder of the circuit comprises an R.F. stage, frequency-changer, two I.F. stages and a second detector. Two pentodes are used in the marker receiver, of which the first is fixed-tuned to 38 mc/s and has fixed regeneration to ensure adequate sensitivity.

There are three principal types of main receiver available at the present time, and there have been many previous types which have been superseded as important modifications were introduced during the development period. The type R1124A has been used most extensively; the other two types are described as the R1466 and R1544. The two latter receivers have continuously-variable tuning instead of covering only six pre-selected frequencies, and have been developed from the earlier model.

Referring to the R1124A, then, the R.F. stage has pre-set tuning in both grid and anode circuits. An H.F. transformer is connected in the anode circuit and the secondary of this also has pre-set tuning. The fourth bank of pre-set condensers is for tuning the Hartley oscillator portion of the frequency-changer. There are thus four banks of six pre-set condensers, all controlled by a frequency-selection switch, operated through a Bowden cable from the selector knob on the P.C.P.

As already stated, the oscillator has a fine-tuning device on the P.C.P., consisting of a variable resistor in the supply line from the neon-stabilised 120-volt H.T. line to the tapping on the Hartley coil.

An intermediate frequency of 7 mc/s is employed. The band width is so adjusted in setting-up the receiver that it is not less than 70 kc/s for 3dB attenuation, and not greater than 400 kc/s for 40dB attenuation.

Standing bias (derived from a potential divider across the 13-volt L.T. heater supply) is applied along with A.V.C. bias to the grids of the R.F. and two I.F. valves. In addition, a cathode-bias resistor is provided for the first I.F. valve (V3), but there is provision for short-circuiting this by means of the "Normal-Test" switch on the P.C.P. In the "Normal" position the resistor is short-circuited, whereas in the "Test" position it is open-circuited, so that the standing bias on V3 is increased from about 4.5 to 14.5 volts. This is sufficient to render the A.V.C. virtually non-operative.

The second I.F. stage (V4) is a normal R.F. amplifier and is included to increase the I.F. gain, and also to introduce additional tuned circuits in order to ensure an adequate degree of selectivity.

An R.F. pentode is used as an anode-bend detector, operating with a standing bias of 7 volts negative. This valve does not itself provide the A.V.C., which is obtained separately from a "Westector" circuit. The signal-strength meter forming the "nose" of the visual indicator is connected in the cathode circuit of the second detector; it will be remembered that the cathode current of an anode-bend detector is proportional to the amplitude of the signal applied to the grid.

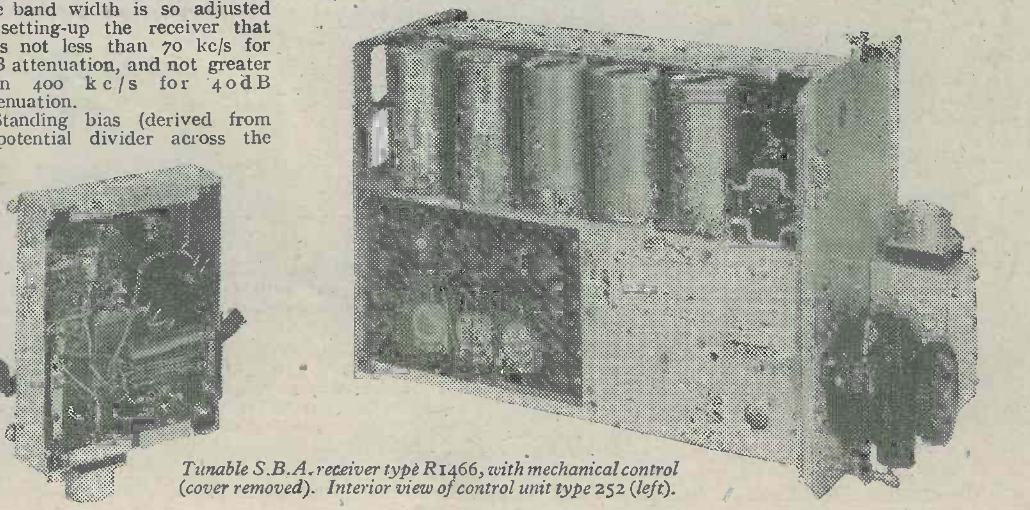
An audio-frequency transformer is connected in the anode circuit of the second detector. The secondary winding of this feeds, through a volume control, into the grid circuit of the A.F. valve in the marker receiver.

The final valve (V6) is used only to operate the kicker meter and has no effect on the audio circuits. It takes its input from the anode of the second detector and has automatic bias.

As the action of the A.V.C. and kicker circuits are closely allied, a brief explanation will be given of the two together. Fig. 2 gives the circuit arrangement.

A small portion of the output from the second detector is applied to the "Westector" marked W2, where it is rectified and used as A.V.C. bias. An 18-volt delay is provided by the P.D. developed across R1. Now when an incoming signal produces a positive half-cycle in excess of 18 volts a P.D. is developed across R2, and this is added to the standing bias.

Resistor R3 and condenser C1, which form a series



Tunable S.B.A. receiver type R1466, with mechanical control (cover removed). Interior view of control unit type 252 (left).

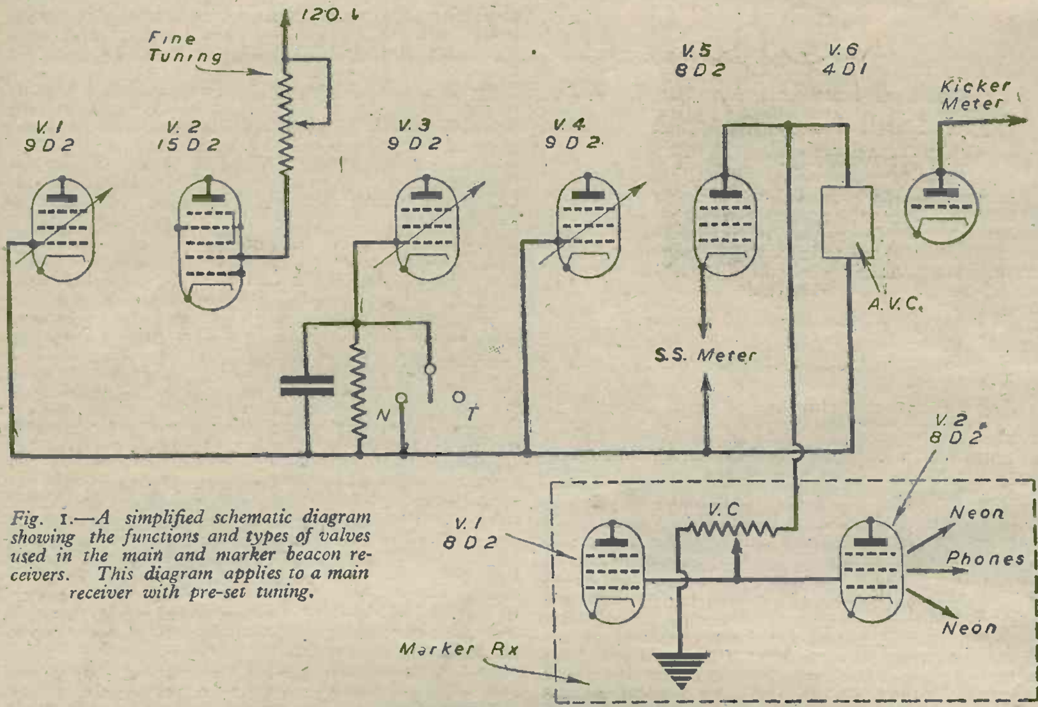
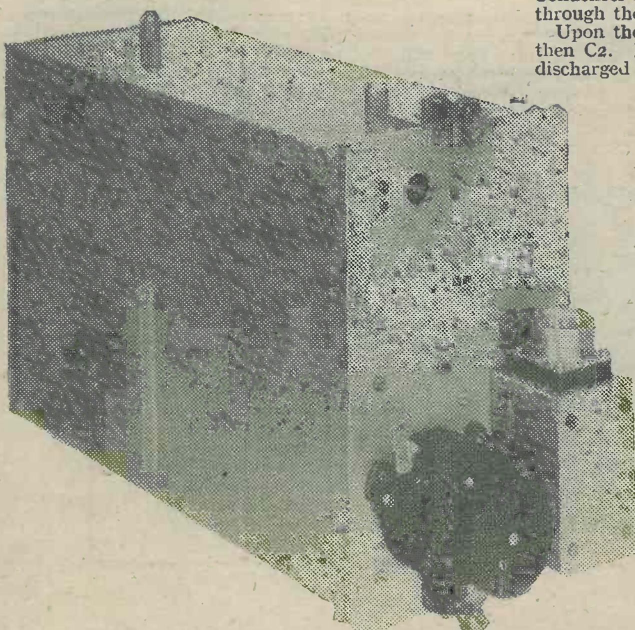


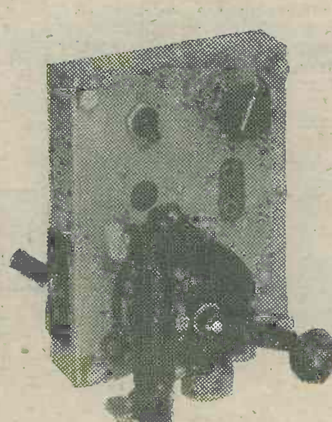
Fig. 1.—A simplified schematic diagram showing the functions and types of valves used in the main and marker beacon receivers. This diagram applies to a main receiver with pre-set tuning.

circuit across the output from the second detector, smooth both the 1,150 c/s audio and also the applied A.V.C. voltage when dots or dashes are being received.

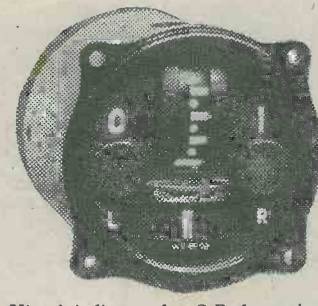
When A.V.C. is removed—in the absence of a signal of sufficient amplitude, or in the "Test" position—the resistance of W2 and R9 in parallel is almost 5 megohms, and C2 is immediately charged to the full standing-bias voltage through the "Westector" marked W3. Condenser C1 is then slowly charged to the same potential through the resistance network.

Upon the re-application of A.V.C. C1 is charged, and then C2. Later removal of A.V.C. results in C2 being discharged slowly. The A.V.C. delay time should be between 15 and 20 secs. and can be checked on the signal strength meter by switching to "Test" and then back to "Normal."





Tunable S.B.A. receiver, type R1466, with mechanical control. Outer view of control unit (right).



Visual indicator for S.B.A. receivers.

During the reception of dots and dashes the grid condenser of V6, marked C3 in Fig. 2, is charged and discharged alternately, with the result that a fluctuating bias voltage is developed across R5. When the grid is made more negative there is, of course, a reduction in the anode current passed by V6. Conversely, when the grid is made more positive the anode current rises.

The anode current of V6 is drawn through the primary of an iron-core transformer, the secondary of which is connected to the centre-zero kicker meter through a pre-set amplitude control. Each time the anode current through the primary undergoes a change there is a pulse of current through the secondary winding and hence through the meter; the meter is entirely unaffected by a steady flow of anode current.

When receiving dots, or when the signal has "dot predominance" (in the "dot" twilight zone) the needle of the meter kicks to the right. At this moment the bias to V6 is positive-going. The needle returns to zero after ⅛ sec. due to hair springs acting against normal inertia, and again kicks to the right when the next dot is received.

During the reception of dashes the needle kicks to the left when the bias to the grid of V6 becomes more negative at the end of a dash. It returns to zero during the interval between dashes and remains there until the end of the next dash, when it again kicks to the left.

The mechanically-operated continuously tunable receiver type R1466 is similar in main details to the R1124A. The 24 pre-set condensers are, however, replaced by a three-gang condenser which tunes the grid and anode circuits of the R.F. stage and also the Hartley circuit of the oscillator. This gang condenser is driven through a torsional cable from the handle on the P.C.P.

A normal tuned-anode coupling is used between V1 and V2. Fine tuning is not required in addition to the main tuning circuit and therefore the oscillator takes its H.T. directly from the 130 volt stabilised line.

A frequency coverage of 33.5 to 40.5 mc/s. is given, which means that more than 30 frequencies are available, allowing for a channel separation of 200 kc/s., which is usual. A different type of Pilot's Control Panel is used, and is illustrated in one of the accompanying half-tones. In addition to the on-off switch, "Normal-Test" switch, volume control and tuning handle, the panel includes the components fitted in the mixer box used with the R1124A.

The advantages of continuously-variable tuning are apparent, for the pilot has a choice of every S.B.A. frequency in use. Despite the accuracy of the tuning-scale calibration, it is not necessary to rely on correct reading of this (and the pilot of a night bomber has very little light) for main beams are now coded. In other words, the reflectors are made "dead" at intervals of 1, 2½ or 5 minutes and a two-letter call sign is radiated. The pilot is thus able to identify the airfield, for he carries a list of call signs.

This keying is carried out automatically by fitting a so-called code sender to the main beacon installation.

The receiver type R1544, which is electrically tuned over the same range as the R1466, combines all of the advantages of the latter with many others. For example, there are three I.F. stages, which give sufficient selectivity to permit of 100 kc/s. separation between transmitters; this is twice the selectivity provided by the other

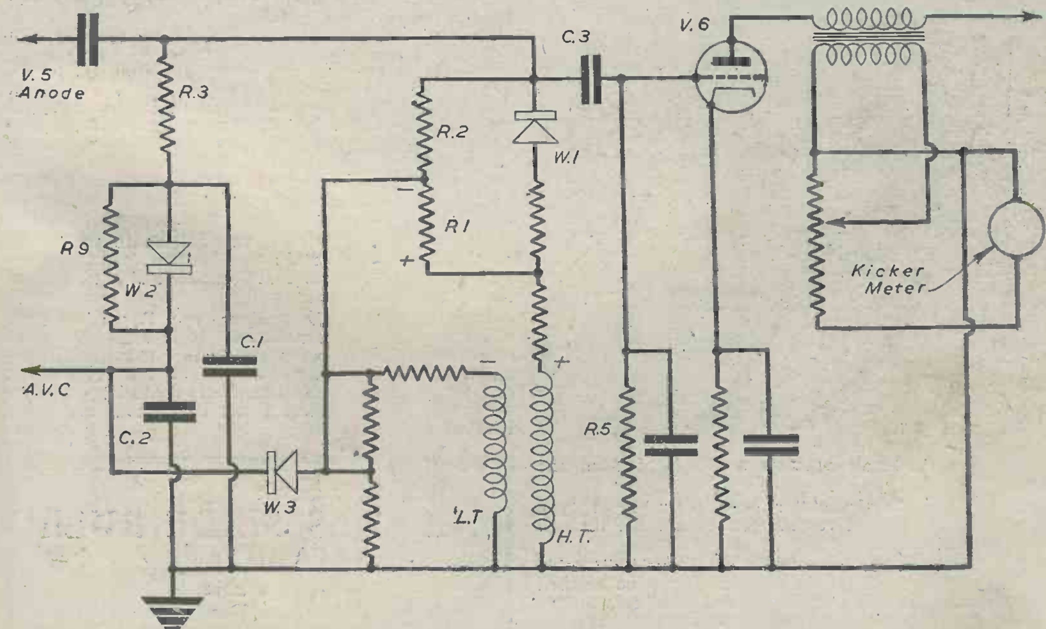


Fig. 2.—A skeleton diagram to illustrate the principal components associated with the A.V.C. and kicker-meter circuits of the main beacon receiver.

receivers. The I.F. stages operate on a frequency of 5 mc/s., instead of 7 mc/s.

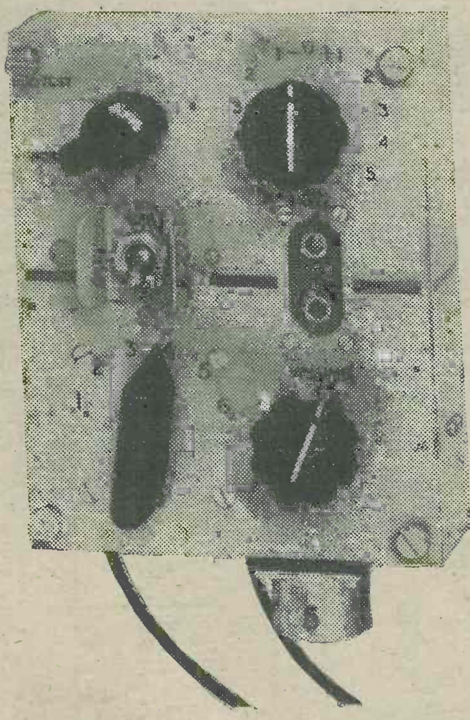
In addition, "Westectors" are replaced by the diode sections of a double-diode triode, and these provide the A.V.C. voltage as well as rectification of the input to the kicker-meter amplifier. The amplifier is the triode section of the same valve—a type EBC33.

The valve arrangement is: H.F. pentode R.F. amplifier; heptode mixer, with electron-coupled oscillator portion; three H.F. pentodes as I.F. amplifiers; H.F. pentode as anode-bend second detector; double-diode triode for A.V.C. and kicker-meter operation.. The additional bias resistor for "Normal-Test" switching is included in the cathode lead of the third I.F. valve, and the signal strength meter (sometimes called a "come-go" meter) is included in the cathode circuit of the second detector.

Most of the other circuit details are similar to those of the mechanically-tuned receiver type R1466.

Remote Control Unit

For remote tuning use is made of a special type of motor designed by Evershed and Vignoles. The motor unit is fitted in the receiver and is arranged to drive the rotor of the three-gang condenser. There is a six-pole stator, the three windings of which are connected by three leads to a commutator in the Pilot's Control Panel;



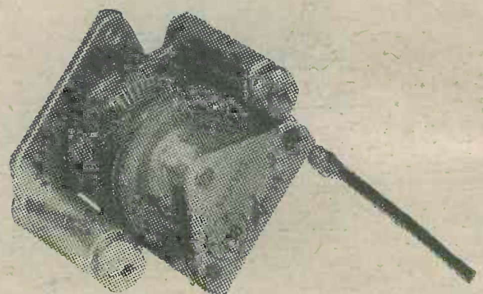
thus, all make-break contacts are isolated from the receiver itself.

Pivoted within the stator is a plain, band type armature, and this drives the condenser shaft through a reduction gearing.

The commutator in the remote control panel is rotatable by means of the tuning handle, which drives the bevelled drum scale. As it rotates the polarity and connections to the three motor stator windings are changed. Phasing is adjusted so that the armature is rotated in synchronism with the rotation of the remote tuning handle. Thus it is moved alternately to a position in line with a pair of pole pieces, and to a position midway between two pairs of poles.

This means that the armature is moved round in steps of one-twelfth of a revolution, or 30 degs. Gearing is included between the armature and the condenser drive shaft so that the condenser is moved in steps of only one-tenth of a degree; this is equivalent to a frequency change of approximately 10 kc/s.

The commutator is geared 3 : 1 to the remote tuning



Control and remote control units for S.B.A. receivers.

handle with the result that the full 300 degs. represented by the calibrated portion of the tuning scale is swept by 42 revolutions of the tuning handle. It should be mentioned that synchronisation of the remote control to the tuning condenser can be effected very easily—if and when this should be necessary—by rotating the tuning scale to its end stop in one direction and then to the other end stop by turning it in the opposite direction.

In practice such synchronisation is seldom required except after the receiver or P.C.P. has been removed from the aircraft for servicing. This is because a D.C. switch is included in the tuning handle assembly so that current is not applied to the tuning motor until the handle is pressed inward against a light spring. A further safeguard consists of a mechanical interlock, with relay control, which prevents the handle from engaging with the drive unless the main switch is "on."

Details of the remote control unit are illustrated in an accompanying half-tone. From this it will be seen that the tuning scale is large, clearly marked and set at an angle of 45 degs. to the face of the control unit, to ensure easy visibility from almost any angle. The scale itself is translucent, and may be indirectly illuminated by a small 12-volt lamp mounted inside the scale assembly.

The control unit carries, in addition to the tuning handle and scale, the main on-off switch, "B.A.—Mix—I/C" switch, "Normal-Test" switch and a test socket for telephones.

In every respect, the receiver type R1544 is a great advance over its forerunners. It is somewhat more efficient, is easier to operate and easier to instal. Installation is greatly simplified due to the replacement of Bowden or mechanical torsional control by a three-way electrical cable which can be bent at any angle without ill effect.

Remote Control

The Principles Explained.

By S. A. KNIGHT

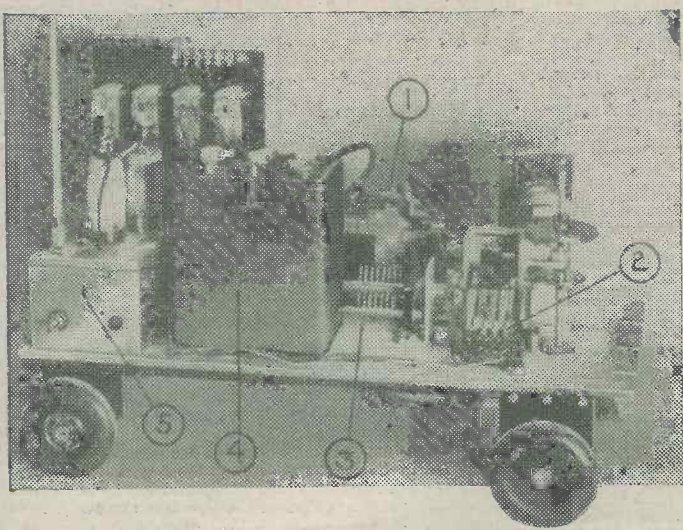


Fig. 1.—General layout of the remote controlled trolley.

THE following account might be of some interest to readers who have experimented, or intend to experiment, in single systems of remote radio control. The writer has experimented with a small remote-controlled trolley, the operations demanded being kept at the minimum of six, namely, start, increase speed, turn left, turn right, straight ahead and stop. These operations, once the machine has been set in motion, can be carried out in any order at the discretion of the controller, each command being distinct and foolproof in that no two contrary commands are capable of affecting the device at one and the same instant. The photographs, while they do not show the details of the machine, at least give a general idea of its layout and mechanism. The short account which follows will give the principles of working and will probably enable those interested among readers to incorporate ideas and suggestions of their own. The principle is, of course, adaptable to a radio-controlled model speed boat, and used in such the difficulties associated with steering experienced with the trolley would be largely overcome.

Operational Details

Simple radio control may be carried out in two ways: (a) by modulation tones, and (b) by separate carrier wave selection. The former method is, perhaps, slightly the easier of the two, but the second method embodies such interesting features that it was employed by the writer on the present trolley.

Briefly, the tone system consists of a transmitter whose carrier can be modulated with a series of spot, low frequency tones, each tone corresponding to a particular command. On the machine to be controlled is situated the receiver which detects and amplifies the transmitted tones in the ordinary manner, passing the output to a bank of relays, the reeds of which are adjusted to be sharply resonant (mechanically) to certain L.F. tones. Each relay then operates a corresponding slave, i.e., heavier, relay which in turn performs the particular command.

The carrier wave selection consists of a transmitter capable of transmitting on a number of spot frequencies (preferably in pulse form), each *frequency* corresponding to a particular command. On the machine to be controlled is situated the receiver, which is *continuously* tuned by means of a driven condenser, throughout the band covered by the transmitter. On reception of a burst of R.F. on a particular frequency, one particular position of the tuning condenser will receive the signal and pass it on for detection and amplification. An output selector switch, synchronised with the tuning condenser, then passes the signal to one particular relay, which operates the corresponding slave, which in turn performs the particular command to which it is associated.

Fig. 1 shows the general layout of the trolley which operates on the above carrier wave system. (1) Indicates the driving motor, driven from the 6-volt motorcycle battery (4), this motor being connected through a single series of reduction gears to the rear driving wheels, to the variable tuning condenser (3), and to the output

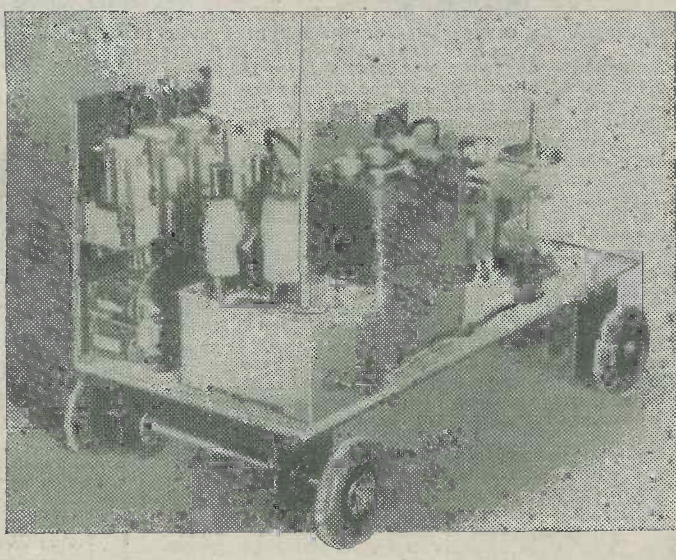


Fig. 2.—Showing the vertical rod aerial and the relay bank to its left.

selector switch (2). The receiver, with rod aerial, is seen to the left of the photograph at (5), the relay bank being situated immediately behind. This section of the machine is best seen in the second photograph, Fig. 2.

A block diagram of the receiver is shown in Fig. 3 and from this a good general idea of the operational details can be obtained. The receiver itself consists of a three valve circuit, all R.F. pentodes, heater voltage being derived from the driving battery, with H.T. supply from a small 90-volt battery normally housed above the driving motor (not shown on the photographs). The first valve is a normal leaky grid detector with a fixed amount of regeneration to ensure selectivity, with the L.F. amplifier consisting of a multivibrator and output bridge circuit. The multivibrator principle ensures an extremely rapid lifting of the output bias necessary for "snap" relay operation, and the output bridge circuit is arranged to give considerable unbalance for any small change in the anode current conditions of the output valve. This unbalance current operates the requisite relay, which in turn operates the heavy duty slave. The system calls for a certain amount of patience in setting up, but once adjusted gives a remarkable snap action for each of the received frequencies. The following account will perhaps best describe the operational details of the system.

Starting with the machine at rest, all relays are "open," and the receiver is tuned by a *fixed* condenser across the tuning coil. The command "start" is transmitted as a short pulse of R.F. on the same frequency at that to which the receiver is then tuned, and on reception of this pulse a relay in the output circuit is made to close. This in turn operates a slave which performs three functions. One, it completes the motor circuit and so applies power to the driving mechanism; also, since these are geared to the driving shaft, the variable condenser and the output selector switch are set rotating. Two, the variable condenser is switched in place of the fixed condenser across the receiver tuned circuit, and the receiver is henceforth being tuned continuously through a given range of frequencies. Three, the output selector switch takes over from the single "starting" relay in the output anode circuit.

Suppose now, as an example of the control process, it is desired to steer the machine to the left. The transmitter sends a pulse on the requisite frequency, and at one position of its rotation the receiver variable condenser selects this pulse and passes it on to the detector. This position of the variable condenser also corresponds to one position of the output selector switch, and the output pulse therefore actuates one particular relay. This relay operates the corresponding slave, which in turn controls the steering mechanism. This latter, which incidentally proved one of the most difficult points in construction, is solenoid operated and is ratchet controlled so that approximately 10 deg. of steering is accomplished at a time. The transmitter pulse is simply repeated the requisite number of times to control the amount of turn. At the end of the turn the "straight ahead" frequency is transmitted to the receiver, operating events exactly similar to those described above, and releasing the ratchet mechanism which allows the steering to take up a straight course again.

The "increase speed" control simply shorts a resistance from the motor field winding; the "stop" control breaks the motor input from the accumulator. Once the machine is at rest, the fixed tuning circuit takes over from the variable condenser, and the output switch is replaced by the single "starting" relay. In this position only the command "start" will have any effect on the machine.

All relays are self-holding and are arranged so that no signal can affect one without breaking the circuits to the others (with, of course, the exception of the stop relay which is only affected by the direct signal). This precaution ensures that no conflicting operations can take place at one and the same time—even allowing for great operating speed on the part of the controller at the transmitter! Complete electrical and mechanical details are, of course, beyond the scope of these brief notes, but those readers who are interested in remote control will find, I trust, plenty of scope for mechanical and electrical ingenuity in the construction of such a trolley as the one described above.

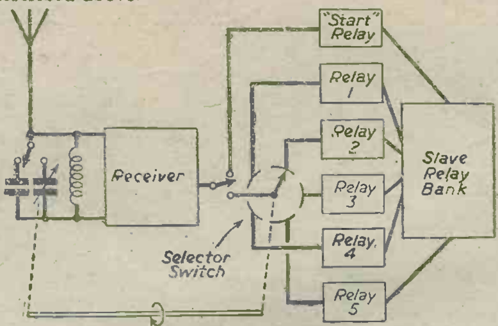


Fig. 3.—Diagram showing essential operating mechanism of the radio-controlled trolley.

The Decibel

THE comparative unit of sound strength. The value chosen for 1 decibel is the sound which can just be discerned by the trained ear.

Due to the fact that the human ear does not perceive simple increases of sound intensity as such, but tends to follow approximately a logarithmic law, the decibel is logarithmic in character and is independent of frequency.

If P_1 is the input power to an amplifier or attenuator, and P_2 the output power, then the simple power ratio is $\frac{P_2}{P_1}$. The logarithmic unit, the bel, is the logarithm of the simple power ratio, so that the power ratio (bels) is $\text{Log}_{10} \frac{P_2}{P_1}$ (common logarithms to the base 10 being used). Since the bel, as a unit, is too large for practical purposes, the decibel is used, this being a tenth part of a bel. Thus power ratio (decibels) is $10 \text{ Log}_{10} \frac{P_2}{P_1}$.

Since the power output is proportional to the square of the voltage or current, when dealing with these units the power ratio becomes

$$10 \text{ Log}_{10} \frac{I_2^2}{I_1^2} \text{ which is } 20 \text{ Log}_{10} \frac{I_2}{I_1}$$

In the case of loudspeakers it is becoming common practice to give a graph of the power output over the entire audio-frequency range in decibels above and below the output at some standard frequency, such as Middle C (256 cycles per sec.). If the output is greater than the standard frequency, then the ratio in decibels is positive, whilst if less it is negative.

It is interesting to note that a change of power output of three decibels is the smallest change in intensity that can be detected by the average ear.

The decibel is also used to express power level transmitted in a circuit. It is necessary to refer it to an arbitrary standard called zero level or 0 decibels, it being recognised that this shall represent .006 watt of audio-frequency power. Thus 10 decibels is .06 watt and 20 decibels .6 watt, etc. To express values below the zero level a negative sign is put in front of the sign for the decibel, so that −10 decibels is .0006 watt and −20 decibels .00006 watt.

Wide-band Coupling Circuits

Notes on the Modification of Broadcast Receiver Circuits to Meet the Needs of Television

By P. FREEMAN, B.Sc.

THE reopening of the London Television Station and the probable transmission of frequency modulated sound programmes will encourage those interested in television and high-fidelity reception to avail themselves of the new facilities. The purpose of this article is to discuss briefly the way in which the basic coupling circuits of the familiar broadcast receiver are modified and developed to meet the requirements of television and frequency modulation reception.

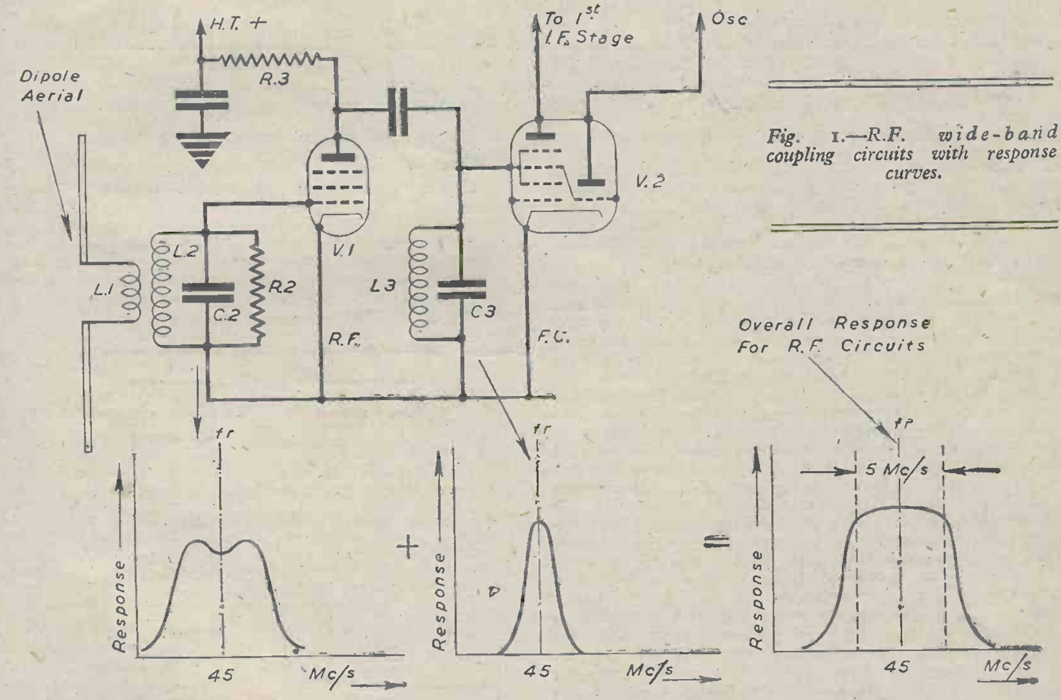


Fig. 1.—R.F. wide-band coupling circuits with response curves.

For the purpose of illustration a typical ultra-short wave superheterodyne is shown as a block diagram in Fig. 2 This receiver is assumed to be operating on the Alexandra Palace television channel of 45 mc/s with the intermediate frequency stages tuned to 13 mc/s. A similar layout would be appropriate in the case of a frequency modulation receiver except that two additional stages, the limiter stage and the discriminator stage, are interposed between the I.F. stage and the demodulator or second detector. As the function of these two stages does not concern the discussion in this article, they will, for the sake of simplicity, be omitted.

High fidelity reception of sound and much more so of vision demand the use of intervalve coupling circuits which deal with a much wider range of frequencies than is met with in normal broadcast receiver design. The R.F. and I.F. stages must not only select and amplify the required signal at the resonant frequency but handle sidebands which, in the case of television, have a coverage greater than the entire frequency spectrum of the long- and medium-wave broadcast bands together ! Such a task is only made possible by the adoption of what are known as wide-band amplifying stages in the receiver. These wide-band coupling circuits are of two distinct kinds, those which precede the demodulator stage, i.e., R.F. and I.F. amplifiers, and those which follow the demodulator, i.e., A.F., or in the case of television V.F. (video frequency) amplifiers. The former circuits are always some kind of bandpass filter which should amplify the carrier or intermediate frequency and its sidebands to an equal extent yet have rapid attenuation below and above the limits of the transmitter sidebands, whereas the latter must amplify uniformly a band of frequencies extending ideally from zero to the highest modulation frequency. In Fig. 2 are shown the ideal response curves of the various stages in a perfectly designed receiver. It will be noted firstly that all the response curves have a "flat" top, and secondly that the sides of the curves for the R.F. and I.F. stages are vertical. The "flat top" signifies that all modulation frequencies are amplified to an equal extent, while the "vertical sides" indicate very abrupt attenuation at the limits of the passband, ensuring freedom of interference from any adjacent transmission. The need for such abrupt attenuation is not yet experienced in Britain, where only one television channel exists and the only adjacent transmission is the accompanying sound on 41.5 mc/s, whereas in the U.S.A. the ultra-short wave ether is already crowded and numerous television stations are

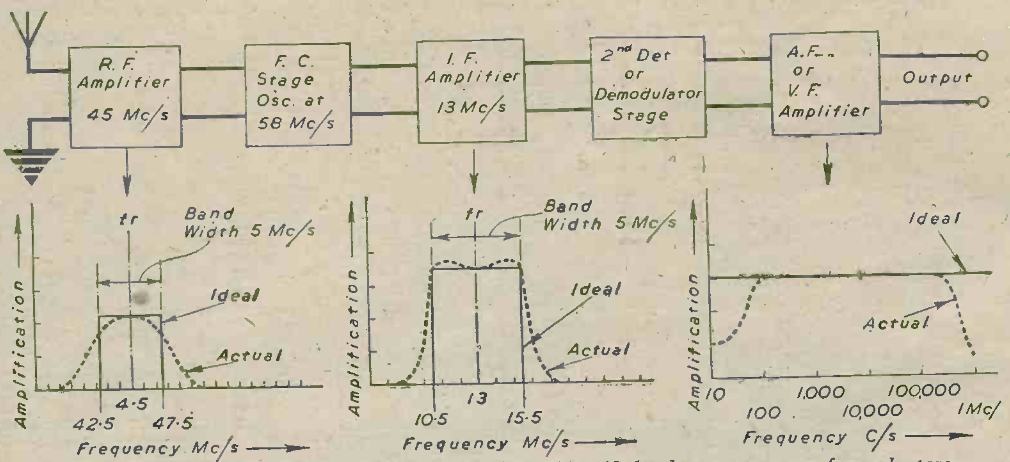


Fig. 2.—Block diagram of ultra-short wave receiver with wide-band response curves for each stage.

allotted channels 6 mc/s apart. In practice the response curves from even the best designed receiver would never be the ideal ones of Fig. 2 (full line), but would probably resemble the dotted line curves. It will now be explained how these response curves are obtained by suitable design of the coupling circuits.

The Loaded Tuned Circuit

The basis of design is the "loaded tuned circuit," an example of which is shown in Fig. 4, together with the response curves obtained with different values of resistance load. The tuned circuit must have as large an L/C ratio as possible, and in practice the condenser C is often omitted, the inductance being designed to resonate with the stray circuit and valve capacities. The value of R, the damping resistance, is chosen in relation to the bandwidth required. The lower the resistance, the flatter the response and the greater the bandwidth, but it should be noticed that a simple tuned circuit, no matter how loaded, cannot produce perfectly uniform response over a frequency range which includes the resonant frequency. The sloping response either side of the resonant frequency apparent in Fig. 2 cannot be avoided. However, if two loaded tuned circuits are coupled closely together, it is possible to produce a response that is higher at frequencies off resonance than at resonance (the familiar double-humped bandpass filter). The response of such an overcoupled stage can be made to compensate for the loss of response of a simple tuned circuit stage by operating the two stages in cascade, the "peak" of the single circuit filling up, as it were, the "valley" in the double-humped response.

The R.F. Coupling Circuits

The skeleton R.F. circuit of the receiver would be as shown in Fig. 1, with the respective response curves drawn under each coupling stage. No loading resistance is required in the aerial transformer as the dipole aerial itself loads this coil. The anode coupling resistance R_3 of the first R.F. valve V_1, although apparently apart from the tuned circuit L_3C_3, is actually the loading resistance as far as A.C. voltages are concerned. At frequencies as high as 45 mc/s the gain of a wide-band R.F. stage is small and only one stage of R.F. amplification is usually found in superheterodynes. The small gain is due to the fact that, at high frequencies, the input resistance of the R.F. valves decreases rapidly (it varies in inverse proportion to the frequency) and at frequencies above 40 mc/s it is low enough to damp the tuned circuit so heavily that worthwhile amplification cannot be obtained.

The R.F. stage does, however, perform two useful functions, it provides a great improvement in the signal/noise ratio and it reduces second-channel interference. R.F. amplification is always included in frequency modulation receivers, since an extremely high signal/noise ratio is a feature of their performance. In television receivers a low signal/noise ratio causes a "dirty" background to the picture, and omission of the R.F. pre-selection may cause wavy lines across the screen due to interference from the adjacent sound channel.

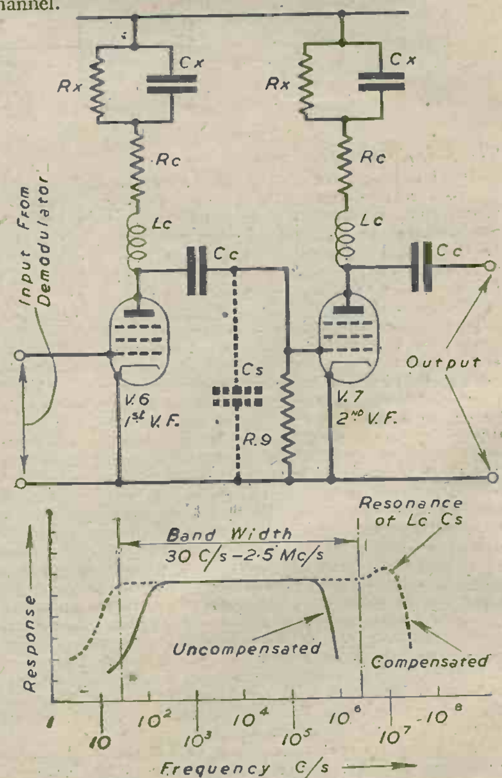


Fig. 3.—Two-stage video amplifier with response curve.

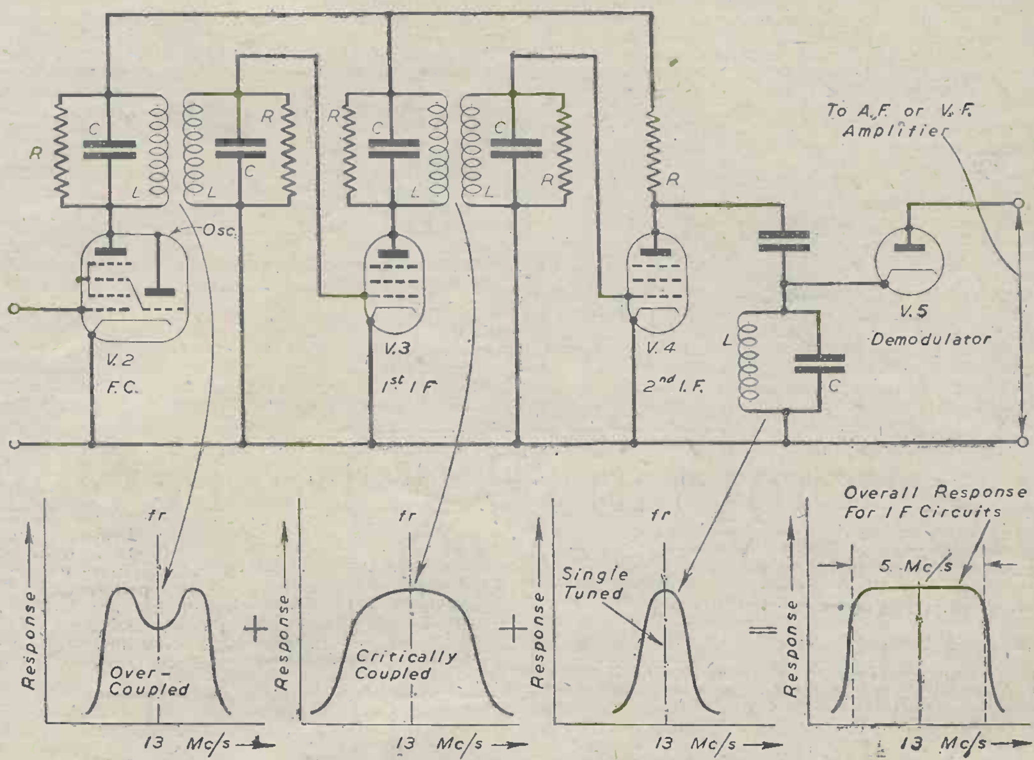


Fig. 4.—I.F. wide-band coupling circuits with response curves.

The I.F. Coupling Circuits

It is the design of the I.F. stages which contributes most to the performance of the receiver with regard to selectivity, sensitivity and fidelity, and hence their design must be such as to give as close a resemblance to the ideal square-shaped response as possible. It is found in general that the wider the band of frequencies to be amplified, the lower the value of the loading resistance and the smaller the gain of each individual stage. The stage gain is roughly proportional to g_mR where g_m is the mutual conductance of the valve and R the loading resistance. In order to increase the stage-gain values of high mutual conductance, the so-called "television" pentodes have been developed (SP41, SP42, 1852, 1853, etc.). Even so, the stage gain does not usually exceed 15 as compared with several hundred in a broadcast receiver, so three to five I.F. stages are generally required to bring the signal up to the required strength to be demodulated. The process of frequency changing automatically enables a higher stage gain to be received from the individual I.F. stages, as at the intermediate frequency of 13 mc/s the damping effect of the valve input resistance, though not negligible, is considerably reduced. This fact explains one of the chief reasons why straight receivers are rarely employed for ultra-short wave reception. A typical three-stage I.F. amplifier with the respective response curves below each stage is shown in Fig. 4. The combined response curve of the three stages bears a tolerable resemblance to the flat-topped vertical-sided ideal. In American television receivers, the I.F. coupling circuits usually contain a more complex system of inductances and capacitances arranged according to the theory of band-pass filter design in order that the sides of the response curve may be made still more nearly vertical.

The Audio or Video Coupling Circuits

The stages following the demodulator valve are invariably a modification of the well-known resistance-capacity coupled type of amplifier. A video amplifier in a television receiver must have level response from near zero to 2.5 mc/s, an impossible feat for straightforward R.C. coupling which, with optimum design,

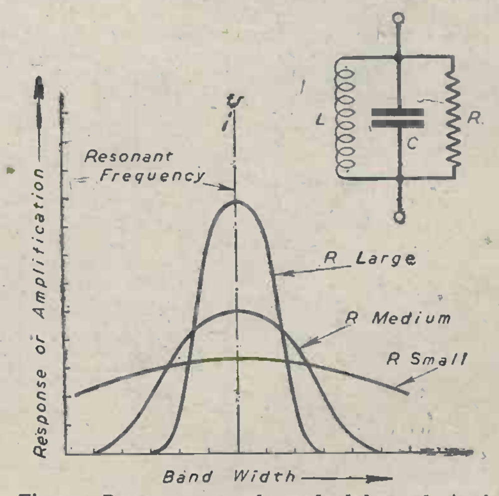


Fig. 5.—Response curves for a loaded tuned circuit.

produces a response similar to that shown by the full line in Fig. 3. It will be noted that at frequencies above 1 mc/s and at frequencies below 100 c/s, the level responses fall off sharply. The loss of high-frequency response is due to the combined shunting effect of the input capacity of V6, and the stray wiring capacity represented by a dotted capacity C_s. As this shunting capacity cannot be reduced below a certain minimum value even in the best designed pentodes, it is necessary to compensate for it in some way. This is done by including a small inductance L_c in series with the anode coupling resistance R_c; when correctly chosen the inductance L_c resonates with the shunt capacity C_s at a frequency higher than the maximum modulation frequency to be reproduced, say at 3 mc/s. This prevents the attenuation at 1 mc/s and extends the response curve in the manner shown by the dotted curve in Fig. 3. The low-frequency response could be improved by increasing the capacity of the coupling condenser C_c, but a condenser of sufficient capacity (several microfarads) would introduce a large additional stray capacity to earth by reason of its sizeable physical dimensions, and this would spoil the high-frequency response. The coupling condenser is therefore not made higher than about .01 μfd., and a compensating network consisting of a resistance R_x and a condenser C_x in parallel is introduced in series with the anode load. At frequencies above 100 c/s C_x provides little impedance, thereby effectively short-circuiting R_x and producing a level response as though R_c were the sole anode load.

As the frequency is lowered, however, C_x provides an ever increasing impedance, and the total anode load is proportionately increased, giving increased amplification to compensate for the attenuation below 100 c/s. The resultant response at the low frequency end of the band is shown in Fig. 3 which also shows the skeleton circuit of a fully compensated two-stage video amplifier.

The fidelity of the complete receiver depends, of course, on the synthesis of all the response curves in the various stages described. This final response curve is known as the overall response, and it should be perfectly level and extend throughout the desired range of modulation frequencies.

Economy in Battery Power

BECAUSE a large amount of actual listening time is spent tuned to the local stations the writer has originated several useful and interesting circuits for this purpose. They are additions or modifications of standard circuits and can be added to almost any receiver. Moreover, the receiver can be restored to normal operation immediately as a switch is used for the change over. Some of the circuits can be used with short-wave receivers with advantage when using earphones; with others ample speaker volume will be obtained even when the set is operated in the "local" distance condition.

Cutting Out an H.F. Stage

After various experiments the circuit shown in Fig. 1 was arrived at. It has the advantage that no switching is required in the grid leads of the valves or the aerial circuit. Looking at Fig. 1 it will be seen that a standard H.F.-Detector circuit is used, but the coils are connected together at the earth end of the windings and to the filament of the H.F. valve. A switch is included between this line and the earth line of the receiver. The gang condenser and other parts are left connected as originally, and either tuned grid or H.F. transformer coupling may be used. Tuned anode coupling is not suitable.

When the switch S is closed the circuit will function exactly as before, but when it is opened the H.F. valve will cease to operate and the two tuned circuits will become a bandpass pair with bottom common-impedance coupling. The common-impedance is provided by the H.F. valve filament and low tension wiring and was found to be just right in two receivers upon which this modification was tried.

A single pole switch only is required, and in one receiver use was made of the switch upon the V.M. volume control, so that when this was turned to minimum the circuit was opened for bandpass operation. When closed operation was normal, with the volume control functioning in the usual way. An additional switch was added to the L.T. supply for switching the receiver on and off, and to avoid drilling the cabinet this was one of the electric-light pear type on a length of flex.

One point must be noted in conjunction with this circuit—the V.M. bias cannot be applied to the H.F. valve through the tuning coil, but a leak must be used as in Fig. 1.

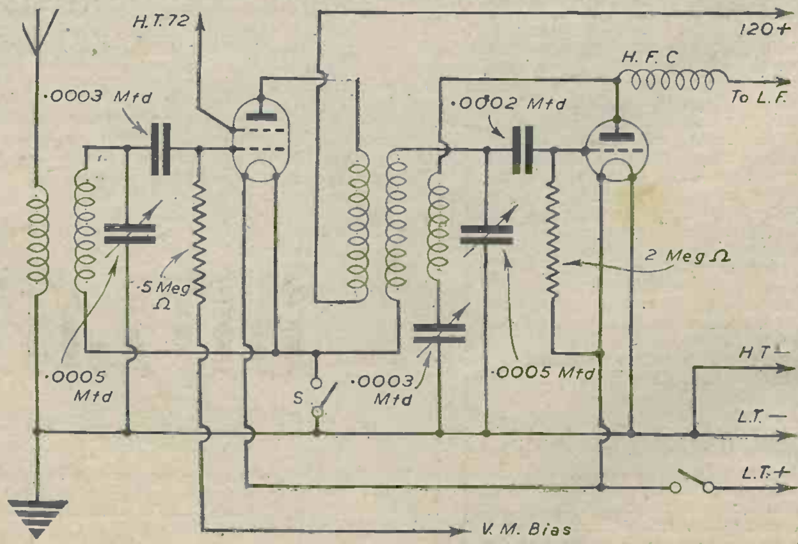


Fig. 1.—Experimental circuit.

Optional L.F. Stage

In a receiver with two L.F. stages it will be found very convenient to be able to cut one out at will. A satisfactory circuit is shown in Fig. 5. A double-pole-double-throw switch is added to the receiver as shown. When the switch is in one position the L.F. valve filament

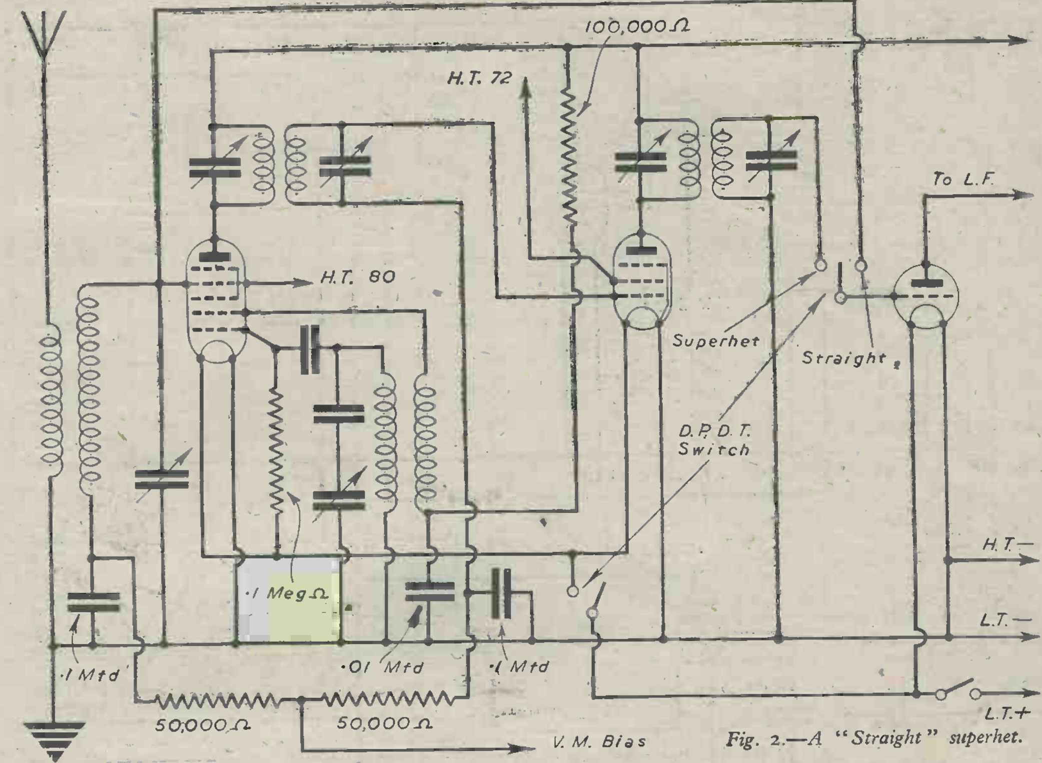


Fig. 2.—A "Straight" superhet.

is connected and also the coupling condenser is connected to the valve grid. Results are then normal. In the other position the valve filament is disconnected and the connection from the coupling condenser transferred to the anode. The L.F. transformer will then be parafed and the L.F. stage by-passed.

As with circuit 1, this will result in a saving of both H.T. and L.T. current. There is also the advantage that the anode load of the detector is not modified so that different reaction effects due to changed voltage, for example, are not produced. It is a very useful circuit for a short-wave receiver. The L.F. valve can then be of high-gain type, such as the Osram HL2, and can be switched out when powerful stations tend to overload it.

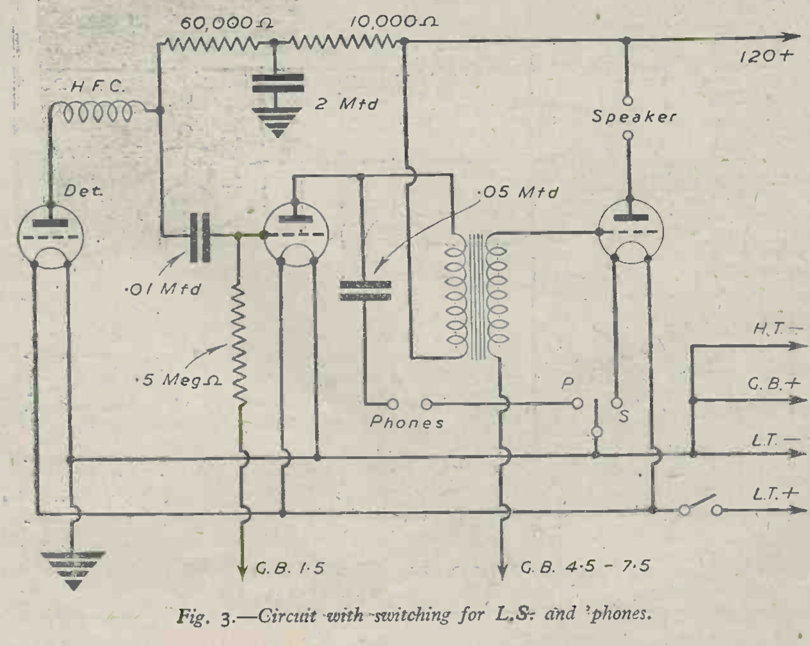


Fig. 3.—Circuit with switching for L.S. and 'phones.

Speaker-'phone Listening

'Phones are often connected in place of the speaker for S.W. listening, but sometimes this brings disadvantages. Excessive amplification may cause background noise, while sometimes the 'phones may be incapable of carrying the anode current of the output valve.

A useful circuit to overcome these difficulties is shown in Fig. 3. The only additional parts required are a .05 mfd. coupling condenser and single-pole-double-throw

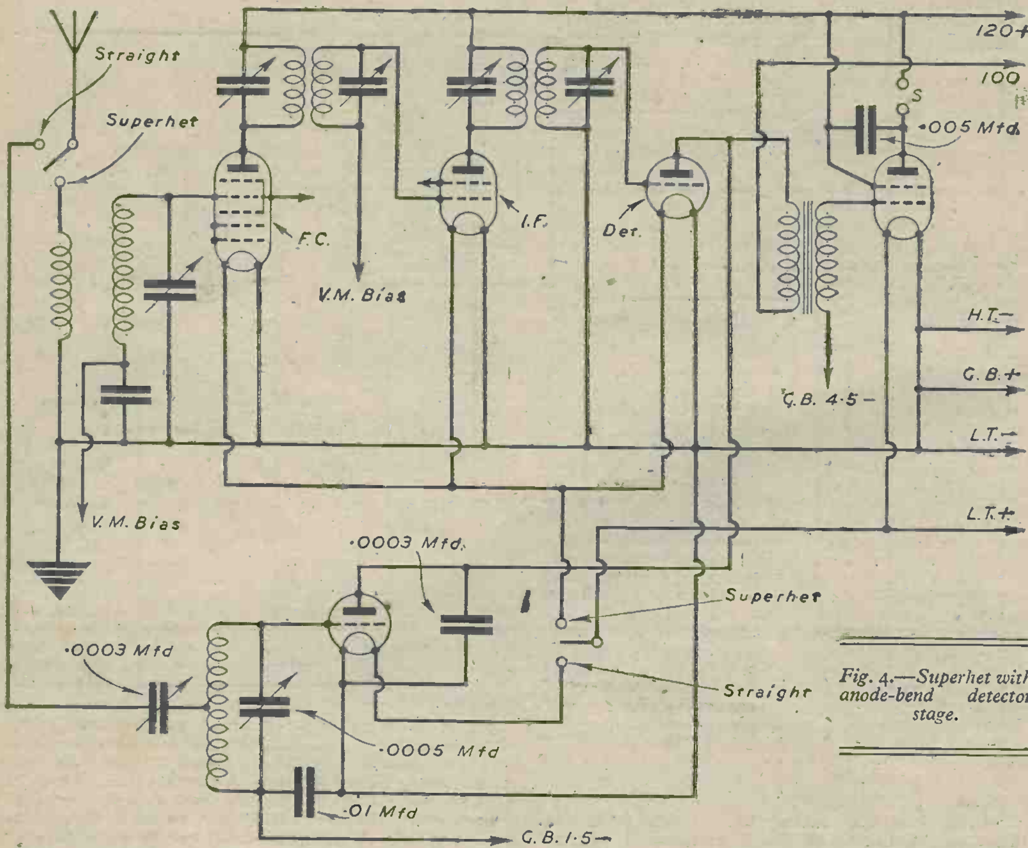


Fig. 4.—Superhet with anode-bend detector stage.

switch. They are connected as shown, and it will be seen that in one position the 'phones are cut out and the circuit operates normally. In the other position the output valve ceases to operate and the 'phones are fed through the condenser from the L.F. stage.

This circuit may also be used if a transformer is employed between detector and L.F. stages and the modifications will be just the same.

Straight-superhet Listening

The circuit is shown in Fig. 2, and again a D.P.D.T. switch is required. This should be mounted so that the lead from the second I.F. transformer to the detector is not unduly long, for this connection is now taken *via* the switch as will be seen. The other contact of this section of the switch is taken to the

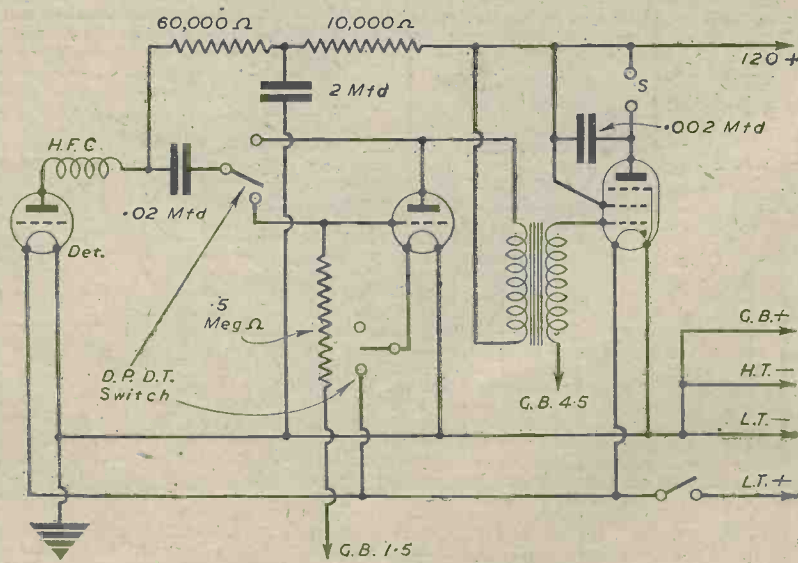


Fig. 5.—Ciuit with optional L.F. stage.

control grid of the frequency changer. It will probably be best to screen this wire to prevent risk of instability. The filament circuit of the F.C. and I.F. valves is now modified as shown, and there is little risk of introducing instability by these leads. When the filament circuits of the F.C. and I.F. valves are completed and the detector grid connected to the I.F. transformer, results will be as before. In the second, or "straight" circuit position, the F.C. and I.F. stages will cease to operate and the second detector will operate directly from the aerial circuit. Local stations can then be tuned in as when operating normally, but the circuit will be merely a detector followed by L.F. amplification. When listening in the "straight" position the V.M. volume control will have to be turned so that little or no bias is applied to the coil, or distortion will arise in the detector. If desired, this can be obviated by inserting a grid leak and condenser in the detector grid circuit.

Superhet-anode-bend

A circuit favoured by the writer is shown in Fig. 4. Here a standard superhet of all-wave design has an use of le-bend detector added. The superhet F.C. circuit t shown in full because it is as in Fig. 2.

If the connections are followed it will be seen that when the switch is in one position all-wave superhet reception as usual will be obtained. In the other position the F.C., I.F. and second detector stages will cease to function and the anode-bend detector will become operative as its filament is connected by the switch. The aerial is also transferred to the anode-bend detector coil, which is pre-set tuned to the local station. The .0003 mfd. pre-set in the aerial connection is for volume control, and once set does not need to be altered.

In one position, therefore, the set functions as a normal 4-valve superhet, but in the other becomes a detector-pentode tuned to the local station. This will be found a very useful circuit and the switch may be marked "Superhet Reception" and "Local Station Reception." The anode-bend detector will give good volume and quality, and there is no reason why reaction should not be added to the circuit if desired.

Bias Notes

It will be seen that battery bias is used in all the circuits and this is because the changing anode current caused by manipulating the economy switch would upset automatic biasing circuits. This could be overcome by having additional resistors to be switched into circuit but the use of battery bias is the simplest and best solution.

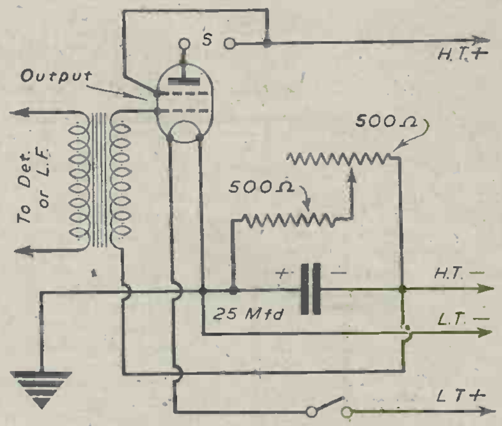


Fig. 6.—Addition to auto-bias circuit.

In any case the use of a little additional bias results in economical running. A new Mullard PM22A was tested and the results of altering bias were as follows:

Bias	Anode Current
3 volts	8mA.
4.5 volts	4.4mA.
6 volts	1.75mA.

This was with 120 volts on both anode and screen and the saving is easily seen. When listening with the volume control a little below maximum it was found impossible to determine orally whether 3 or 4.5 volts bias was in use. Six volts bias gave some reduction in volume and quality, but both were still surprisingly good.

Fig. 6 shows an addition which can be made to an auto-bias circuit. A 500 ohm wire-wound potentiometer or variable resistor is added to the fixed one already used. (500 ohms is shown for this, which is average for a battery set, although it may vary, of course, with different circuits and valves.) When this resistor is adjusted to zero results will be as before, but when it is rotated towards maximum the bias will be gradually increased. The effect while measuring anode current is very noticeable, and it will generally be found some additional bias can be used without any appreciable loss of quality or volume.

Radar Receivers

THE problem of the receiver for radar is a complex one. In practically all radars the superheterodyne principle is employed, which involves generating at low power a radio frequency fairly close to that received, and "beating" this against the received signals, forming an intermediate frequency which is then amplified, many times. Curiously enough, the old-timer's crystal of the 1910-1920's, used, as a detector and mixer, has again come into its own in microwave receivers. The peculiar characteristics of pulse signals require that receivers be built with extremely fast response, much faster even than that required in television. The final stages must prepare the signals for suitable presentation in the indicator. The receiver normally occupies a relatively small box in the complete radar set, and yet this box represents a marvel of engineering ingenuity. A particularly difficult piece of development is concerned with a part closely connected with the receiver. This is a method of disconnecting the receiver from the antenna during intervals when the transmitter is operating so that it will not be paralysed or burned out by the stupendous bursts of radio frequency energy generated by the transmitter. Within a millionth of a second after the transmitter has completed its pulse, however, the receiver must be ready to receive the relatively weak echo signals; but now the transmitter part of the circuit must be switched off so it will not absorb any of the energy.—*Radio-Craft.*

Output Matching

FOR any given output valve there are certain limits within which the load of the speaker must fall if the full output of the valve and good-quality reproduction are to be obtained. But suppose that we have a pentode, requiring an anode load of 8,000 ohms, and a speaker the impedance of which is only 2,000 ohms. Or, again, suppose we have a valve the optimum load of which is 2,000 ohms and a moving-coil speaker of low resistance—say, 6 ohms only.

Obviously, it will not do to connect the speaker direct in the anode circuit of the valve, as its impedance is far too low. What must be done is to employ an output transformer so designed that the impedance of the primary (which is connected in the anode circuit of the valve) matches the valve resistance, while the secondary is wound to match the speaker impedance. The correct ratio for such a speaker is found by dividing the optimum value of the load, as recommended by the valve-maker, by the impedance of the speaker, and extracting the square root.

It should be noted that it is the *impedance* of the speaker and not its *resistance* figure in the case of a moving-iron instrument, or one and a half times the resistance in the case of a moving-coil speaker.

ON YOUR WAVELENGTH

By THERMION

The Supply of American Valves, etc.

PERHAPS I can add something to the discussion on the supply, or rather the absence of supply, of American radio valves and components. The valves imported for the maintenance of receivers imported before the war are distributed through firms who were accustomed to importing radio valves before the war, and also through valve manufacturers. It has not been possible to import valves in quantities sufficiently to enable retailers throughout the country to carry stocks of all types. Therefore, should a retailer want a valve of a type which he does not have in stock he must place an order for it with his usual supplier of American type valves who, if he is not an importer-distributor or a valve manufacturer, should in turn pass it on to his usual supplier of these valves.

With regard to components for receivers imported before the war it has generally been found possible to obtain suitable equivalents manufactured in this country, and according to the Board of Trade it has not been necessary to arrange special importation of components other than valves. With this I profoundly disagree. Where there has been a suitable English equivalent it has been practically unobtainable since the demand for it as a replacement in the receiver for which it was originally designed has far exceeded the supply. It has not, therefore, except in theory, been possible to find suitable equivalents.

The receivers imported under Government auspices during the war were distributed to the trades through two main distributors. Owing to the small numbers of a wide variety of valve types, and the particular types of electrolytic condensers with which these receivers were equipped, it was considered to be more satisfactory from the purchaser's point of view, to distribute the valves and components through these two firms. To obtain parts for such receivers users should place their orders with the retailers from whom the sets were purchased. The retailer in turn should pass on the order through the wholesaler who supplied him to the main distributor of the receiver, who will then deliver the necessary components or a suitable equivalent.

Whilst I am dealing with American type receivers I should like to recall that they have not been found entirely satisfactory when operated under English conditions. They are all designed for 110 volts, necessitating in most cases the use of a resistance cord between the mains and the set. This has not been found satisfactory here, and the components used in general seem to give plenty of trouble. I cannot see, therefore, that American receivers, unless specially designed for this market, will ever find a ready sale over here.

Wireless Licences and Prosecutions

THE number of wireless receiving licences in force in Great Britain and Northern Ireland continues to increase, and has now reached the record total of 9,884,300.

Even so, the Post Office is constantly detecting unlicensed sets, and users of such sets should remember that they run the risk of prosecution and consequent fines.

Some cases recently brought before the courts resulted in fines of as much as £6, with the alternative of 30 days' imprisonment, and the confiscation of the offenders' sets.

Motorists are reminded that it is necessary for them to take out a separate wireless receiving licence for a wireless set fitted in a motor-car.

Australian Radio Day

THEY rodeodo on Radio Day each year on December 12th when they celebrate Radio Founders Day as a tribute to those who gave radio to the world.

It was on December 12th, 1901, that the famous "S" signal sent out by Marconi from Poldhu, in Cornwall, was received by his assistants Kemp and Paget with their elementary Kite Aerial on Signal Hill, Newfoundland. Radio had spanned 1,700 miles of ocean from one British territory to another British territory—the critics were confounded—and radio as we know it to-day [illegible]

Thus radio was given to the world like so [illegible] blessings through British enterprise, for it was in [illegible] that Marconi found the faith and support he needed.

Australia realises, perhaps more than any other country what radio means to the world, for it eliminated the vast spaces between her and the older world.

During this year's Australian celebrations of Radio Founders Day, H.R.H. the Duke of Gloucester and the President of the Australian Institution of Radio Engineers broadcast to Great Britain and the rest of the world.

Romford Radio Society

MR. R. C. E. Beardow, of 3, Geneva Gardens, Whalebone Lane North, Chadwell Heath, Essex, tells me that the Romford and District Radio Society are moving to new premises, the Y.M.C.A. Red Triangle Club, late Masonic Hall, Western Road, Romford, near Romford station. Meetings are held every Tuesday evening at 8 p.m. and new members are welcome.

Radar Directional Antennas

THE problem of antenna design is one of the major problems in radar, incomprehensible as this may seem to the operator of a home radio receiver, who finds a few yards of wire strung up on his roof adequate for his purpose.

The scanning of the portion of space which the radar set is intended to cover must usually be done by mechanical motion of the antenna structure itself. This means that the structure, whatever its size, must swing around or up and down to direct the beam in the necessary direction. In certain cases where one needs to scan only a small sector, techniques have been worked out for rapid electrical scanning not requiring the motion of the whole antenna structure itself. So far, however, there has been no method for extending this rapid electrical scanning to cover more than a relatively small sector. Radars for directing guns which need accurate and fast data in a small sector are making use, however, of this valuable technique.

To carry the radio-frequency energy from the oscillator to the antenna, and the echo from the antenna to the receiver, wires and coaxial cables are used at ordinary wavelengths. For microwaves, however, it is more efficient to use wave guides, which essentially are carefully proportioned hollow pipes—and the transmission system hence is called "plumbing," by radar men.

Auxiliary Equipment for the Amateur Transmitting Station

Apparatus which will Increase the Efficiency of the Amateur Station

By A. D. TAYLOR

NEWS that the wartime ban on the use of amateur transmitting apparatus is about to be lifted will no doubt mean that quite a number of readers of PRACTICAL WIRELESS will shortly be applying for their first transmitting licence. This article has, therefore, been written to give an outline of certain auxiliary equipment, the use of which will both greatly increase the efficiency of an amateur station and also allow of much more accurate experimental work being carried out.

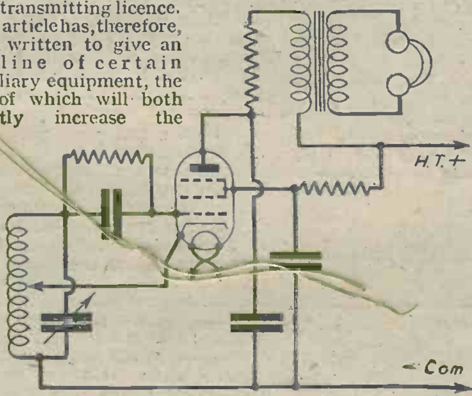


Fig. 1.—Circuit for electron-coupled frequency meter-monitor.

The first instruments suggested are two multi-range test instruments built up around two 0-1 M/a. moving coil milliammeters. The use of two of these instruments may seem an extravagance at first, but it is suggested that one be permanently installed in the transmitter, with suitable switching to allow of all D.C. voltages and currents in the set being checked, while the other be made up as a portable instrument which, besides being used for ordinary test and service work, can also be plugged into some of the apparatus described later in the article. The principles of this type of instrument will probably be known by the average amateur, but if help is required reference should be made to an article by the writer in a previous issue of PRACTICAL WIRELESS.

A stable and accurately calibrated frequency meter is essential in any amateur station. An economy can be effected, however, by constructing an instrument which besides being a frequency meter can also be used as a monitor for C.W. transmissions. The circuit for an electron-coupled frequency meter-monitor is shown in Fig. 1. The meter should be carefully constructed on a sturdy metal chassis and mounted in a stout metal screening box. A really good slow motion dial must be used and the power supply should be well regulated.

It is usual to calibrate the frequency meter with the aid of a 100 kc. crystal oscillator, but another method which the writer has tried seems just as accurate and eliminates the cost of the crystal. A small single valve oscillator is built which will tune to 200 kc/s. With the aid of an ordinary broadcast receiver it is then tuned to zero beat with the B.B.C. Light Programme transmitter on 200 kc/s and its harmonics will give marker points at every 200 kc/s throughout the tuning range of the frequency meter. Owing to the high frequency stability of B.B.C. transmitters this is a very accurate method of calibration.

One of the most useful pieces of apparatus in an amateur station is the artificial aerial. A useful circuit is shown in Fig. 2. C and L should be suitable for the transmission frequency in use, and R can consist of an ordinary 25 watt electric light bulb. M is the 0-1 M/a. range of the portable multi-range test meter, and W is an ordinary receiving type Westector. This Westector should be mounted on a suitable plug, as it is also used for plugging into the instrument described in the next paragraph. The size of L2 and its coupling to L must be determined by experiment, and should be adjusted until M reads half scale with the transmitter running normally and L at the optimum coupling distance from the transmitter output stage anode coil. Once this is done, any variations in the transmitter output during tests or modifications can be immediately checked on M.

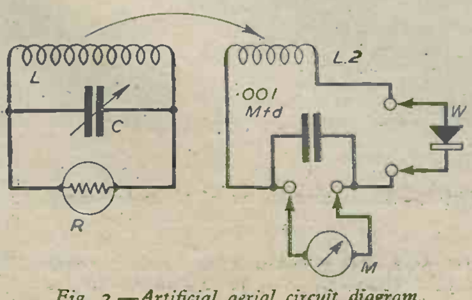


Fig. 2.—Artificial aerial circuit diagram.

The last piece of apparatus to be described is a simple field strength meter, which can also be used as a telephony and key click monitor, and as an absorption wavemeter. L and C should be suitable for the frequency in use, M is as described for the artificial aerial and W is the Westector. A is 2ft. of copper rod mounted on a suitable stand-off aerial and E is an earth pin which can be pushed into the ground when taking field strength readings in the neighbourhood of the aerial.

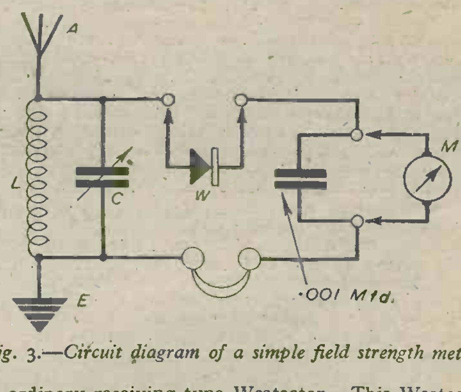


Fig. 3.—Circuit diagram of a simple field strength meter.

A 5-50 Metre Set

A Receiver Capable of Providing Good Results upon All Frequencies. By F. G. RAYER

As amateur activity is increasing it was thought that a receiver capable of providing good results upon *all* the frequencies of interest would prove useful. As it was intended that the set should function very well upon 10 metres, and even retain a high degree of efficiency upon the U.S. wavebands, some thought and experiment was given to the layout—particularly in the detector stage. The result is a layout it would be difficult to beat. Upon wavelengths from 10 to 50 metres operation is everything that can be desired from such a circuit; upon wavelengths near 5 metres tuning becomes a little critical, due to the use of a tuning condenser capable of giving a good tuning range upon the higher wavelengths, but efficiency is still high.

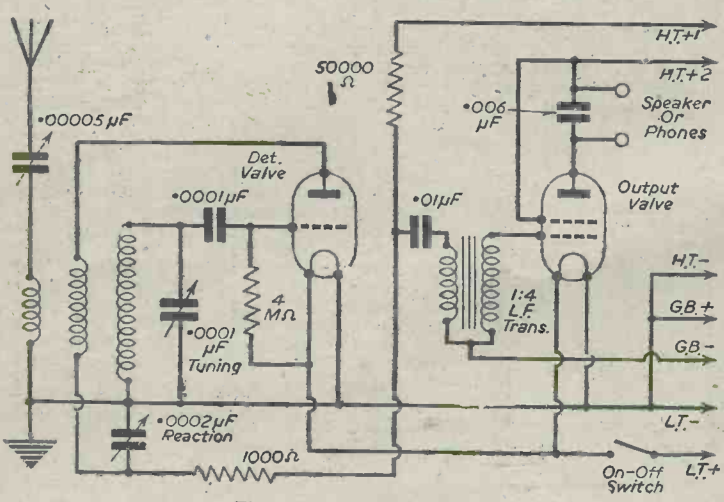


Fig. 1.—Theoretical circuit.

Circuit

This is shown in Fig. 1. The two valves will provide good speaker volume of the more powerful stations, and phones are used for listening to weak transmissions. Bandspreading has been discarded, due to the losses introduced by using two condensers and a dual-ratio epicyclic reduction used instead. A reaction choke is not used due to the danger of encountering resonant peaks, and instead a 1,000 ohm resistor is incorporated. The detector circuit is taken through the reaction coil to avoid any possibility of weak reaction upon U.S.W. A reduction drive is also added to the reaction condenser to facilitate operation.

Construction

The layout is shown in Fig. 3. A 5-ply wooden baseboard 9in. by 10in. is used, and a panel 10in. by 8in. Both are covered with foil, although in final experiments it was found that the foil could be omitted and that no hand-capacity was introduced. This is because the tuning and reaction condensers are set well back from the panel. Brackets hold panel and baseboard together, and to raise the controls to a more convenient height for operating the baseboard is fixed about 1in. from the bottom edge of the panel.

The small box affair, which enables such short wiring, should now be made. It is 3in. high and 3½in. long. It is about 2in. from front to back. Plywood is used for the top and side carrying the coil and valve holders, and thicker wood for the remaining side. The arrangement of these pieces will be seen in Fig. 2.

A hole is drilled in the side, near the top, for the detector holder (which should be a ceramic type), and a second hole in the top piece for the coil holder. The holders are bolted in position and small brackets secure the box to the baseboard.

The tuning condenser is entirely within the box, as shown in Fig. 3. The reaction condenser is just outside so that the vanes can open beyond the edge and close proximity of the fixed plates to the tuning condenser does not give undesired anode - to - grid coupling.

If Figs. 2 and 3 are examined in conjunction with the circuit no difficulty will arise in wiring. The appropriate tags of the coil holder are wired directly across the tuning condenser, and 1½in. of wire will be ample for both these connections. The wire from detector anode to coil will be about 1in. long and from reaction coil to reaction condenser 1¼in. long. These connections should be direct and well soldered. 18 S.W.G. tinned copper wire is used. Note that the reaction condenser is earthed directly to the tuning condenser and that a short wire is taken from the filament of the detector to the earth lead of the coil. The shortness of these connections is also important as they form part of the tuning and reaction circuit.

The leak is soldered on as shown, and the grid condenser is suspended between the tuning condenser and grid socket of the holder. To complete the detector circuit the aerial pre-set is added, with a small insulator for aerial connection, and the 1,000 ohm resistor is joined to the fixed plates of the reaction condenser.

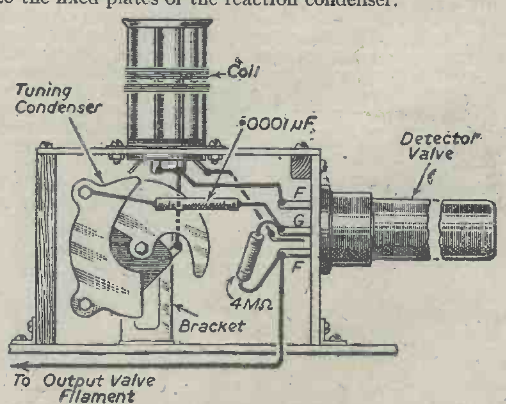


Fig. 2.—Shows arrangement of pieces for carrying coil and valve holders in box form.

Both the variable condensers are mounted upon brackets, and further brackets support the lugs of the epicyclic reduction drives. A smoothly-finished clearance hole in the panel is suitable for the reaction spindle (the metal foil being cleared away from the edges of the hole to prevent noises). A ¼in. diameter hole is drilled for the tuning control spindle. A bearing is made up to support this so that there is a clear space left around the top half of the hole. This enables a *thick* wire to be bent as shown in Fig. 3 to form a pointer. The portion lying in line with the spindle travels around the axle without touching either panel or axle, and if it is firmly supported by a screw in the rear section of the reduction drive this will be found perfectly satisfactory. A celluloid dial completes this item.

The L.F. stage is very simple and Fig. 3 shows all connections. All the battery connections are taken to a 6-way terminal block beside the L.F. valve (not shown in Fig. 3 for clarity). This may be seen from the cover photograph, and can be omitted if desired. The terminals upon the .006 mfd. condenser are used for speaker connections. If an earth is used, it can be connected to L.T. minus. A fibre washer insulates the on/off switch from the foil to avoid shorting the L.T. supply.

Notes on Coils and Operation

The ordinary plug-in coils are used for the higher wavelengths. For U.S.W. reception it would be possible to wind coils upon similar formers, but self-supporting coils were made for the set described as follows: Take a base from a discarded octal valve and saw off the sleeve portion to leave a flat disc with pins attached. The coils are now wound and the ends so bent that when they are slipped down the centre of the pins and soldered the coils lie in a proper position. The coils are wound ⅜in. in diameter from 16 S.W.G. tinned copper wire. Grid windings are 4 and 6 turns. Reaction 4 and 5 respectively. No aerial coupling is used, the aerial pin being taken to a tapping upon the coils (¾ turn and 1 turn from earthed end respectively). These coils may be plugged in as desired. Examining one of the ready-made plug-in coils will show how the ends of the various windings are connected, and the "sense" in which the windings must be.

An Osram HL2 is suitable for detector (or HL2/K if available because of its slightly different internal construction). A tetrode or pentode is used for L.F., or a L.F. valve of the triode type if phones only are to be used.

H.T.1 will require about 100 volts, and H.T.2 preferably 120. Grid bias must be adjusted according to the valve in the L.F. stage.

As the reaction condenser is closed the detector should slip into oscillation. If not, the aerial pre-set may require opening, or slightly more H.T. applied. It is very necessary reaction should be smooth and adequate. However, little difficulty should arise here unless reception is attempted upon wavelengths below 5 metres. If the user has not previously operated upon U.S.W., it should be noted that tuning should be carried out with extreme care. Reaction should be barely upon the point where the detector commences to hiss or stations may be swamped. It should also be remembered that no transmissions are available upon large sections of the U.S.W. bands and in consequence all dial readings should be noted down for reference.

Reception upon 10 metres and upwards will be found simple and satisfactory, provided normal regard is taken of times of transmission, etc.

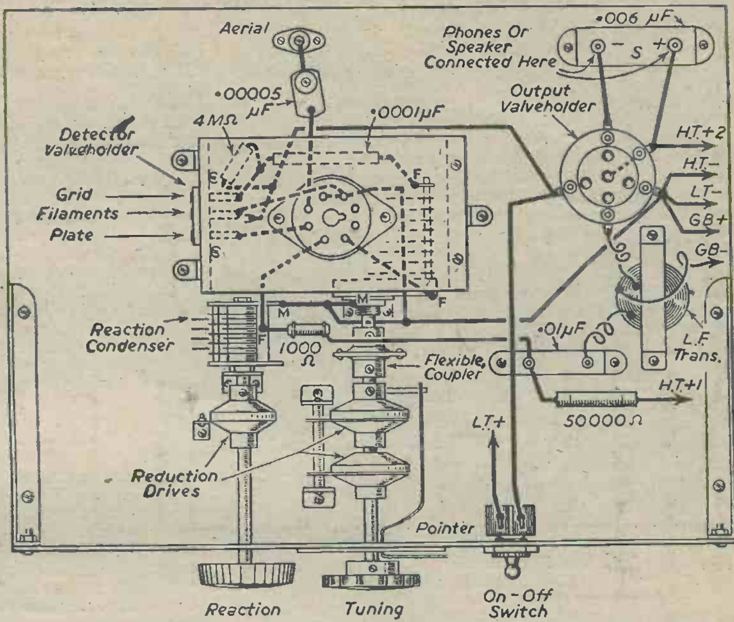


Fig. 3.—Wiring diagram.

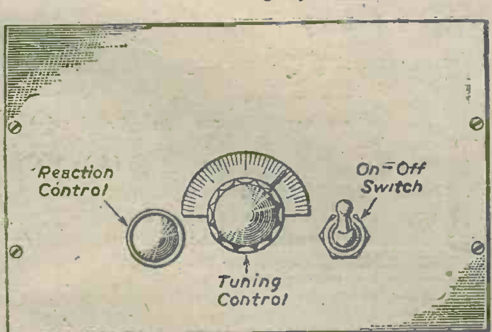


Fig. 4.—Panel layout.

LIST OF COMPONENTS

.00005 mfd. pre-set (mica); .0001 mfd. (mica); .006 mfd. and .01 mfd. fixed condensers.
.0001 and .0002 mfd. low-loss variables.
4-pin ceramic holder.
5-pin standard holder.
4 megohm, 1,000 and 50,000 ohm resistors.
Parafeed transformer.
Coil holder and coils.
Two drives.
Switch, brackets, flexible coupler, etc.

Multiplicative Mixing

A Further Discussion on Frequency Changing.

By H. REES

THE term multiplicative mixing first appeared in accounts of the triode-hexode frequency-changer, and various erroneous ideas seem to be held about its meaning.

Owing to the unfortunate terminology used in many textbooks, there is a widespread belief that a process of modulation is somehow employed to generate a difference-frequency in these modern mixers. Indeed, one finds quite authoritative references to "sidebands" $(f_1 \pm f_2)$ being generated, where f_1 and f_2 are the local oscillator and incoming frequencies.

The definition of side-frequency given in British Standards, 204, 1943 ("*Glossary of Terms used in Telecommunication*") admits of a pretty wide meaning to the term. Yet modulation and detection are two very different things, and if H.F. sidebands are generated in one case, it is hardly correct to say the same is true of the other.

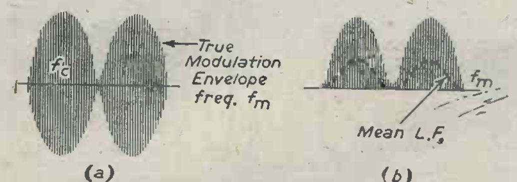


Fig. 1.—Modulated H.F. carrier (a), and extraction of L.F. component (b).

There is this much in common: Any device such as a detector operating in a non-linear condition can also be used for modulating, if the appropriate frequencies are applied, i.e., H.F. and L.F. Sidebands $(f_c \pm f_m)$ are then generated, for each A.F. "tone." But if the same non-linear device is used for demodulating (a not very satisfactory Americanism for detection), how are we to say further "sidebands" are generated?

A detector gives rise to harmonics, it is true, and also "sum" and "difference" frequencies $(f_1 \pm f_2)$ in the case of beat rectification. Is it true to say that $(f_1 \pm f_2)$ is a sum or difference of the same "kind" as $(f_c \pm f_m)$ when modulating? In other words, do both represent sidebands?

There are those who would dismiss such questions as mere "verbal quibbles." That is one way of making light of an untenable position! Since students derive their ideas from language, the answer should be obvious, e.g., if the same term is used to denote concepts as different as the proverbial "chalk and cheese."

The logic of the matter is somewhat as follows: On the one hand, a sideband is a high-frequency—the sum or difference of a carrier f_c and relatively low modulating frequency f_m. In fact, the word is understood to mean "H.F. side-frequencies." Note, carefully, that a sum and difference of this type cannot be explained by any theory of "beats," or simple harmonics.

When we beat two frequencies f_1 and f_2, a "difference" $(f_1 - f_2)$ is obtained after rectification. This can be an audible note, and not a radio-frequency at all. For example: If $f_1 = 1{,}000$ kc/s, $f_2 = 999$ kc/s, we shall get after detection an audible note of 1 kc/s $= 1{,}000$ c/s. This is certainly not an H.F. sideband, in the above sense, but a low frequency of 1,000 cycles/sec.

If not an H.F. sideband, is it correct to describe $(f_1 - f_2)$ as a sideband, in any sense of the term? We cannot get things both ways; if $(f_c - f_m)$ is an H.F. quantity, $(f_1 - f_2)$ is not necessarily so. In fact, as already stated, a lower side-frequency $(f_c - f_m)$ is not anything in the nature of a beat-difference.

Hence the importance of logical definitions. If technical terms are used in a loose manner, contradiction and confusion must result. So "verbal quibbling" often makes for clear thinking.

The "First Detector"

However, to get back to the triode-hexode. Should this be described as the equivalent of a detector, or of a modulator generating "upper and lower sidebands" $(f_1 \pm f_2)$?

The above comments on $(f_1 - f_2)$ partly answer the question. But let us look at the matter from another standpoint.

In the old days we used to speak of the first detector in a superheterodyne. There was no question whatever as to whether or not it was a detector. It would be considered quite fantastic to talk of modulation and sidebands, because it was perfectly obvious that what occurred was extraction of a beat envelope of frequency $(f_1 - f_2)$, just as any detector extracts a modulation envelope of frequency f_m.

The writer gave an account of beat principles in a previous article. In a sense, any regular amplitude variation of an H.F. wave is a "modulation envelope," and, also, a beat envelope.

Carrier modulation by an L.F. tone is again illustrated in Fig. 1 (a). The envelope may be regarded as resulting from a beat between either sideband and the carrier, i.e., $f_m = (f_c + f_m) - f_c$, or, $f_c - (f_c - f_m)$. A detector is essential to give a separate current component at the envelope frequency, as in (b).

Suppose, however, the carrier was suppressed at the transmitter. The sidebands only would then be radiated, and, being two waves of equal amplitudes, they will heterodyne to give a resultant envelope of the form shown in Fig. 2 (a). Actually, this is an envelope at twice the modulating frequency f_m, i.e., a simple beat-difference $(f_c + f_m) - (f_c - f_m) = 2f_m$.

However, if instead of two H.F. sidebands we consider any other heterodyning frequencies f_1 and f_2, the envelope frequency is similarly the beat difference $(f_1 - f_2)$. It will be exactly the same as Fig. 2 (a) for two beating waves of equal amplitudes. Clearly, a detector is again essential to give an independent current component at the "modulation" frequency $(f_1 - f_2)$, as shown in 2 (b).

We have deliberately used the word "modulation" here, because there is an obvious similarity between Figs. 1 (a) and 2 (a), in the sense of a periodic amplitude

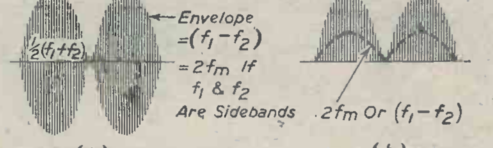


Fig. 2.—Beat resultant of two frequencies f_1 and f_2, which may be the sidebands (f_c+f_m) and (f_c-f_m) in Fig. 1. Frequency doubling of the modulation envelope would then occur, i.e., $2f_m$.

variation. Also, both envelopes arise as a result of a beat between high frequencies: in one case, between three frequencies—a carrier and two sidebands.

Fig. 2 (a) illustrates what may be called a simple beat, between *two* frequencies. There is really no modulating frequency at all, as in Fig. 1 (a): i.e., no separate frequency corresponding to f_m, but simply f_1 and f_2 which heterodyne to give an envelope $(f_1 - f_2)$. Of course, in modulation proper, f_1 and f_2 would be upper and lower H.F. sidebands (f_c+f_m), and (f_c-f_m).

Thus, if we have two beating waves of equal amplitudes produced, say, by two oscillators, we might regard the frequencies f_1 and f_2 as the sidebands of a non-existent carrier, but why talk of "sidebands" at all in such a case? There is no modulating frequency f_m, and no carrier to which it is added and subtracted!

If the amplitude of the heterodyning waves are unequal, as is generally the case, the resultant beat envelope will be more like a true modulation envelope, Fig. 1 (a)—though still not of true sine shape. This is a more complicated case to explain, but the envelope is still at the frequency (f_1-f_2), and a detector is again necessary to extract this difference.

Hence, the first detector in the orthodox superhet. It extracts the beat envelope, or gives rise to a separate current component at the intermediate frequency. The latter carries the incoming modulation f_m, so a second detector is essential to extract f_m.

Now, the hexode mixer, and similar types, has taken the place of the first detector. In fact, the word detector has disappeared, although, be it noted, no fundamental change in principle is involved. The "superheterodyne" is still a receiver employing heterodyne principles, e.g., beating an incoming carrier by the local oscillator frequency, and the equivalent of a first detector is still essential to extract the beat frequency.

Actually, in the triode-hexode nothing that looks like ordinary detection process is employed. The "mixing" is done in such a way that the equivalent of detection is accomplished simultaneously. This is what multiplicative mixing really means, but it is quite erroneous to translate it modulation. Let us consider this in more detail.

Some Graphical Experiments

Take, first, two relatively "high" and "low" frequencies, Fig. 3 (a).

If we carried out the laborious job of adding the instantaneous values of these two waves, and plotting the results on squared paper, we would get simple superposition as in (b). It is fairly easy to see how this comes about. The L.F. wave is positive (or negative) for several cycles of H.F., which has the effect of "lifting" (or depressing) successive H.F. cycles, about the L.F. wave as a mean value.

Obviously, there is no amplitude modulation. "Additive mixing" leaves the component frequencies entirely separated, while there can be no question of beating when the frequencies differ so widely.

But if we multiplied instantaneous values and plotted the results, the waveform would become that shown in (c)—the H.F. wave modulated at low frequency! It is not too difficult to explain mathematically how this comes about, instead of (b), but we will not worry about that now.

The interesting fact which emerges from this graphical experiment is that amplitude modulation involves multiplicative mixing. Merely adding instantaneous values gives simple superposition, (b), without modulation. It is seen, therefore, that the word "multiplicative" signifies something quite real, and the question is: How can a valve or other modulator perform this arithmetic operation?

The answer is quite easy, though it would require trigonometry to prove it clearly: Any non-linear circuit element, such as a valve having curvature of a characteristic or otherwise arranged to rectify, gives rise to multiplicative products of instantaneous values of two alternating voltages applied to it simultaneously.

In this sense, every rectifying device is a "multiplicative mixer," capable of giving rise to modulation if appropriate frequencies are applied. This is only repeating from another standpoint what we said earlier—every detector can be a modulator. But other complicated "products," as well as harmonics, are also produced.

It would be interesting to speculate how the sums and differences called sidebands are generated, but the writer knows of no simple physical explanation apart from fairly simple mathematics. When we come to think of it, a physical picture of how harmonics are generated is by no means easy!

But let us proceed with our graphical observations. Suppose, instead of a high and a low frequency, we have two high frequencies f_1 and f_2 which will beat. No multiplicative mixing is necessary to produce the beat effect. If we add successive instantaneous values, as we did in Fig. 3 (b), a beat resultant will be obtained directly—of the form of Fig. 2 (a) for two waves of equal amplitudes. The waves heterodyne on simple superposition; a non-linear device, detector, is required only for extracting the beat-difference, Fig. 2 (b).

Again, superimposing this beat resultant upon a carrier whose frequency is midway between f_1 and f_2, i.e., the mean frequency $\frac{1}{2}(f_1 + f_2)$, would give a true

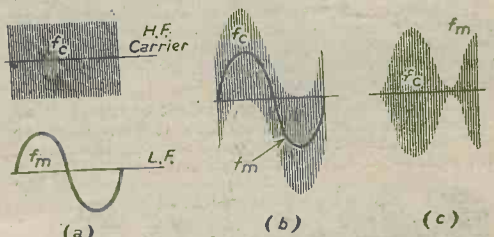


Fig. 3.—"Additive" (a) and "Multiplicative" (b) mixing of H.F. and L.F.

modulated resultant. Remember, however, that in actual modulation, the H.F. sidebands, corresponding to f_1 and f_2, must be generated in a non-linear device.

And, now, we come to the real secret of the triode-hexode mixer. Taking the same two beating frequencies again, f_1 and f_2, let us multiply the successive instantaneous values, as we did in Fig. 3 (c). There, we got a modulated resultant, but if we plotted our results in the present case, the effect would be rather surprising!

It would take the same form as Fig. 3 (b)! The beat difference (f_1-f_2) exists as a separate "L.F. component," like the modulating frequency f_m in simple superposition.

The important point is that what we get is a beat-difference. The heterodyne principle is still part of the process, but an effect like that in Fig. 2 (a) does not appear as an intermediate waveform, requiring rectification.

In other words, beating, together with the equivalent of demodulating, have been accomplished at one and the same time. No separate detection of a beat-wave (Fig. 2 (a)), is necessary. So, in a sense, a triode-hexode performs the demodulating process without anything that looks like an ordinary "detector."

Nevertheless, the mechanism is equivalent to detection. The anode current (A.C. component) is proportional to the product of the instantaneous potentials of two internal electrodes, e.g., the signal grid, and a "virtual cathode" whose potential is varying at the oscillator frequency.

In saying this, we are implying a non-linear relationship between I_a and the internal instantaneous potentials referred to. The A.C. component depends, not upon the sum, but the product of the potentials.

What it really means is that the mutual conductance (or "transconductance"), with respect to the signal grid, depends also upon the instantaneous voltage of the oscillator section. A characteristic connecting I_a and E_g will be a function also of the oscillator potential—if various values could be given to the latter while the signal grid potentials are varied, the resulting characteristic will be curved.

Meaning of "Curvature"

This brings us right back to the language of detection.

In an ordinary valve a curved characteristic between I_a and E_g simply means that the mutual conductance g_m is not constant, but varies with the grid potential. A linear characteristic shows I_a and E_g in direct proportion, and therefore g_m will be a constant.

It is because some third factor, namely g_m, depends upon the instantaneous values of grid potential that modulation by means of a non-linear device is possible. Thus, if E_g is an audio-frequency e.m.f., application of an H.F. voltage simultaneously will give an output H.F. current whose amplitude is varying at A.F., because the valve mutual conductance is already changing at A.F.

It also explains demodulation. Because of curvature the mutual conductance varies more with respect to positive H.F. cycles than the negative ones, giving a separate current component whose mean value is changing at the frequency of the amplitude variation.

In each case the mathematical explanation is the multiplicative effect previously referred to. It is merely another way of stating that use is made of some non-linear relationship. It would not be possible, of course, to use the multiplicative effect in a triode-hexode directly for detection, since it depends upon the action of the oscillator portion.

But the inherent action is equivalent to detection all the same. We have explained how it boils down to much the same thing as operating on a curved characteristic. A rather crude illustration would be to insert a rectifier in a linear tuned circuit, when the difference (f_1-f_2) would be extracted at the same time as "mixing."

It should be said, however, that a triode-hexode is more of a pure multiplicative device than any ordinary rectifier. The latter has a complex curvature which gives rise to a large number of harmonics and by-products. We should find these less in evidence in the output of an electron mixer, though the oscillator harmonics may still be troublesome if not guarded against.

The "Sum Frequency"

One component that will be found in the output of every mixer is, in addition to (f_1-f_2), the sum frequency (f_1+f_2), and this indicates a strong second harmonic output, as will be explained in a moment.

This "sum" lends considerable colour to the idea that it is of the nature of an "upper sideband," and, therefore, arises as a result of a process of modulation! The difference-frequency can be explained along well-known heterodyne principles, i.e., two waves having a continuous phase-shift (because their frequencies are slightly different), and therefore working into phase and out of phase to give the effect illustrated in Fig. 2 (a).

But how does the "sum frequency" arise? Its existence could be readily demonstrated by inserting a tuned-circuit(s) set to (f_1+f_2) kc/s., instead of (f_1-f_2) as in the ordinary superhet. This, however, is nothing peculiar to a triode-hexode. A sum frequency will be found in every case where an ordinary detector is used.

It is not anything like an upper H.F. sideband of the type (f_c+f_m). Consider first demodulation of an ordinary carrier, Figs. 1 (a) and (b). The detector generates harmonics of the carrier, so in the output circuit we might find the second harmonic of frequency $2f_c$ by tuning to it.

This is equally true in the rectification of a beat, Figs. 2 (a) and (b). There is no carrier f_c, but as mentioned earlier the resultant H.F. takes up the mid-value $\frac{1}{2}(f_1+f_2)$. The second harmonic of this is (f_1+f_2), which is our sum frequency.

It is perhaps the best demonstration that no sidebands whatever are involved!

Wind Chargers

ANOTHER method of charging, which has much to recommend it, consists of driving a dynamo or generator by means of wind sails. Although wind power in this country is apt to be rather erratic, far too much of it at times and not enough of it at others to provide any useful results, it is a notable fact that, taken over a long period, careful observations have proved that serviceable wind power is available for an average of eight hours per day in the majority of localities, if the site is carefully chosen.

The problem with wind motors is, of course, to control the variations in speed arising from extreme weather conditions, such as periods of calm on the one hand, and tempests on the other. A wind motor to be successful must be so constructed as to resist disaster in a gale and yet be sufficiently sensitive to develop useful power in winds of light or moderate velocity.

This brings us to the necessity for some definition as to what constitutes the difference between a breeze and a hurricane. The Meteorological Office has compiled a table known as "Beaufort Scale Numbers," which are attributed to winds of varying forces according to their characteristics as below:

Beaufort Scale	Corresponding Wind	Velocities in M.P.H.
0	Calm	Under 2
1 to 3	Light breeze	2 to 12
4 to 5	Moderate wind	13 to 23
6 to 7	Strong wind	24 to 37
8 to 9	Gale	38 to 55
10 to 11	Storm	56 to 75
12	Hurricane	Above 75

The indispensable parts in any such outfit comprise: (1) the constant-voltage dynamo, (2) the propeller, (3) a tailpiece to keep the propeller in the wind, (4) the collector rings for conveying current from the movable head to fixed terminal points, and (5) the mast upon which the whole is mounted.

So far as the generator is concerned there are plenty of good second-hand car lighting dynamos to be picked up cheaply.

The Propeller

Item (2), the propeller, will no doubt demand some little patience and several modifications before a satisfactory home-made article is arrived at. Lightness and strength is, of course, essential, as the centrifugal effect and thrust will be considerable at high speeds. A well-seasoned piece of straight-grained pine or cedar will be required, in one piece 6ft. long and 1½in. thick, tapering from 6½in. wide at the hub to 3½in. or 4in. at the tips, the pitch of the blades being about 35 deg. measured from the plane of rotation. The boss needs strengthening by a flanged double-arm casting, keyed to the dynamo shaft and retained by an end lock nut.

The Rotatable Head

The rotatable head with the collector rings needs planning out with a view to utilising whatever material happens to be available in the workshop, and dimensions are of secondary importance, so long as the collector is not too small, say, 3in. in diameter.

Mechanical Governor

Some attempts have been made to steady the charging current by the addition of a mechanical governor or wind-diverter, or even a small wind-vane attached to the tail to move the propeller into less effective positions with increasing force of the wind.

Electrical Circuits

Apart from details of design, the electrical circuit is similar in all outfits, and in its simplest form without any switches, instruments or other complications consists of placing the dynamo and battery in parallel.

But there must be some automatic means of preventing current from the battery discharging back to the dynamo when the latter is not running fast enough to charge. Also, switches are required to control individual lamps and an ammeter to measure the charge or discharge current in the accumulator circuit.

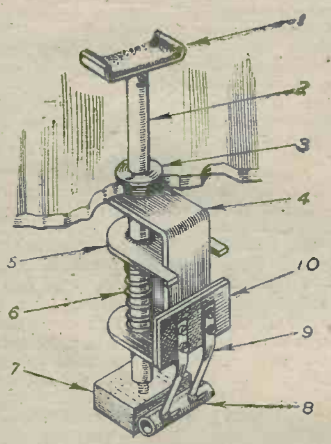
Any lighting system to be practicable must be so designed as to allow a reasonably constant voltage to be maintained at the terminals.

Practical Hints

Pickup Rest with On/Off Switch

TO make the operation of a home-built radiogram more simple, I incorporated the on/off switch in the pickup rest, as shown in the accompanying sketch.

When the pickup is placed on the



Details of a pickup rest with an on/off switch incorporated.

velvet covered rest (1), the brass rod (2) moves against the action of spring (6), thus opening contacts (8) and (9) and stopping the motor. Contact (8) is the interior of a 15-amp. porcelain connector fixed by long screws to the fibre block (7). Contacts (9) are springy brass strips, mounted on insulation (10) which also acts as a stop to the downward motion of the guide shoe (5).

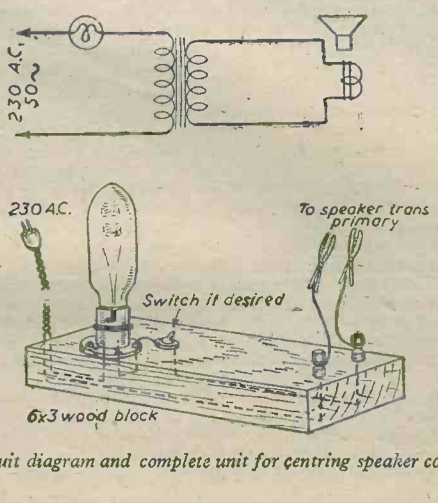
The unit is fixed to the motor board by the panel bush (3) which also holds the bracket (4).—H. J. R. TOWNSEND (Adderbury, Oxon).

Centring Speaker Cones

I HAVE devised a simple system for centring speaker cones consisting of a neon tube lamp (a small Osglim indicator lamp) which is connected in series with the speaker output primary and the A.C. mains, as shown in the sketch. When in use a low-pitched hum will be reproduced.

The speech coil centring screws should be loosened with the A.C. ripple still being heard and the centring screws tightened again. The speech coil will then be perfectly centred.

The parts used for the unit consist of a 6in. x 3in. recessed wood switch block, and a batten SBC lamp holder, toggle switch, two terminals, flex, and two small crocodile clips.—J. R. POTTS (Newcastle-on-Tyne).

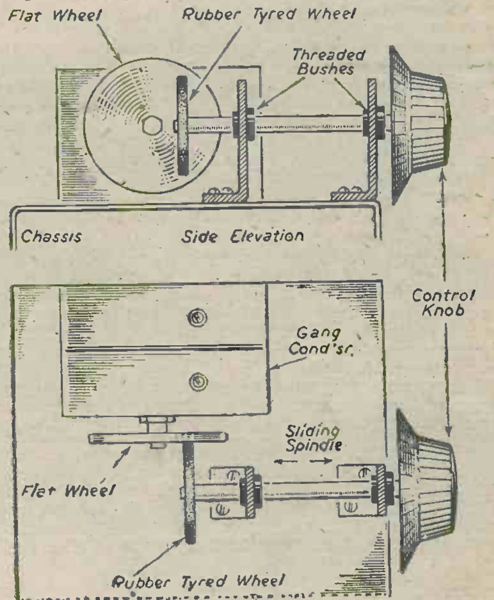


Circuit diagram and complete unit for centring speaker cones.

Variable Slow-motion Drive

THE accompanying sketches show a variable speed slow-motion drive which is gearless and has not, during the numerous times I have used it, exhibited any signs of backlash. The device incorporates a friction drive formed by a rubber-tyred wheel driving at right angles to a flat wheel which is sweated on to the driving shaft of the tuning condenser. Both wheels were obtained from a well-known mechanical toy construction outfit.

The other wheel is sweated on to a rod which passes through two threaded bushes (taken from old condensers) which are in turn supported by brackets. The rod is rubbed down with smooth emery cloth until the whole is a good sliding fit in the bushes.



Side view and plan of a variable slow-motion drive.

It will then be found that a good drive can be obtained if care is taken in the setting up of the unit. It is obvious that the ratio of slow-motion drive is decreased as the rubber-tyred wheel is pushed farther in towards the centre of the flat wheel. The wheels can be made any convenient sizes to suit individual requirements.—R. S. GRANT (Godalming).

Programme Pointers

By MAURICE REEVE

JEAN SIBELIUS, whose eightieth birthday celebration concert was broadcast from the Albert Hall towards the end of 1945, was born at Tavastehus, Finland, on December 8th, 1865. Finland was then, and until 1919, a province of the Russian Empire.

Son of a doctor and, on his mother's side, coming from a clergyman's family, he was of sturdy peasant stock. Unlike his predecessors in the founding of a Finnish national school of music, who were either settlers from North Germany or Sweden, Sibelius was wholly Finnish.

Defeating attempts to give him a classical education, he entered the Helsingfors Conservatoire. Later he went to Berlin and Vienna.

His strong nationalist individuality asserted itself immediately he started composing on his return to Finland in 1893. He had already some work to his credit, including the first of his works, "Kullervo," based on the Finnish national epic, the "Kalevala." But he never allowed this to be published.

Recognition was such that, in 1897, the State awarded him a life grant, thus enabling him to devote his time to composition free of economic anxieties.

He has visited England many times, also the U.S.A. and other countries.

His chief works are as follows: Seven symphonies; the Kalevala pieces, which include the Kullervo Symphony and the "Origin of Fire" for male voices and orchestra. The Legends, "The Swan of Tuolena" and "The Return of Lemmenkainen." Also "Pojola's Daughter." Tone poems: "A Night Ride and Sunrise," and "The Bard." A Violin Concerto and symphonic poems, "The Ferryman's Brides" and "The Captive Queen."

Not omitting Valse Triste, the two works for which, perhaps, he is most widely known, are the two nationalistic symphonic poems, "En Saga" and "Finlandia."

There are, of course, many smaller works, as well as a large number of very highly esteemed songs.

Sibelius has long been recognised as a musician of outstanding genius. If not quite of the rank of the greatest German masters, he is the equal of such masters of national idiom as Dvorak, in whose struggle for freedom of nationalistic expression he resembles at many points.

Imbued with this strong patriotic current, Sibelius's music is modern in the best sense of the word, inasmuch as whilst extremely personal and never hesitating (as in his conception of symphonic form) to be new when such a powerful and original mind would naturally strike out for itself, it is largely built on those foundations from the past which are ignored or violated at our peril.

Symphonies

The symphonies have, of recent years, held an honoured place in orchestral repertoires, and the second, than which there are few more exciting yet noble examples extant, is a close rival in popularity with the longest established classics. Few can hear the magnificent theme and the passionate climaxes without feeling that posterity will accord it a place in the direct line of succession.

All seven have been performed at the Promenade Concerts in one season, an honour they share only with Beethoven and Brahms.

Sibelius's mood is generally one of grandeur and majesty, with struggle, longing, and occasional gloom intruding. The limitless northern night and cold would seem to be typified. In this he frequently resembles Tschaikowsky. But the glittering scherzos and the seductive waltz themes, etc., of the Russian master are often lacking.

But stirring melodies abound in Sibelius, together with climaxes of the utmost thrill and intensity, whilst the throb and ardour of his Kalevala pieces would stir the pulse and quicken the imagination of all those for who music is the incomparable medium for portraying the romantic and glamorous.

In honouring Sibelius we honour not only one of the foremost musicians of our own day, but one who will unquestionably take his place in the classical repertory of days to come.

Fashions in Music

Fashions in music are an interesting subject and would be an excellent theme for an article en solo. Casting my mind back over 40 years of concert programmes, I can see certain composers and individual works passing through strange vicissitudes. Also the unfailing loyalty given to others, which transcends both political passions and musical "progress."

The present unfashionableness of Scriabine is, I trust, only temporary. This Russian pianist and composer died in 1915 at the age of 44. For about a decade later his name served as a magnet for both concert givers and goers alike. Possibly to too great an extent, he was looked upon as the quintessence of all that was best and most likely to survive in modern music.

Albert Coates used to give scintillating performances of his provocative and mystic symphonic poems, whilst pianists vied with each other for including his brilliant piano works in their programmes. Scriabine has left an indelible mark on piano literature.

But perhaps it is a combination of his regrettably early death and the glittering career, since then, of that other great Russian composer-pianist, Rachmaninow, which have tended to push Scriabine into the background to-day.

Almost uninfluenced by the contemporary Russian nationalist school, Scriabine should be due for an early and, what will be to me, a welcome revival.

Pianoforte Concertos

Amongst pianoforte concertos seldom if ever heard nowadays are those of Paderewski, Tcherepnine Pere, Scriabine himself, and an excellent burlesque of Richard Strauss. These, and probably others (I nearly omitted Rimsky-Korsakov's), could well be done, even occasionally, in preference to the lamentable and almost nauseatingly constant repetition of certain other examples these days—no names, no pack drill.

They are all very fine and, I venture to suggest, vastly superior to Tschaikowsky No. 2 and Rachmaninow No. 1, both in the repertory to-day presumably for variety's sake and "a change."

The everlasting popularity of the masterpieces of Beethoven is as understandable as commendable. This incomparable master, who, like Shakespeare, ranges over the whole gamut of human experience, is to-day, ever has been, and I trust ever will be, the biggest magnet in the concert world.

Wagner, who always has been his closest rival, has had to retire a few paces into the background through "circumstances beyond his control." Like Beethoven, Wagner is in a category quite his own, and, although still prominent in programmes, I pray that he will shortly be again to the same extent as formerly.

"Danse Macabre"

On the other hand, I do not regret seeing Saint-Saëns in eclipse. Although very fascinating and glittering,

(*Continued on page 124*)

Receiver Noises

Their Cause and Cure.

By T. FREEMAN, B.Sc.

A Programme of Noise

NEXT time you switch on the radio, tune in to a spot on the dial where there is no station, turn the volume control to maximum, set the tone control to treble and shake the cabinet sharply. If you live in a busy street and choose a hot sultry morning in summer for this unusual treatment, you will be amazed at the resulting variety programme of noise. How many different noises can you identify? Crackles, clicks,

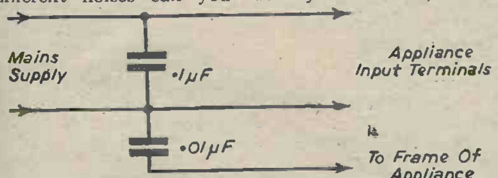


Fig. 1a.—Suppression circuit for motor interference, for use where the appliance has no direct earthing terminal.

irregular crashes, whirring, buzzing, high-pitched hum, low-pitched hum, continuous hissings—each noise has its particular cause and cure. But neither the cause nor the cure can be found unless the various noises are isolated and identified in a systematic way. To simplify matters, we first of all divide noise into two main categories according to its origin. Noise from outside the receiver is termed "external noise" and noise from within the receiver "internal noise." The set designer is not to blame for external noise, rather is it the duty of the owner to find a cure, and such a cure is usually applied outside the receiver. Internal noise, on the other hand, may often be the designer's fault and where a cure is possible it is always applied within.

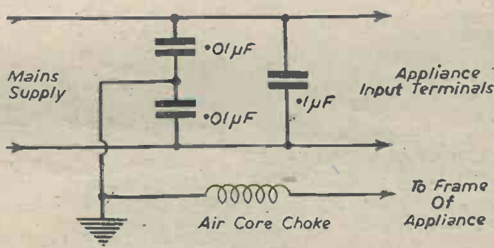


Fig. 1b.—Suppression circuit for use where earth is available.

Distinguishing Between External and Internal Noise

The first test is to disconnect the aerial and earth. If the set is a battery model, all remaining noise is almost certainly due to internal noise in the receiver itself. In the case of a mains set, however, it is not always possible to tell whether or not certain noises are being brought into the receiver via the mains supply. The simplest test is to borrow another mains set and use it in the same location without aerial or earth, noting whether the suspected noises persist. If they do, then

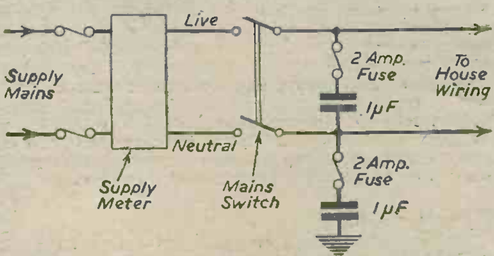


Fig. 2.—Condenser filter to isolate house wiring systems in the case of mains-borne interference.

they come into the category of external noise transferred via the power supply.

External Noise

External noise is due to voltages induced in the aerial or power supply lines by either natural or man-made sources of interference. This type of noise may enter the receiver in several possible ways; through the aerial-earth system, along the power line to the mains transformer, or very occasionally by direct pick-up of the receiver itself.

Natural Static

Radio waves generated by natural causes are referred to as "static" or "atmospherics" and produce irregular bursts of noise in the receiver in the form of rumblings and crashes. Static has its origin in thunderstorms and similar electrical disturbances. A large part of the static observed in summer in Great Britain is due to thunderstorms within a radius of a few hundred miles of the receiver, but the static observable all the year round originates in tropical regions particularly in Equatorial Africa. Static consists of electromagnetic waves in the form of sharp impulses or transients, the energy of which is distributed throughout the whole range of radio frequencies. The energy level of static is at its greatest on wavelengths in the neighbourhood of 20,000 metres and decreases steadily as the wavelength is lowered until at wavelengths below 10 metres it is barely noticeable. A great

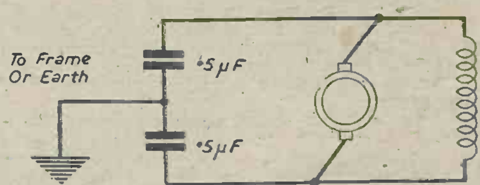


Fig. 1c.—For D.C. motors and A.C. series motors of larger size than those used in connection with domestic appliances, condensers are connected from the brushes to the frame or earth as shown above.

deal of effort has been expended in trying to devise "static eliminators" but all of these devices have been failures. There are, however, ways of considerably reducing the level of the static background in reception. One method is to use a directional aerial, but this is only successful where the static and signal arrive from different directions. Another method is to use a receiver with the narrowest r.f. response band allowable for the reception of intelligible speech. Since static is spread throughout the whole frequency range, such a highly selective receiver will obviously receive proportionally less noise than an unselective one.

Man-made Static

Man-made static is due to the interference radiated by various electrical appliances, chief of which are electric motors, vacuum cleaners, hair dryers, flashing signs, light switches, diathermy apparatus, automobile ignition

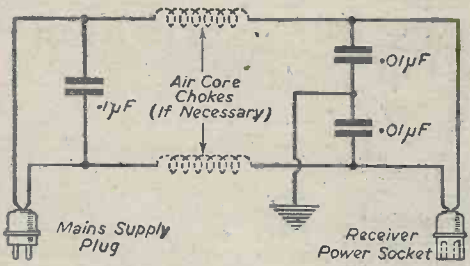


Fig. 3.—Filter for the elimination of radiated interference.

systems, electric trains, trams and trolley buses. Like static the interference waves are caused by spark discharge and are present as transients over a wide range of frequencies though the radiation is often predominant at one particular frequency.

Suppression of Man-made Static at the Source

The obvious and most effective way to cure man-made static is to trace it to its source and suppress it on the apparatus concerned.

Noise originating from rotating appliances, such as electric motors, is usually easy to diagnose, owing to the regularity and continuity of the sound. In most cases it is a rasping hum or whirring, and the receiver often responds most strongly at one particular frequency. Unfortunately, motor interference, unless inside the owner's house, is not so easy to locate unless direction-finding apparatus is used. Where it can be traced, however, one of the suppression circuits shown in Fig. 1 will provide an excellent cure. Fig. 1(a) is used where the appliance has no direct earthing terminal. Where an earth is available or a 3-pin plug is fitted to the appliance, Fig. 1(b) is very effective. For D.C. motors and A.C. series motors of larger size than those found in domestic appliances, condensers are connected from the brushes to the frame or earth as shown in Fig. 1(c).

Switches

Switches in frequent use and carrying a heavy current often arc between the contacts and give rise to loud clicks whenever they are operated. A similar source of annoying interference is the intermittent clicking due to the make and break contacts of thermostats in domestic refrigerators and water heaters. To prevent this trouble a .1 mfd. condenser in series with a small resistor should be connected across the contacts. The size of the resistor is critical, and values from 50 to 200 ohms should be tried.

Diathermy Apparatus

Ordinary suppression methods are not effective. The only practical cure on the spot is to enclose the entire room containing the apparatus with a wire mesh screen.

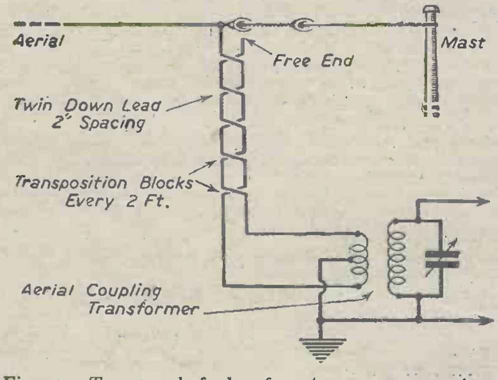


Fig. 5.—Transposed feeder for short-wave reception.

Faulty Contacts

Electrical apparatus used in the same house as the receiver occasionally gives rise to mysterious intermittent noises. Loose plugs, ill-fitting electric light bulbs, broken wires are examples of this type of fault.

Cars, Trolleybuses, Trams, Trains

All these vehicles can be readily fitted with suppressors, but there is, unfortunately, no obligation on the part of the owners to do so, and other means of suppression must be sought.

Suppression of Man-made Static at the Receiver

It is clear that man-made static, consisting as it does of high-frequency impulses, can be picked up by the aerial-earth system by direct radiation from the source, or on the other hand it can travel in the form of high-frequency currents along the power supply mains and into the house wiring system and so to the receiver mains transformer. There is, however, a third possibility which is often overlooked. H.F. currents having entered the house via the power mains can themselves radiate interference from the house wiring, which may be picked up by the lengths of aerial and earth wire within the house or occasionally by direct pick-up of the set.

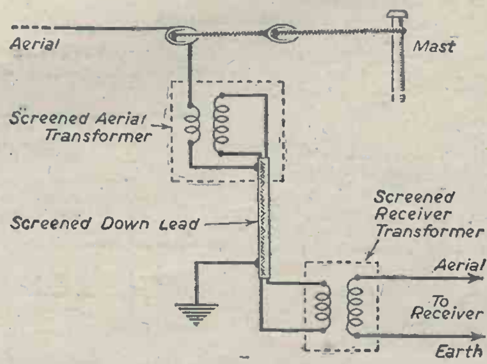


Fig. 4.—Connections of commercial "anti-static" aerial.

Mains-borne Interference

The first thing to do in a case of mains-borne interference is to isolate the house wiring system from H.F. currents in the district supply mains. This is done by means of the condenser filter shown in Fig. 2, which is mounted on the meter board. Each condenser should have a 2-amp. series fuse and very short connecting leads. The whole unit should be enclosed by a protective cover. This filter does not exclude radiated interference, which may be picked up by the house wiring and transmitted to the set, and in order to eliminate this a simple filter, such as that of Fig. 3, should be placed across the receiver power supply socket. In severe cases of mains interference it may be necessary to supplement the condenser filter with H.F. chokes in series with each power line. These must be designed to carry the full line current, and may be bulky and expensive.

Aerial Borne Interference

When noise-free operation has been secured with the aerial disconnected, any interference which still occurs when the receiver is in use must be due to pick-up by the aerial or its lead-in. The ideal remedy is to employ an aerial which will pick up signals and reject noise, but since both signal and noise are waves in space, no such aerial can exist. The only course is to compromise by erecting the aerial proper as far outside the field of interference as possible and prevent pick-up by the

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lead-in which has to pass through the field of interference. (Nothing much can be done about indoor aerials, which have a notoriously bad signal/noise ratio, except to find by experiment a more noise-free position.)

The Outdoor Aerial

The pick-up wire of the aerial system should be erected at least 10ft. clear of the house, and not lie parallel to power or telephone lines in order to prevent pick-up of re-radiated interference A high aerial will give greater signal pick-up and also freedom from man-made interference fields, which tend to spread over the earth and buildings rather than extend in a vertical direction. A horizontal aerial is usually preferable since it does not respond to car ignition interference, which is vertically polarised. The design of the down lead is of the greatest importance in the anti-interference type of aerial, and there is a choice of several systems. Commercial "anti-static" aerials consist of two matching transformers and a lead-in of screened cable connected as shown in Fig. 4. Unless exceptionally well designed multi-range transformers are used this system only gives good results on one waveband. For short-wave reception the transposed feeder shown in Fig. 5 has much to recommend it. Two lead-in wires about 2in. apart and transposed every 2ft. are used. At the aerial end one wire is left free and at the receiver the feeder is connected

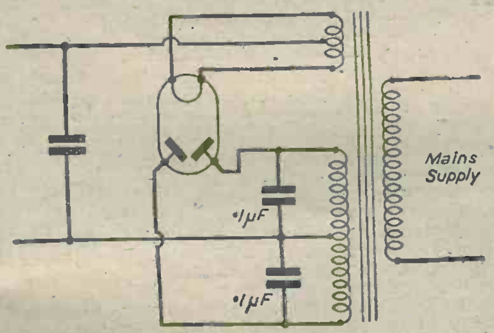


Fig. 7.—Cure for modulation hum when the rectifier circuit is to blame.

across the two ends of the aerial coil. As the centre point of the aerial coil must be earthed a slight modification of the wiring may be necessary. Interference is picked up by both lead-in wires, but the effects in each wire are equal and opposite, causing mutual cancellation of noise voltages. Another anti-noise aerial which works well on short waves is the doublet shown in Fig. 6. The lead-in can be twisted rubber lamp flex or twin coaxial cable. This aerial is particularly efficient when the length of the top is made half a wavelength.

Where trolleybuses or trams cause interference none of the above systems will be effective unless the aerial is high and well clear of buildings. If a horizontal aerial cannot be erected due to the unfavourable site, it is best to use a short vertical "sky rod" fitted to the highest point of the building and connected by a transmission line to the receiver. This type of aerial has poor signal pick-up, and should only be used where interference is exceptionally severe.

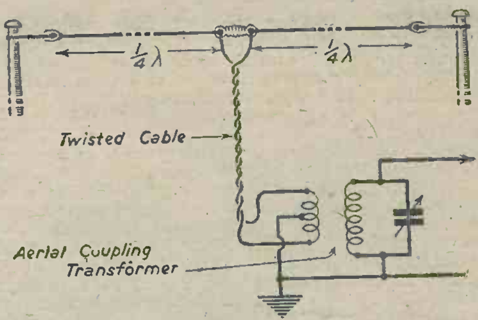


Fig. 6.—An anti-noise aerial which works well on short-waves.

Internal Noise

Having dealt with all sources of noise external to the receiver we will now consider what type of noise can be generated in the receiver itself. (Interference due to whistles, sideband splash, a simultaneous reception of several programmes and the hum caused by defective mains smoothing do not strictly come under the heading of internal noise, and will not be dealt with here.)

Modulation Hum

There is one peculiar type of high-pitched hum which will be mentioned because it is sometimes mistaken for defective smoothing or external interference. This hum is only apparent when the receiver is tuned to a strong signal which is in some way modulated by hum voltages or L.F. currents in the mains supply. If the rectifier circuit is to blame then the circuit of Fig. 7 will effect a cure. Otherwise, a mains input filter such as that in Fig. 3 must be used.

Microphony

Microphonic noise is a source of trouble which frequently occurs in amateur built receivers; more particularly in S.W. adaptors and portable sets. This noise usually consists of a low-pitched howl which fluctuates in intensity according to the output from the loudspeaker. The howling is due to acoustic feedback from the loudspeaker causing valves or other components to vibrate in such a manner that the signal currents in the components concerned are modulated by the mechanical vibration. Microphonic valves can be located by gentle tapping with a pencil and noting the character of the response from the speaker. As valve microphony is due to defective electrode structure the best course is to replace the valve, but remedies such as packing the valve with cotton wool or mounting it in an anti-microphonic valveholder may first be tried. In S.W. receivers microphony is usually caused by the vibration of the vanes of the tuning condenser or of the tuning coil

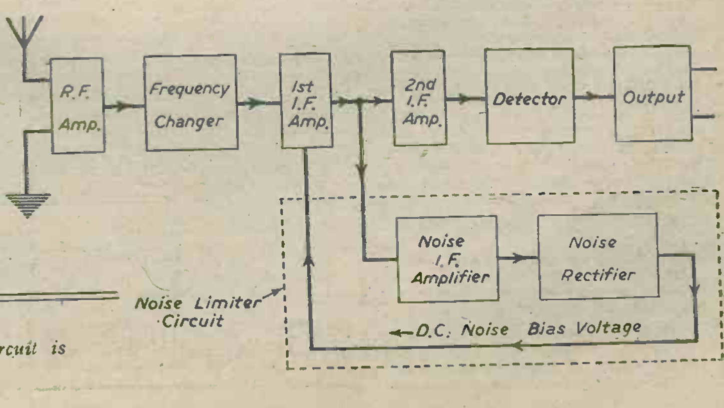


Fig. 8.—How the noise limiter circuit is introduced.

assembly. To effect a cure the whole tuning unit should be floated on blocks of sponge rubber. If this proves ineffective the speaker must be acoustically isolated from the chassis, either by means of an absorbent baffle or by mounting it in a separate cabinet.

Crackling

The individual sources of crackling noises in receivers are numerous, and only a brief survey is possible. There are, however, three outstanding causes—dirt in components, bad wiring connections and faulty components. Dust between the vanes of the tuning condenser and greasy or rusty switch contacts are distinctive examples of crackling due to "dirt." Dust may be expelled by means of a vacuum cleaner; while grease, rust or other dirt can usually be removed by soaking the components in carbon tetrachloride and wiping it dry with a clean rag. Faulty components and bad connections are not easy to trace. Prodding with a wire dressing tool will often assist in localising the fault, but if this fails the circuit must be systematically analysed stage by stage. The analysis is carried out by earthing the control grid inputs of the receiver stages, working successively from the R.F. to the output stage, until the crackling ceases. Having found the offending stage the components in it are tested individually.

Inherent Circuit Noise

The one remaining source of internal noise is that produced by atomic activity within the valves, wires and components of the receiver. From the point of view of the designer the magnitude of this noise sets a limit to the overall amplification from a particular circuit, though the source of noise is ultimately outside his control. "Inherent circuit noise" is the continuous hiss heard when the receiver is adjusted for maximum sensitivity and is markedly noticeable in multi-valve superheterodynes. It is present over the entire tuning range but rises in intensity when the receiver is brought into resonance with an unmodulated signal due to the heterodyne action between the circuit noise voltages and the carrier wave. Inherent noise is of two classes, thermal effects in the conductors and shot noise in the valves. In both instances it is usually only the first stages in the receiver that have to be considered as in later stages the signal is amplified and is much greater than any noise likely to be produced in these stages.

Thermal Noise

All wires, resistances and coils, in fact all conducting substances, contain free electrons in a state of random motion. The average velocity of these electrons is proportional to the temperature and is only zero at 0 deg. Absolute (−273 C.). Each electron in motion constitutes a minute electric current, and although the resultant total of their currents over a long period of time is zero, at any given instant there is a net current in one direction or another. These transient currents produce voltages having frequencies which extend from zero to infinity across the ends of the conductor.

Shot Noise

The other important source of circuit noise is shot noise produced by the streams of electrons flowing from cathode to anode in the valves. These electrons are emitted in groups that represent small irregular pulses of current and have an effect analogous to a rain shower on a corrugated iron roof. These pulses excite the anode circuit over the entire frequency range to which it is responsive. Shot noise is strongest in multi-electrode valves, particularly in frequency-changers where the oscillator contributes to the noise voltage.

Reduction of Circuit Noise

Both shot and circuit noise cause interference over an infinite band of frequencies. Their magnitude can therefore be lessened by reducing the response band of the receiver, i.e., using more selective circuits. The magnitude of both types of noises depends on the size of the resistance in which they are developed, making careful proportioning of the load resistances in the first stage desirable. The frequency-changer in low noise level of communication receivers should always be preceded by an R.F. stage in order to minimise the excessive shot effect in the former.

Noise Limiter

By systematic tests and careful design most external noise and all internal noise, with the exception of circuit noise, can be eliminated. There remain, however, two types of external interference which, despite all anti-noise devices, cannot be entirely prevented; namely, atmospherics and severe man-made static. It is in these cases that resort must be made to a receiver incorporating a "noise limiting" stage. This is an extra I.F. stage, where the noise is amplified like a signal, rectified and thus made to produce a D.C. voltage which is proportional in magnitude to the strength of the noise. This D.C. noise voltage is applied as a bias voltage to the usual I.F. stages of the receiver in the same way that A.V.C. is applied. A burst of noise puts a heavy bias on the I.F. valves and suppresses the signal for the few instants during which the noise lasts. As most atmospherics are of extremely short duration the programme continuity is not lost. This type of receiver suppresses severe interference by passing electric vehicles and permits broadcast reception in tropical countries where atmospherics are prevalent (see fig. 8).

Programme Pointers

(*Continued from page 118*)

and very grateful stuff for instrumentalists to play, his is not great music, and certain works of his—"Danse Macabre" always being an exception—done to death in recent seasons, can do with their well-earned rest.

His works, especially those for violin and violincello, have a sensuous charm and do not lack beautiful melodies and themes. The bowed instruments are particularly suited to bring out these qualities. But even Casals seems to have put the 'cello concerto on the shelf during his present tour. He used to play it regularly.

Fauré is being performed more than was wont, but not yet half enough. Debussy, one of music's great masters, is not amongst those subject to fashion's caprice.

The great Beethoven interpreter Artur Schnabel is with us again, and is going to do all five concerts. Possessing small hands compared to some notable pianists, but fingers of steel, he has an ideal touch for broadcasting and gramophone recording. A pre-war performance by him of the "Emperor" was one of the best I ever heard.

A word of advice regarding the volume of tone you listen-in to. Expediency, and the demands of family life apart, don't be afraid of turning it on. All the best effects, such as muted strings and quiet string playing generally, woodwind, etc., will be partially lost. And as for climaxes, they will be non-existent. After all, a hundred musicians in the Albert Hall produce a pretty big earful, and sometimes we pay the equivalent of a year's wireless licence to hear them just once. There you hear the real thing. Although we may not want the Albert Hall in our back parlour, don't cease to bear the original in mind.

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

THIS month is, so far as record releases are concerned, more like old times. I have before me a selection of 27 records; 18 12in. and nine 10in. and I shall be very surprised indeed if anyone finds any difficulty in finding one or more to suit their taste, whether he be high- or low-brow. There is one snag about a good list of fine recordings, one just does not know which not to purchase, or should I say, how to refrain from adding just another one to the monthly addition to one's record library. For most of us, our budget is the deciding factor. Nevertheless, this does not eliminate the problem of having to decide which shall be put on the waiting list. For example, in the H.M.V. latest recordings, there is a truly delightful recording by the B.B.C. Symphony Orchestra, conducted by Sir Adrian Boult, of Mendelssohn's "A Midsummer Night's Dream," consisting of the Overture (Op. 21) in three parts, and the Wedding March (Op. 61, No. 9). These will be found on *H.M.V. DB*6242-43, and I strongly recommend them for your hearing as the Overture possesses great beauty, revealing the delicate tone patterns, and the stirring majestic passages so closely associated with the master touch of Mendelssohn. The Wedding March with its delightful martial air is too well known and calls for no comment, other than for me to say that it completes two exceptionally fine records of a first-class performance by the B.B.C. Symphony Orchestra.

After hearing the above, *H.M.V. DB*6241 will tempt you to add it to your list of purchases. It is "Les Troyens" Royal Hunt and Storm, by Berlioz, recorded by the London Philharmonic Orchestra, conducted by Sir Thomas Beecham, Bart. Once again, this forms another recording of exceptional quality. In the opening, the wood wind and strings create an atmosphere of calm and peace, and then, augmented by the horns and brass, build up the tense expectation of the hunt and the coming storm, which develops with dramatic intensity.

This brilliantly descriptive phase is followed by a return to the serenity of the quiet calm following, as in nature, the fury of the tempests. The performance and recording call for special mention.

The next seven H.M.V. records have been recorded under the auspices of the British Council, and they present "Dido and Æneas" (Tate and Purcell), edited by E. J. Dent. The records are *H.M.V. C*3471-77, and in this instance brief details must suffice, as lack of space prevents anything like a comprehensive review. The orchestra is the Philharmonia String Orchestra, conducted by Constant Lambert, with harpsichord by Boris Ord.

*C*3471 consists of (a) "Overture," (b) "Shake the Cloud From Off Your Brow," the singer being Isobel Baillie (soprano). On the other side is recorded (a) "Ah, Belinda!" (b) "When Monarchs Unite," the singers being Joan Hammond (soprano) and Isobel Baillie. On *C*3472 we have (a) "Whence Could So Much Virtue Spring," and (b) "Fear No Danger"; artists, J. Hammond, I. Baillie and J. Fullerton. On the opposite side is recorded "See, See, Your Royal Guest Appears"; I. Baillie, J. Hammond and Dennis Noble (baritone).

Part 5 (*C*3473), "Wayward Sisters"; E. Coates (contralto) and E. Hobson (soprano). Part 6, "Ruin'd Ere the Set of Sun?"; E. Hobson, G. Ripley (contralto) and E. Coates. Part 7 (*C*3474), (a) "In Our Deep Vaulted Cell," (b) "Echo Dance of the Furies." Part 8 (a) "Thanks To These Lonesome Vales," (b) "Oft She Visits This Lone Mountain"; I. Baillie. Part 9 (*C*3475), "Behold Upon My Bending Spear"; D. Noble, J. Hammond, I. Baillie and S. Patriss (soprano). Part 10 (a) "Come Away, Fellow Sailors," (b) "Sailors' Dance," and (c) "See The Flags and Streamers," T. Jones, E. Coates, G. Ripley and E. Hobson.

Part 11 (*C*3476), (a) "Our Next Motion," (b) "Destruction's Our Delight," and (c) "Dances of Witches and Sailors"; Edith Coates. Part 12 (a) "Your Counsel All Is Urged In Vain," (b) "Great Minds Against Themselves Conspire"; J. Hammond, I. Baillie and D. Noble. Part 13 (*C*3477), (a) "Thy Hands, Belinda," (b) "When I Am Laid In Earth"; J. Hammond. Part 14, "With Drooping Wings, Ye Cupids."

The artists mentioned are supported by a full chorus, and great credit is due to all concerned for the exceptional recording of a work of such magnitude.

In the 10in. series, I have only two H.M.V.s, the first being a Red Label, *DA*1841 which has been recorded by Jussi Bjorling (tenor) who sings, in Italian, "La Mattinata" and "Messun Dorma (None Shall Sleep)," from Act 3 "Turandot." This is a record which all who appreciate a tenor voice of the first quality will be eager to add to the vocal section of their library. While speaking about vocals, the second H.M.V. 10in. must also be considered, as it is by Joan Hammond (soprano) singing, with piano accompaniment by Gerald Moore, "Black Roses" and "The Tryst," two songs which Miss Hammond renders in a delightful manner.

Columbia

COLUMBIA offer this month a very varied and attractive programme, and I hesitate to say which is the high-light, as each item stands to the fore in its particular class. If you fancy pianoforte recordings I strongly advise you to hear *Columbia DX*1214, on which you will hear Cyril Smith giving a splendid performance —solo pianoforte—of "La Campanella" (Paganini-Liszt), and "Triana" from Suite "Iberia." Or, if you like Gershwin's "Rhapsody in Blue" then put *Columbia DX*1212 on the turn-table and enjoy Oscar Levant (pianoforte) and the Philadelphia Orchestra, conducted by Eugene Ormandy, playing in brilliant style that ever popular rhapsody.

For those whose fancies turn to something more in the, shall we say, light classicals, there is *Columbia DX*1221, which is a charming recording by the Philharmonia String Orchestra of "Roumanian Folk Dances Nos. 1 to 7," by Bela Bartok—arr. Wilmer.

For the vocal section, might I draw your attention to the latest recording by John McHugh (tenor), who, on *Columbia DX*1224, has recorded "Liebestraum" (featured in the film "I'll Turn To You") and "Serenade" from the "Goldsmith of Toledo." In both recordings the artist is supported by chorus and orchestra under the baton of Henry Geehl.

On *Columbia DX*1223 the City of Birmingham Orchestra, conducted by George Weldon, have made a good recording of the popular "Ruy Blas—Overture," by Mendelssohn. Finally, in the 12in. series, we have another of the light cheerful recordings by Harry Davidson and his Orchestra of "Naval Three Step" and "The Ladbroke," which form Nos. 20 and 21 of Old Time Dance Series.

Albert Sandler and his Palm Court Orchestra provide a first-class light music record by their latest recording on *Columbia DB*2199. For this, "Waltz Time—Selection" forms the subject, and it introduces "The Waltz"; "Only To You"; "Little White Horse Polka"; "Break of Day" and "You Will Return to Vienna." A most pleasing record well up to Sandler's standard.

(*Continued on page* 128)

A Universal "Utility"

A Wartime Civilian Receiver Converted to A.C./D.C. Operation

THE wartime civilian receiver, in spite of its looks, has proved to be a very efficient little set. Listeners on D.C. mains, however—and there are still many of them—are unable to use the A.C. model, while the idea of using the battery version where there is a mains supply available in the house is distasteful to many people. For their benefit, the standard "Utility" receiver can be easily converted to work on direct current mains as well.

The alteration consists of removing the mains transformer, replacing the A.C. output and rectifier valves with "universal" equivalents, and adding one valveholder and a mains-dropping resistance.

The frequency-changer and I.F. amplifier valves may be retained, but the heater current taken by each of them is important. In the various choice of valves listed by the manufacturers of this set to work in these two positions, there are some with heaters rated at 6 volts, 0.2 amp, and some at 6 volts, 0.3 amp. In all other respects the valves are identical, and on A.C. supplies they may be interchanged freely. On D.C. supplies, however, all valve heaters are connected in series, and while the *voltage* of each heater may be, and often is, different, the *current* taken by each must be the same. Thus it is essential to determine the heater ratings of the frequency-changer and I.F. amplifier in the set before anything else is begun.

Resistance readings of the heaters are not very conclusive, and the actual current should be measured with a good meter reading up to at least half an amp. The simplest way is to connect each valve heater in turn in series with the meter across a 6-volt battery (two "800" cycle lamp batteries in series will do). If no meter is available, any radio serviceman will be able to make the check for a small fee.

If both heaters are found to take the same current, either 0.2 or 0.3 amp., select an output and rectifier valve having the same heater current rating from the list shown opposite.

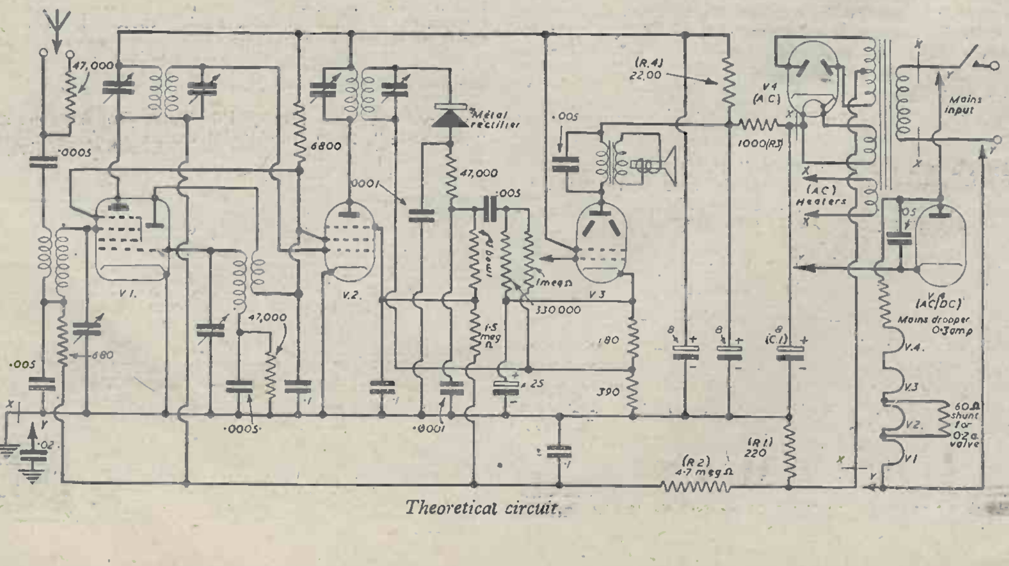
If one heater takes 0.2 amp. and the other 0.3 amp., which is quite likely, the lower-rated heater must be shunted by a 60-ohm 2-watt resistor, preferably wire wound. It may then be treated in the same way as a 0.3 amp. valve, and the rest of the circuit adjusted to this current value. The circuit diagram shows an example of a shunted heater.

	0.2 amp.	0.3 amp.
Output Valve (V.3)	Mullard CL33 (Oct.)	Osram KT32 (Oct.) American 25L6G (Oct.) American 25A6G (Oct.) (With 25A6G, incr. bias resistor to 500 ohms.)
	No change in the existing valveholder connections is necessary with any of the above valves.	
Rectifier Valve (V.4)	Brimar 1D5 (Br. 5-pin) Cossor 40SUA ,, Mazda U4020 ,, Mullard UR1C ,, Mullard CY31 (Oct.) Tungsram V20 (5-pin) Tungsram V30 ,,	Osram U31 (Oct.) American 25Z6G (Oct.)* * Strap each anode together and each cathode, i.e., as a half-wave rectifier.

A 0.3 amp. mains dropper will be suitable for either 0.2 amp. or 0.3 amp. valves. Its resistance may be worked out by adding together the heater voltages of all valves (including the shunted heater, if any, which still requires 6 volts) and subtracting it from the mains voltage on which the set is to operate. This will determine the number of volts to be dropped by the resistor; and, by Ohm's Law, the necessary resistance will be equal to this voltage divided by the heater current.

Having settled this question of the valves, remove the mains transformer completely, mounting the mains dropper, adjusted to its correct resistance, in the space now left on the chassis. (Remember this resistor will run hot, so mount it away from the edge of the chassis to protect the wooden side of the cabinet.) As the A.C. rectifier is mounted on the transformer tag panel, a new valveholder will be required, either International Octal or British 5-pin, according to the valve chosen. In most cases an unused hole in the chassis will be found (normally concealed by the transformer) in which the new valveholder may be fitted. When there is no such hole, mount the valveholder on small pillars

(*Continued on page* 128)



Theoretical circuit.

or spacers above the chassis, high enough to clear the sockets.

Remove the on/off toggle switch at the rear of the chassis and mount it in a suitable hole cut in the fibre back of the set. This is to isolate it from the chassis, which, in A.C./D.C. receivers, may be live; with the new mounting there is no danger of shock when operating the switch. Alternatively, the 1 megohm volume control may be replaced by one of the same value, but fitted with an on/off switch, so that rotation of the volume knob also switches the set.

The mains lead should be connected as shown in the diagram, one side to one switch contact, the other to the junction of R1 and R2. (Note that one side of the mains is *not* connected direct to chassis.) Join the remaining switch contact to the anode socket of the rectifier valveholder and also to one side of the mains dropper. Connect the rectifier cathode socket to the junction of R3 and C1. The .005 μF condenser shown between anode and cathode of the rectifier helps to eliminate hum.

Alter the wiring of all heaters from parallel to series connection, as indicated in the circuit diagram. The rectifier should be highest in the chain, wired next to the mains dropper, and remember that the lowest point in the chain (the earthy side of the frequency-changer heater) is joined to the junction of R1 and R2, *not* to the chassis.

A condenser of about 0.02 μF must be inserted between the " Earth " socket and the chassis, to prevent any possibility of the mains being earthed via R1. On some models a 47,000 ohm resistor is connected from the top of the 0.0005 aerial series condenser to the chassis, and this should be removed so that no D.C. connection to chassis is possible when adjusting the aerial input. The performance of the set will not be materially affected.

With the same idea of preventing contact with the metal parts of the set, a piece of mica, talc, perspex or other tough transparent material must be placed, on the inside of the cabinet to cover the dial opening and a piece of cardboard or other similar insulating sheet must cover the exposed part of the chassis under the fibre back. Appropriate holes must be made for the aerial and earth connections, but they should not be large enough to expose any part of the chassis. The grub screws in the knobs must be sunk well below the surface, and preferably sealed with wax.

If these simple precautions are taken, the set will be quite safe to operate, and has been found most satisfactory on either A.C. or D.C. mains.

New Radar Developments

USE of " television technique " marked a great step forward in the versatility of this new instrument. The use of the very high frequency technique for the detection of low-flying aircraft had made it practicable to mount the whole aerial system (now smaller because of the shorter wavelength) on a turntable and to concentrate the energy into a beam rather like a widely dispersed searchlight. This beam could sweep the horizon if necessary through the whole 360 degrees, and by suitable devices on the cathode-ray tube line, a map-like view of the scene below could be traced out in synchronism, says *Radio Craft*.

If the echo signal returned from an aircraft were made to brighten the line instead of deflecting it, the position of any aircraft encountered by the beam could be shown as a bright spot on the circular face of the cathode-ray tube which could then have a map of the surrounding terrain superimposed on it. This technique is known as P.P.I. (Plan Position Indicators).

Moreover, by other almost fantastic developments, it became possible to project the map optically, plus aircraft indications and handwritten plots—all together on a translucent screen. The dream of many commanders is realised in this—the ability to sit in a room at headquarters and actually see all the movements of hostile and friendly aircraft displayed before their eyes on a map.

The ground controller is able to note the relative positions of the enemy 'plane or 'planes as well as the 'planes under his control. By means of " vector " directions, his 'planes could then be manoeuvred directly toward the enemy. The pilots, informed when and where to expect the enemy, had a great advantage over him—so great that the small R.A.F. (Royal Air Force) was able not only to turn back vastly superior forces of Nazi raiders but to shoot down what to the Germans seemed to be altogether disproportionate numbers of them.

A still later development was the smaller AI, or Aircraft Interceptor, a short-range radar which is carried in the 'plane. The fighter receives " vectors " from his ground-control station till within AI range of the enemy, and is then directed to " flash his instrument " and proceed on his own. An ingenious adaption permits the pilot to see the image of the opposing fighter reflected on his windshield. As he approaches, the enemy image becomes broader—" grows wings." By centering the image dead ahead, the flyer approaches till the actual enemy 'plane is seen, superimposed on its own radar image. Again the advantage of knowing just where the enemy would appear gave the defending 'plane an immense advantage in the darkness, and the luckless Nazi's first warning of the presence of fighters might be a fatal burst of fire.

IMPRESSIONS ON THE WAX

(*Continued from page* 125)

Frank Sinatra, on *Columbia DB*2197, offers two film feature numbers, namely, " I Begged Her " and " I Fall in Love Too Easily."

Parlophone

NOT for a long time have I had a 12in. Parlophone record, therefore, this one, *Parlophone R*20543 is welcomed, and doubly so when I played it over. It is by Richard Tauber (tenor), and a particularly fine example of his skill and production. He sings " In Native Worth " (Haydn), from " The Creation," and " Joseph's Aria " (Mein Vaterland), by Mehul from " Joseph." The first is in English, and the latter in German. In the 10in. series, I recommend Billy Thorburn—solo Pianoforte—playing " In A Monastery Garden " and " Dearest of All " on *Parlophone F*2103.

Geraldo and his Swing Orchestra—with Ivor Mairants on the Guitar—swinging " Two Moods " and " In Charlie's Footsteps," on *Parlophone F*2105.

Ivor Moreton and Dave Kaye provide No. 68 of " Tin Pan Alley Medley," on *Parlophone F*2109, while Dorothy Squires, with Orchestra conducted by Billy Read, offers " I'll Close My Eyes " and " Let the Rest of The World Go By," on *Parlophone F*2102.

Regal

TO finish this month's review, here is one Regal record which will have great appeal to those dance enthusiasts who followed the recent All-Britain Amateur Dance Band Championship (1945), as it has been recorded by the winning band—Billy Weedon's Eltham Studio Band. They play " Two O'Clock Jump " and " Song of The Volga Boatmen." The number of the record is *Regal MR*3766.

Open to Discussion

The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

Dance Music?

SIR,—I used the word "jazz" in my letter referred to by Mr. Saunders, in the general way that it is usually thought of, when perhaps "dance-music" was the word.

"Jazz," we are told by Mr. A. McGugan, of Belfast (PRACTICAL WIRELESS, January, 1943), is a development of the folk-music of the State of New Orleans, and presumably is, or was originally, a definite musical form, as Mr. Saunders says. I can sympathise with him in wishing to enlighten the ordinary listener, therefore, and it seems he also dislikes the "anæmic music, the incessant song plugging of tuneless, uninspired musical combinations, etc.," and which seems, in my humble opinion, a very good description of the type of thing I meant to refer to, and not necessarily dance-music.

An interpretation of some of the modern compositions was made by Dr. Malcolm Sargent (and it may have included dance-music), in a recent broadcast of the Brains Trust, when he said that it represented the restless spirit of the age, and that he thought the composers had made a very good job of it.

As is probably known, a certain type of "music" has been banned here for some time, and it is an advantage, especially during our limited hours of broadcasting, to be able to listen without the risk of having to switch off in disgust, or listen elsewhere.

The enjoyment of Beethoven, Mendelssohn and Brahms, for instance, may be an acquired taste, but such music, I imagine, is "the one incorporeal entrance into the higher world of knowledge," as, we are told, Beethoven said.

Maurice Reeve is welcome back, with his interesting "Programme Pointers."—M. K. HUGGARD (Dublin).

Station Frequencies

SIR,—In reply to G. C. Bagley's request for the frequencies of W.T. stations he has logged, I hope the following will be of use in calibrating his set. I have not listed all the calls he mentioned but the list covers most of them.

In some cases the frequency I have given may not be correct, as several of the stations mentioned work on numerous channels.

CGX2, Canada, 13,000 kc/s.
ICD, Italy, 13,250 kc/s.
CUL, Lisbon, 12,535 kc/s.
EAK, Aranjuary, 13,790 kc/s.
EAW, Spain, 13,980 kc/s.
CZG7, Prince Rupert, B.C., 14,700 kc/s.
TFJ, Reykjavik, Iceland, 12,235 kc/s.
THA, Algiers, 12,120 kc/s.
SDA3, Varberg, 13,845 kc/s.
SDE3, Varberg, 13,815 kc/s.
FYJ, 15,455 kc/s.
CNR2, Rabat, Fr. Morocco, 11,940 kc/s.
FZK3, Dakar, Senegal, 15,800 kc/s.
ICA, Rome, Italy, 11,550 kc/s.
HBW, Geneva, 11,465 kc/s.
HBU3, Geneva, 11,220 kc/s.
ODK, Beirut, Syria, 10,575 kc/s.
HBO, Geneva, 10,400 kc/s.
YVR, Maracay, Venezuela, 9,147 and 18,294 kc/s.
HBJ, Geneva, 13,205 kc/s.
ICD, Italy, 13,250 kc/s.
HVJ, Vatican City, 15,120 kc/s.
ODD, Beirut, Syria, 16,075 kc/s.
CUS, Lisbon, 15,890 kc/s.

I'm afraid I cannot help as regards the American telephone station as I don't know the frequency myself, although one of these stations operates on about 29 metres.
—R. REYNOLDS (Anfield).

A.C./D.C. Amplifier

SIR,—I should like to point out that the rectifier used in the "A.C./D.C. Amplifier," described in the January, 1946, issue, should be a URIC, not a CY1, as the CY1 is only made with a "side contact" and an international octal base, not a 5-pin base as shown in the wiring diagram; the only suitable one in the Mullard range is the URIC.—G. KNIGHTS (Ipswich).

A Super without the Het

SIR,—With reference to the article in your December issue, "A Super without the Het," it can be seen that there is a great disadvantage in the employment of such a method of frequency changing described as compared with the normal arrangement. The method suggested entails the actual rectification of the input signal which is then used to modulate the local I.F. supplied. Due to this process of rectification and modulation it will be seen that if poor selectivity exists before the frequency changer, then by no amount of selective I.F. stages employed after this stage can greater selectivity be obtained. Sideband attenuation will as usual be obtained, but any interference on a neighbouring frequency to the input of the frequency changer will appear in the output.
—H. G. KING (Reigate).

SIR,—I read with interest the description of "A Super without the Het" in your December issue. Although, however, this circuit may work as a frequency changer, it is unlikely to supersede the present type as used in superhet receivers. It is obvious from the description that *all* frequencies reaching the frequency changer grid will be converted to the I.F. frequency and consequently, however selective the I.F. circuits may be, they will not remove any interfering signals which were present at the frequency changer. These signals will, in fact, be amplified with the wanted signals. No additional selectivity is therefore introduced to the set and the whole advantage of the superhet is lost. For similar reasons the system of detecting the signals and then feeding them into the frequency changer seems to be of little value. With the usual type of frequency changer there are only two frequencies which can normally be converted to the I.F., and with reasonably selective R.F. circuits preceding the frequency changer the image frequency can be so reduced in strength as to cause no trouble.

As to the use of this device in a double superheterodyne receiver, I should point out that the second frequency changer has all its tuned circuits fixed in any case; those on the input side being tuned to the first I.F., and the oscillator to the first I.F. plus or minus of the second I.F.

I should like to point out a misprint in your "Ultra Midget Battery Loudspeaker Receiver" (December issue). The 3-ohm resistor should obviously be in the common L.T.+ line and not just in the L.T.+ line for the XY valve; in addition it should have been stated that the 2v. valves were to be used, as Hivac make two series with the same numbers; differing only in the filament voltages. I would suggest, however, that the 1.4 v. types are used, with the XL and XD in parallel with each other and in series with the XY, this dispenses with the wasteful dropping resistance and takes less current from the L.T. battery. In any case, the circuit seems somewhat unorthodox to me, using a triode R.F.

amplifier with no form of neutralisation. Surely an R.F. pentode would be more suitable.—H. STERN.

International Radio Language

SIR,—In spite of the interesting arguments put forward by Mr. Dutton in last month's issue, I think most readers will agree with you about immense difficulties to be faced and overcome before there is any International Radio Language, or at least one of a synthetic nature. And is there any real need for such a language if one could be devised and perfected ?

Have we not what is an almost universally spoken language in our own native tongue . . . for there are very few parts of the world in which English is not understood and is entirely unspoken.

And as English is the native language of the two greatest commercial nations of the earth, Britain and America, its increasing use is not to be wondered at. Already, many nations are teaching English as a secondary language in their national schools, and many philologists are of the considered opinion that the English language will become the one great international language, used and understood by all the peoples of the whole world for the conduct of their external trading operations and radio communications also.

The world-wide benefits which would accrue from an international language are obvious, and its use would be the greatest safeguard against the outbreak of further wars, but if the authorities referred to prove to be reliable prophets, and English becomes the universal language of the whole world, would not the time and labour of learning any synthetic and artificial language be largely wasted ? Would not many who had gone to the trouble of learning the "artificial" language still find it very necessary to learn English as well ? Unless it was possible to get every nation to agree on a common "artificial" language and teach it in its schools, such a language could never become international at all.—R. T. HARDMAN (Birkenhead).

Sackville

SIR,—The Canadian shortwave station at Sackville uses 11 frequencies, as shown below with corresponding call letters. CKOB, 6,090 kc/s ; CHAC, 6,160 kc/s ; CHLS, 6,910 kc/s ; CKLO, 9,630 kc/s ; CHMD, 9,640 kc/s ; CKXA, 11,705 kc/s ; CHOL, 11,720 kc/s ; CKCX, 15,190 kc/s ; CHTA, 15,220 kc/s ; CKNC, 17,820 kc/s ; CHLA, 21,710 kc/s. These calls and frequencies are official and although the aerial system on some frequencies is not yet completed, I understand it is practically finished.

The European beam, which is reversible to serve Mexico, Central America and New Zealand, has five separate arrays, 6, 9, 11, 15 and 17 mc/s. The African beam, which is reversible to serve Australia and New Zealand, uses three separate arrays, 6 mc/s, 9 or 11 mc/s, 15 or 17 mc/s. The South American beam also uses three separate arrays, and is reversible to Asia and part of Australia, 6 mc/s, 9 or 11 mc/s, 15 or 17 mc/s.

The aerials are multi-element curtains of the resonant type and consist of four vertical stacks of four pairs of horizontal elements in each stack. Each element has an electrical length of one half wavelength. The vertical spacing between elements is also one half wave length. All four dipoles in a vertical stack are fed in-phase by means of transposed two-wire feeders.

I noticed the other day that one of your readers was inquiring about signals on and above 28 mc/s. The following may be of interest.

13-14.00 G.M.T., 28 mc/s., November 29th, 1945. W1AF, W2MAF, W4BN, WME, W8RTX, EA10, SUMIL, SUIMW, W4EM, W2LAF, W4BFS, WL2M, ON4X, B. Congo.

19 mc/s 15.45 G.M.T., November 29th, 1945.
ZSS, Capetown.
American Telegraph and Telephone Co., testing.

All the above were heard through a loudspeaker.—F. J. W. WALTERS (Bristol).

Sheppey Amateur Radio Club

SIR,—It is proposed to hold a meeting of the above club in the very near future, and it is the intention to publish date, time and place of this meeting in the local paper at least seven days before. All keen short-wave enthusiasts on the Isle of Sheppey, and likewise to all licensed amateurs, A.A. and fully licensed stations are invited.

The general idea is to re-form the above club on a very sound basis and, upon the return of our licences by the G.P.O. authorities and impounded apparatus, commence activities in amateur radio. Prior to the outbreak of war the club had just been formed and was getting into its stride in a real worthy fashion. Membership grew and grew and interest was keen. With the war many of us were called up under the C.W.R., R.A.F.V.R., etc. ; schemes and club meetings were "suspended for the duration."

But now so many of us are coming back to civilian life a few of us feel we would like to start the club going again.

Before the war we had a fair number of licensed stations (e.g., G3GW, G8BO, G8BJ, G8GR, G2VA, G4OU), as well as a number of A.A. stations, etc.

It is felt with confidence that the interest and practice of the hobby on this island is sufficient to warrant the formation of a fine radio society. I shall be pleased to hear from anyone interested in this subject and pass a cordial invitation to all S.W. enthusiasts (transmitting and/or receiving) to attend our first meeting to re-form the old Sheppey Amateur Radio Club.—F. G. MAYNARD (G4OU), 160, Invicta Road, Sheerness, Isle of Sheppey.

"A Cathode-ray Oscilloscope"—Correction

SIR,—There was an error in the circuit diagram of the article "A Cathode-ray Oscilloscope," printed in the November number.

The cathode of the GT1B as well as being strapped to the anode of the W42 should be joined to the C.T. of the heater winding B. Unless this connection is made the time base will not operate.

The Osram 4081 tube recommended for use with the circuit is being replaced by the Osram 4102 tube. Either tube will work in the circuit as both are electrically the same.—E. P. HARRIS (Harrow).

Condenser or Line Cord?

SIR,—In reply to David Homa's letter in your December issue, he is incorrect in stating that the power consumption in the type of circuit mentioned may be found by multiplying the mains voltage by the current taken. In the circuit to which he refers, resistance and capacity in series, the current taken will lead the applied voltage by a certain phase angle depending upon the relative amounts of resistance and capacity and upon the frequency.

The calculations briefly are as follows :—

Reactance of condenser in ohms, C in μf, f the frequency.

$$Z = \frac{10^6}{2\pi fC} \ \Omega$$

$$\text{Tangent of Phase Angle} = \frac{\text{Reactance}}{\text{Resistance}}$$

From a book of tables the phase angle may be found.

Next, the power factor for the circuit is found by looking up in the tables the cosine of the phase angle.

The true power taken from the mains is found thus :

Mains voltage × mains current × cosine of phase angle.

The power factor in such a circuit must be less than unity. The power factor (cosine of phase angle) may be directly calculated thus :

$$\text{Power factor} = \frac{\text{True Power}}{\text{Apparent power}}$$

which is the method I commend to Mr. Homa.

A full treatment of the subject can be found in any textbook on A.C. theory.—JAMES DOYLE (Liverpool).

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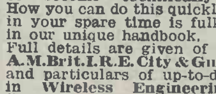

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PRACTICAL WIRELESS, February, 1946

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