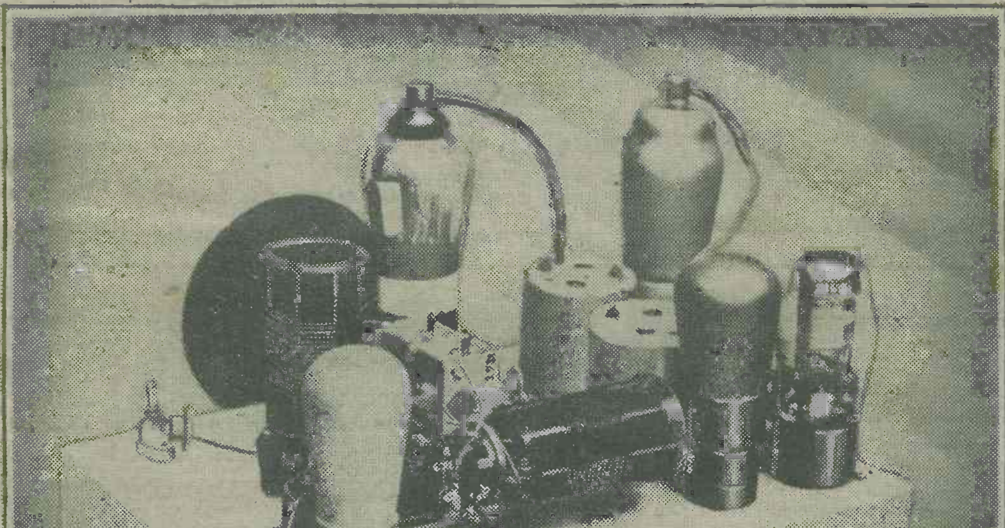
BUILDING A RADIOGRAM

Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

Vol. 22 No. 478 NEW SERIES APRIL, 1946



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SUPER QUALITY A.C./D.C. 15 w. AMPLIFIER, 3 stage, high gain, push/pull, in steel cabinet, £15 15s. 0d.

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BATTERY CHARGERS, for 2 v. batt. at ½ a., 25/- ; for 2, 4 or 6 v. batt. at 1 a., 45/- ; for 6 v. batt. at 1 a., 30/- ; for 2, 6 or 12 v. batt. at 1 a. 49/6 ; for 6 v. and 12 v. batt. at 4 a., £4.

MAINS TRANSFORMERS, 300+300 v., 60 m/a., three 4 v. 2-3 a. windings, 25/- ; 350+350 100 m/a. 5 v. 2a., 6.3 v. 2-3 a., 29/- ; 350+350 100 m/a., three 4 v. 2-3 a. windings, 29/- ; 350+350 150 m/a., 4 v. 2-3 a., 4 v. 3-6 a., 4 v. 1-2 a., 4 v. 1-2 a. winding, 39/- ; 350+350 150 m/a., 5 v. 2 a., 6.3 v. 2 a., 6.3 v. 2 a., 36/- ; 500+500 250 m/a., 5 v. 3 a., 6.3 v. 2 a., 6.3 v. 4 a., 65/- ; 425+425 200 m/a., 4 v. 2-3 a., 4 v. 2-3 a., 4 v., 3 6 a., 47/- ; 350+350 150 m/a., 4 v. 1-2 a., 4 v. 2-3 a., 4 v. 3-4 a., 36/- ; 500+500 150 m/a., four 4 v. 2-3 a., L.T. windings, 47/-.

SHORT-WAVE COILS, fit. octal sockets, 4-pin aerial coils, 9-15, 12-26, 22-47, 41-94, or 76-170 m., 2/6 each; 150-350 or 255-550 m., 3/- ; 490-1,000 or 1,000-2,000 m., 4/- ; 6-pin H.F. trans., 9-15 12-26, 22-47, 41-94, or 76-170 m., 2/6. S.W. chokes, 10-100 m., 1/3 ; 5-200 m., 2/-.

SHORT-WAVE CONDENSERS, all brass easily ganged, 15 mmfd., 2/11 ; 25 mfd., 3/3 ; 40 mmfd., 3/3 ; 100 mmfd., 3/11; 160 mmfd., 4/8 ; 250 mmfd., 5/8 ; shaft couplers, 6d. ; flexible ditto, 1/-.

MIDGET " P " TYPE COILS. 12-35. 16-47, 34-100, 91-261, 250-750, 700-2,000, 200, 557, available as H.F. trans., aerial, or osc. coils, 2/3 each. Suitable Yaxley type wave-change switches, every type available ; locators, 2/6 each ; wafers, 1/6 each. Suitable small 2-gang condensers ; .0005, 12/- ; suitable matched pairs iron-cored 465 K.C. I.F. trans., 15/- pair ; midget type, 21/- pair. Suitable 60 mmfd. trimmers, 1/- ; osc. padder 750 mmfd., 1/9.

1-VALVE BATTERY S.W. RECEIVER, with 2-volt valve, 4 coils, 12-170 m., bandspread tuning, 55/-, including tax.

CHASSIS, 10×8×2½in., 7/- ; 12×9, 7/9 ; 16×8in., 8/6 ; 20×8in., 10/6.

MOVING COIL SPEAKERS. Rola 5in., 21/6 ; 6½in., 22/6; 8in., 24/-. Goodmans, 3½in., 30/-. Above are less output trans. Plessey 8in. P.M. with trans., 29/6. Midget standard or P.P. trans. for any above, 10/6. Super quality giant Matchmaker output transformers, match any tube single or P.P. to any voice coil, 15-watt, 30/- ; 30-watt, 49/6 ; 60-watt. 59/6.

CHOKES 8H. 300 ohms, 40 m/a., 4/6 ; 30H., 400 ohms, 60 m/a., 9/6 ; 30H., 100 m/a. 400 ohms, 15/- ; 30H., 185 ohms, 150 m/a., 25/- ; 25 H., 250 m/a., 120 ohms, 39/6 ; 15H., 500 m/a., 62 ohms, 65/-.

SMOOTHING CONDENSERS. 50 mf. 12 v., 2/3 ; 25 mf. 25 v., 2/3 ; 50 mf. 50 v., 3/- ; 8 mf. 500 v., 3/- ; 16 mf. 150 v., 3/- ; 16 mf. 350 v., 3/3 ; 16×16 mf. 350 v., 8/6 ; 12 mf. 500 v., 4/6 ; 24 mf. 500 v., 6/6.

SUNDRIES. 2 mm. Systoflex, 2½d. yd. ; resin-cored solder, 6d. per coil or 4/6 per lb. ; screened 2-pin plugs and socket, 9d. ; ditto, 8-pin, 2/- ; Octal sockets, 6d. ; ditto, amphenol type, 1/-. Valve screens, 1/2. Knobs, 6d. Pointer knobs, 1/1. Crocodile clips, 4d. " Gain " and " tone " Indicator plates, 7½d. Fuses, any size, 5d. Fuse holders, 6d. 6-volt vibrators, 4-pin, 12/6. Volume controls, any value. 3/9 ; with switch, 5/-.

AMERICAN VALVES. Many types in stock at controlled prices, including 6V6, 6F6, 5Y3, 5Z4, 25L6, 75, 6K7, 6A8, 1C5, 25Z5, 25Z6, 42, 80, 1N5, 1H5, 1T5.

ENAMELLED COPPER WIRE. 1lb. reels, 16 or 18 g., 3/6 ; 20 g., 3/9 ; 22 or 24 g., 3/10 ; 26 or 28 g., 4/2 ; 30 g., 4/4 ; 32 g., 4/6 ; 34 g., 5/- , 36 g., 5/6 ; 38 g., 6/4.

REACTION CONDENSERS, bakelite dielectric, .0001, 2/9 ; .0003, 2/11 ; .0005, 3/3 ; .0003 diff., 3/3.

RESISTANCES. 360×180×60×60 ohms, .3 amp., 5/6 ; 500×100×100×100×100×100, .2 amp., 5/6 ; 40,000 ohms, tapped every 5,000 ohms, 10 w., 5/- ; ½ w., res., 6d. each ; 1 w., 9d each.

OUR 1946 LIST IS NOW AVAILABLE. All enquiries must be accompanied by a 2½d. stamp.

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Practical Wireless

and PRACTICAL TELEVISION

14th YEAR OF ISSUE

EVERY MONTH
VOL. XXII. No. 478. APRIL, 1946

Editor F. J. CAMM

COMMENTS OF THE MONTH. BY THE EDITOR

Sun-spots

IT has long been known that since the sun emits electromagnetic waves in the form of light and heat, it must also emit radio waves of extremely weak intensity. Normally, this is so feeble as to be quite undetectable on radio receivers in the 1-10 metre band. It has, however, recently been found by a British radio scientist that when there is a big and active sun-spot group on the sun, the solar radio emission can be increased up to one hundred thousand times in the 1-10 metre band, and this radio emission can then be detected by sensitive receivers on the earth's surface. It is natural to assume that these abnormal bursts come not from the sun's disc as a whole but from the localised active sun-spot area. Many present-day army receivers, particularly those used in radar, are now so sensitive that they can detect this abnormal solar emission if their receiving aerials are pointed in the direction of the sun. The effect produced on listening in headphones, or loudspeakers, is that of a hissing noise.

Recently there was a large and important group of sun-spots on the sun which could easily be seen through smoked glass with the naked eye. Since the sun itself is rotating (it makes a complete rotation in 27 days) it was calculated that the sun-spot group would cross the meridian on February 5th, and this was found to be the case, when solar noise from it was detected.

A demonstration of solar noise was arranged by Sir Edward Appleton and the Operational Research Group of the Ministry of Supply, when the solar noise was demonstrated as a disturbance on a cathode-ray screen such as is used for the delineation of radar echoes. It was also demonstrated as an audible hissing noise on a loudspeaker and on a measuring instrument which indicated the strength of the radiation. The wavelength of the receiver used was about five metres.

It has long been known that sun-spots affect short-wave radio transmission, because they cause abnormalities in the ionised reflecting layers in the upper atmosphere. We also know that when sun-spots become active first the enhanced radio noise is heard. The radiation causing this noise travels at the speed of light and reaches the earth from the sun in about eight minutes. Secondly, the radio noise is usually followed by and associated with short-wave fade-outs. These are due to the formation of an absorbing blanket underneath the Heaviside Layer, so that radio waves are strongly absorbed there. This blanket is due to a burst of ultra-violet light and causes a fade-out of from half to one hour's duration. Such fade-outs are observed only on the sunlit side of the earth.

Solar radio noise does not affect ordinary broadcast reception on the long and medium waves. This arises from the fact that just as the atmospheric ionised layers prevent such waves from escaping from the earth's atmosphere, so they prevent medium and long radio waves from being heard. It may, however, drown very weak short-wave signals.

Solar radio noise is of very great scientific interest, and a new field of scientific research has been opened up, and it is expected that scientists will start to look for it during the coming period of sun-spot activity which culminates in 1947-8. The discovery of radio noise was made by Sir Edward Appleton and Mr. J. S. Hey. Work on the subject began as far back as 1936, when Appleton analysed reports from a number of wireless amateurs about a curious hiss which they had heard on their receivers. From these reports it was concluded that the noise was due to the emission of radio waves from sun-spot areas on the sun's disc.

Nothing further was heard of this until February, 1942, when Mr. J. S. Hey found that same effect on a number of British Army radar sets in this country, and he was able to prove that the radio noise came from the direction of the sun. He further pointed out that there was a spot on the sun at that time. Since 1942 no further recurrence of the phenomenon had been noted until early in 1946, since when the hiss has been unusually intense, and again the connection with a big sun-spot group has been noted. Once again has the work of the amateur been recognised, for without the careful observation of those who drew the attention of Sir Edward Appleton to the hissing noises the important discovery might not have been made.

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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

Radio Industry Ready for Television

TELEVISION plans of the radio industry are detailed and definite, with 100,000 new television receivers scheduled for production. This means that industry is backing the B.B.C.'s plans for the resumed service to the tune of £5,000,000 in the retail value of sets on the market.

Furthermore, the firms which supplied to pre-war viewers the 20,000 sets which have lain idle since 1939 are planning to give full help in the overhaul of these sets. The aim is to have 120,000 satisfied television-owners by the end of the B.B.C.'s first year of resumed transmission.

The date of the first official programme has not been announced at the time of going to press. Manufacturers would regard an early announcement as complementary to their own plans for meeting public demand.

War Worker Receives B.E.M. Honour for Philco Factory

IN the New Year's Honours List there is a brief, factual account of the award of the B.E.M. to Mrs. Gladys L. Perman, of 40, Granville Road, Hillingdon, Uxbridge. Behind this official statement is a story of devoted service to Great Britain and her employers throughout the fateful years of war. Mrs. Perman was awarded the B.E.M. for her work as a charge-hand at the Perivale factory of the Philco Radio & Television Corporation Ltd.

Gladys Perman is 28, and her work is to supervise about 30 girls who work on a main radio assembly line.

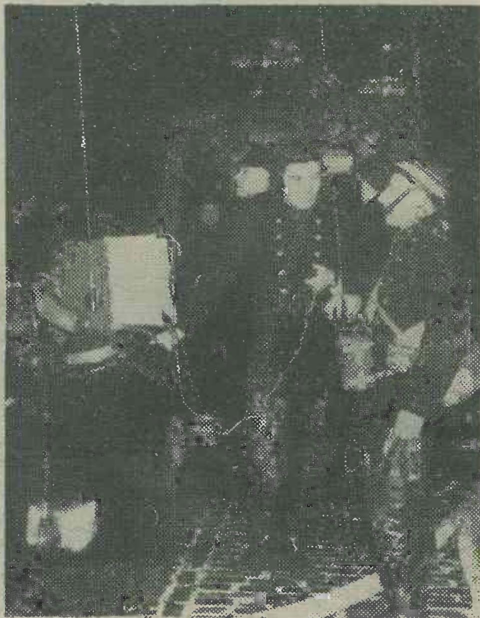
Automobile Radio-telephone

A NEW type of car radio was recently tested in America. This equipment utilises a selector dial mechanism fitted to the dashboard, by means of which it is possible to call up anyone in the town or district who is on the system. In the experiments the driver of a saloon held a conversation with the driver of a goods wagon, and both drivers were able to chat with each other and with a central station whilst cruising through the streets of Manhattan. The chief engineer of the Corporation demonstrating the device stated that it will be several years before such 'phones are generally available.

The chief engineer of the F. M. Link Corporation, testing the car radio-telephone in Manhattan recently.

Telcom Men Live in Batavia Jail

"STILL living in jail," report Cable and Wireless Telcom men, who took a mobile wireless unit to Batavia to handle press stories of the Indonesian disturbances.



Firemen in the street receiving instructions from inside a burning building by means of radio.

No other accommodation being available, the men, 20 of them from Britain, Australia and New Zealand, are in large bare rooms at the head of the line of cells. Mr. L. E. Smith, manager-engineer, occupies the jailers' quarters; nine juniors from New Zealand commandeered the condemned cell as being the largest available.

The staff have now moved the mobile equipment and are transmitting from the Public Relations Office.

B.I.R.E. Meeting

"GOLD Film Electrodes for High Frequency Quartz Plates," was the subject of a paper read by R. Spears at the London Section meeting of the B.I.R.E. on January 29th.

Walkie-talkie for Fire Brigade

A PEACE-TIME use has recently been found for the portable or walkie-talkie radio transmitter-receivers recently used by the military authorities. During a big fire at West Ham, firemen carrying the walkie-talkie entered the burning warehouse and sent out orders to the pumps in the street, thus enabling hoses to be directed to the seat of the fire and otherwise assisting in overcoming the blaze quicker than under normal conditions. The fire commander afterwards announced the experiment to be a great success.

Australians Sending Heaviest Wording from London

AUSTRALIAN correspondents in London are now filing nearly one-third of the aggregate press wordage transmitted overseas by Cable and Wireless, Ltd. Their average weekly filing is now between 300,000 and 320,000 words.

Average transmission time, from filing in London to delivery in Melbourne, of Australian urgent press telegrams in 1945 was about 25 minutes.

The average transmission times of ordinary press telegrams to Australia was about 60 minutes throughout 1945 and, except during the Christmas rush, about 50 minutes during the later months of the year.

Australian Press messages filed with Cable and Wireless, Ltd. are transmitted by the direct beam London-Melbourne (or Perth, Barbados, or Colombo relays). These wireless circuits are, of course, additional to the many alternative cable routes available.

Sun-spots and Radio

A RECENT investigation into the causes and effects of sun-spots has, according to some scientists, "opened up new fields of research." It has been discovered that the spots emit "radio noises" 100,000 times stronger than normal emissions from the sun, as a result of which forewarning of magnetic storms, fade-outs and other radio phenomena will be possible. The effects of the sun-spots are felt mainly on the ultra-short waves.

Time Signals

THE following schedule of time signals controlled from the Royal Observatory, Greenwich, will be of interest to those amateurs who require some fixed and reliable calibrating device in connection with experiments they may be carrying out. The transmissions commence with a preparatory signal consisting of the call sign repeated four times followed by a tuning note, and may be heard at 53 minutes 54 seconds. The time signal itself consists of 306 dots in 300 seconds, and the concluding dot marks the hour.

April 1st to September 30th:

09.55-10.00 ..	GBR	16 kc/s
	GIC	8.640 mc/s
	GKU3	12.455 mc/s
	GYB8	19.080 mc/s
17.55-18.00 ..	GBR	16 kc/s
	GKU3	12.455 mc/s
	GKU2	17.685 mc/s

Cheaper Rates for Phototelegrams

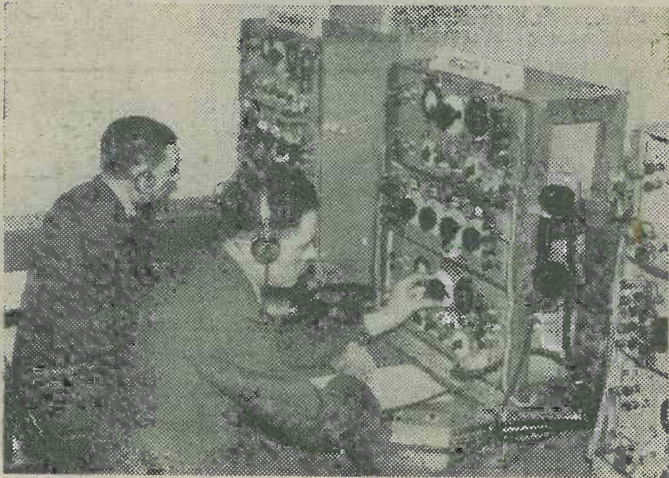
CABLE AND WIRELESS, LTD., recently announced reductions in charges, ranging from 25 per cent. to 70 per cent., for phototelegrams wirelessed from Great Britain to seven oversea Empire and foreign destinations. Lower rates now apply to the phototelegraph services with Canada, South Africa, Australia, India, Ceylon, Egypt and the Argentine.

In addition to overall reductions for social and commercial phototelegrams, specially low rates for Press pictures have been introduced for certain destinations.

Wireless Receiving Licences

THE following statement shows the approximate numbers of licences issued during the year ended December 31st, 1945:

Region	Number
London Postal	1,850,000
Home Counties	1,247,000
Midland	1,406,000
North Eastern	1,549,000
North Western	1,361,000
South Western	833,000
Welsh and Border	588,000
Total England and Wales	8,834,000
Scotland	997,000
Northern Ireland	151,000
Grand Total	9,982,000



The B.B.C. Control Room at the UNO Conference. Mr. F. W. Hills and Mr. K. C. Brown at work on the Internal Control Panel.

Radio Time Signals

POST OFFICE engineers at the Dollis Hill Laboratory have made some quartz crystal clocks which will keep time to a thousandth part of a second. The clocks are to be used to control radio time signals.

National Exhibition of Design

WITH the announcement that the Government's National Exhibition of Design, "Britain Can Make It," will be opened on Tuesday, September 24th, at the Victoria and Albert Museum, there is released a description of the plans to present selected products of British industry with an imaginative use of display methods.

The aim of the Exhibition, which is being organised by the Council of Industrial Design, is to select the best of British-made consumer goods and to show that, in peace as well as in war, the industries of this country can be supreme.

For the first time for over seven years, there will be presented a bird's eye view of the numerous developments in all kinds of furnishings, fabrics, and equipment, that will bring new comfort and convenience to millions of homes. Radio and Television will be featured in the Main Hall exhibits.

A Short-wave Preselector

An Aid to Selectivity Designed Primarily for Use with E.C. S.W. Receiver Described Last Month by G. ELLIOTT, B.Sc.

A PRESELECTOR unit is not frequently used by experimenters who employ straight battery receivers, such as the one described last month. It is true that on short wavelengths below about 50 metres, very little amplification can be obtained from R.F. stages, but this is not the only point to be considered. In general, the main benefits resulting from the use of a preselector are increased selectivity and improved signal-to-noise ratio. In the unit to be described, the use of a small amount of regeneration in the second stage gives increased selectivity, as compared with a non-regenerative stage, and also a limited amount of gain is obtainable on shorter wavelengths than usual.

The theoretical circuit is shown in Fig. 1. The first stage is untuned and acts as a buffer between the antenna and the tuned circuit of V5. The effects of damping are thereby removed, giving improved selectivity. The chokes HFC4 and HFC5 are of the same type as HFC3 in the receiver unit and should be of good quality and high inductance. Tuned-anode transformer-coupling is employed between the two stages, while choke-capacity coupling is used in the output circuit. The grid bias control for the valves is effected by the potentiometer R13 of 50,000 ohms, which should be the type having an integral switch, for the purpose of cutting off the flow of current through the control when not in use. A resistor R14 of 10,000 ohms is placed in series with the potentiometer, to ensure a minimum bias of about —3 volts on the valves. The bias is applied to the valves through the decoupling networks, R15, C22 and R16, C23, and is also taken to terminal B, which may be connected to B on the receiver unit, if it is desired to bias V1 also. It will be observed that no filament choke is used in the cathode circuit of V5. Experiments showed that sufficient regeneration was produced by the small winding L9 alone, as only a small amount of feed-back is permissible in this stage—otherwise the whole circuit becomes unstable. This is not surprising considering that the first stage in the receiver unit also employs regeneration, but to a greater extent. The trimmer C25 of 150 pf. maximum capacity, effects some control over the regeneration, but the larger part of the feed-back takes place via C26 and the coupling coil L3 of the receiver unit. The capacitor AC can be used as before, either in circuit or shorted, according to the sensitivity or selectivity required. To avoid any stray coupling with the receiver unit, the preselector should be fairly well screened, although the total screening of the unit is not really essential.

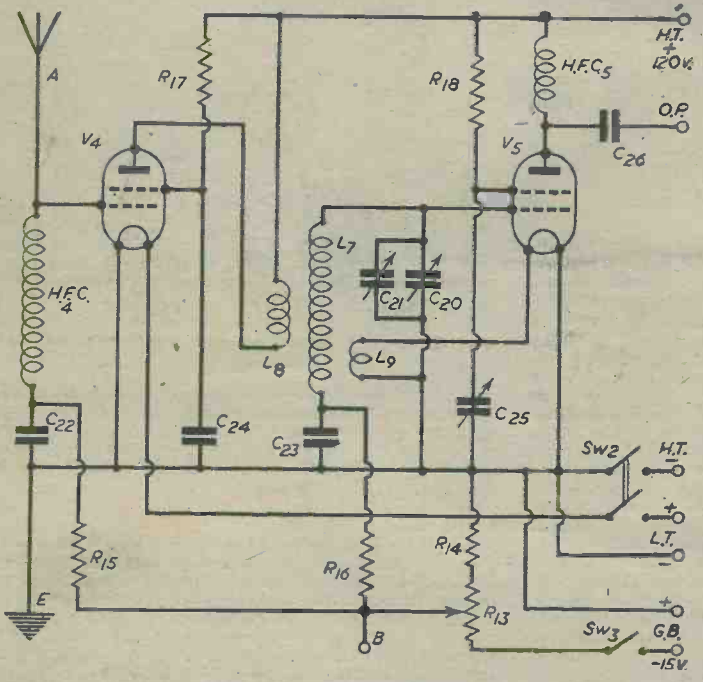


Fig. 1—Circuit of the Preselector.

VALUES OF COMPONENTS

C20 — 160 p.f.
C21 — 60 p.f. max. air-trimmer.
C22, C23 — 0.005 m.f., mica.
C24 — 0.1 m.f.
C25 — 150 p.f. max. trimmer.
C26 — 500 p.f., mica.
R13 — 50,000 Ω pot.
R14 — 10,000 Ω.
R15, R16 — 0.5M Ω.
R17, R18 — 200,000 Ω.
V4, V5 — 1A4.

Construction

With regard to the construction, the general lay-out of the main components is shown in Fig. 2. The preselector unit is quite small, and because of the difficulty in obtaining or manufacturing a small metal chassis, one was constructed from 7-ply wood. A metal panel is desirable, however, both from the point of view of screening and avoiding hand-capacity.

There is a very useful practical point to be noted in the earth wiring of both the preselector and receiver units. It is particularly applicable to metal chassis construction. There should be a single earth point for each separate stage. This can consist of a multiple solder-tag, or a number of single tags, bolted to the chassis at one point (the metal around the hole should be well cleaned). All wires at earth potential are soldered to this point, which in turn is connected directly to the earth terminal of the unit. In this way, circulatory R.F. currents in the chassis and panel, and accidental resonance of "earthed" circuits are completely eliminated. Nothing can be worse than attempting to operate a receiver with a badly designed earthing network. Accidental resonance of the wiring creates the most unpleasant effects, consisting of strong hand-capacity with relation to the so-called "earthed" parts of the receiver—the panel in particular. In these circumstances a metal panel becomes a liability rather than an asset. The earthing system described was employed in the author's apparatus, which is completely free from all hand-capacity effects over the entire frequency range covered.

A slow-motion drive on the preselector turning control is not essential, and a direct drive with a large pointer-knob and dial was used quite successfully. If slow-motion is employed, a reduction ratio of 5 : 1 is ample.

Operation

It is to be hoped that the occasional remarks about avoiding instability have not given the impression that the apparatus described need be at all unstable in use. When the receiver and preselector are correctly adjusted there is no instability whatever. A certain amount of practice in handling the controls is needed, but few difficulties should be encountered in that direction. When using the preselector in conjunction with the receiver unit, first adjust the receiver R.F. stage to resonance, by means of the panel trimmer C3 when a slight peak in reaction strength occurs, and then tune the preselector to resonance, when a peak again occurs. If the regeneration becomes too fierce, either or both of the potentiometers R1 and R13 should be turned back a little way towards their minimum positions. The author does not keep the preselector in continuous use, reception usually being carried out on the receiver unit alone, but occasionally when trouble is experienced from QRM from adjacent transmissions or from heavy static, it is brought into use. The preselector gives a very noticeable reduction in the noise level due to static and other causes. When loudspeaker reception is required, the L.F. valve, V3 is removed from its socket, and the pick-up wires from an L.F. amplifier are plugged into the grid and earth sockets of the valve-holder.

Circuit Analysis

Having described the equipment in use, there remains to discuss the advantages of the more unusual features of the design, as compared with conventional designs. First of all, the detector circuit. The electron-coupled circuit is a very efficient oscillator, as can be seen from the very small size of the coupling coil L6 to obtain satisfactory regeneration. The use of the coupling coil, as opposed to a tapping on the grid coil, is preferable as it has less effect on the "Q" of the tuned circuit. As a consequence of a very small coupling coil, the adjustment of the regeneration control has little effect on the frequency to which the grid circuit is tuned. In addition, as there is no variable capacitor in the regeneration circuit, frequency-pull due to this cause is eliminated. It is also a characteristic of the electron-coupled oscillator that its frequency stability in relation to variations in its supply voltage, is greater than for most other types of self-excited oscillators. The consistency of the calibration of the receiver can therefore be expected to be reliable, and in practice it was found that by varying the H.T. voltage between 60 and 150 volts and using different aerial systems, the changes in calibration were hardly noticeable. The main objection to electron-coupled circuits with battery valves—viz. resonance of the filament choke, has been removed by the use of a loading circuit. The R.F. tetrode forms a very sensitive detector, and high amplification is obtained by employing direct transformer feed to the anode. A good quality transformer gives the high load at audio frequencies required by this type of valve, but only offers a negligible D.C. resistance. Thus the valve can be operated at a high anode voltage. The potentiometer control gives an exceedingly smooth reaction. Comparing with the standard types of detector circuit, e.g., triode valve, with large reaction coil in anode circuit and capacity controlled reaction, the circuit described is superior in respect to frequency stability, sensitivity, tuning "pull" by reaction control, and L.F.-amplification.

Passing on to the regenerative R.F. stages, this type of circuit gives higher amplification on all wavelengths as compared with the non-regenerative circuit. A certain amount of amplification can be obtained down to about 19 or 20 metres, whereas the non-regenerative stage usually ceases to pull its weight below about 40 or 50 metres. The higher selectivity of the regenerative stage is, however, its most important recommendation. It is not generally appreciated how poor is the selectivity of the non-regenerative R.F. stage, especially on the higher frequencies. The actual band-width of a tuned circuit can easily be calculated, and taking an average short-wave tuned circuit with a Q of about 50, the band-width for a loss of 3db on 6 mc/s is 120 kc/s, and on 20 mc/s is 400 kc/s. Considering that most selectivity troubles arise from transmission spaced 5, 10 or 20 kc/s apart, this degree of selectivity is practically useless. By employing regeneration, the selectivity of the R.F. stage is greatly increased and the tuning of the R.F. trimmer control on the receiver (C3) is very sharp. This arrangement is particularly useful for removing interference from powerful local transmitters at, say, 20 kc/s distant from the wanted signal. Powerful signals

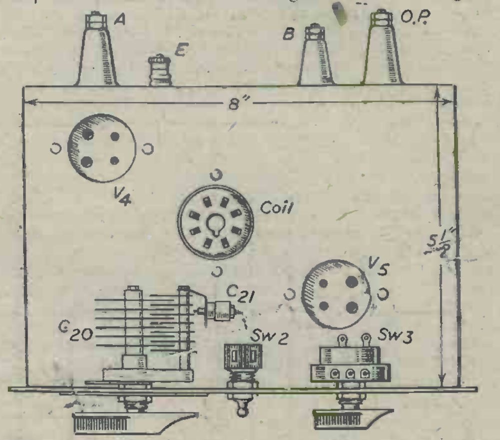


Fig. 2.—Layout of chassis and components for the Preselector.

tend to spread extensively with a non-regenerative stage. The regenerative stage is also superior with regard to signal-to-noise ratio, as it has a much narrower band-width, and so collects less noise from static and other electrical disturbances, which spread uniformly over enormous frequency ranges.

Tuning Details

The last point to be discussed is the use of single-control tuning with a precision-type dial, as opposed to the use of bandspread tuning. It may be interesting to explain where, in the author's opinion, the bandspread system fails to live up to expectations in the straight type of receiver. As far as ease of tuning is concerned, there is nothing to choose between a good slow-motion dial and a bandspread control. If bandspread is to be superior it must give greater ease of station identification by spreading out closely-packed stations, whose dial readings must remain the same over long periods of time. If there is any variability in the calibration—if, for example, a station on 9,550 kc/s is recorded at 85 deg. on the dial, and a week later it is found that another station on 9,560 kc/s occupied 85 deg.—then the whole advantage of easy station identification vanishes, and one is reduced to the usual methods for identification, by listening for announcements or pure guesswork. Calibration variations of this and higher values frequently occur in detector circuits of standard design due to various causes. Mechanical variations, such as the insertion and removal of coils, movements of wires and movements of panels will produce their effects. Electrical variations in the circuit, however, produce the greatest effects. Consider a typical bandspread detector circuit, using a triode valve, as shown in Fig. 3.

The reaction control usually has a very marked influence on the tuning of the circuit, the magnitude of the effect depending to some extent on the components used. The reaction coil L2 usually has been one-third and one-half of the number of turns on the grid coil L1, and the reaction capacitor C3 may be of 200 or 300 p.f. In adjusting C3 to bring the circuit into its most sensitive condition, the resulting variations in the tuning point on the bandspread capacitor C2 produces confusion as to which dial reading to take. C2 is frequently of 15 p.f. capacity. The influence of the reaction capacitor C3 is exerted via the inductive and capacitative coupling between L2 and L1 and via the internal anode-grid capacity of the valve. In addition, as the voltage on the detector anode decreases, as a result, for example, of the gradual running-down of the H.T. battery, the resonant frequency of the circuit for any given setting of C1, C2 and C3 will alter. Furthermore, C3 will have to be increased progressively to obtain reaction, as the H.T. voltage gradually falls, resulting in a progressive drift in the calibration of C2.

Other electrical variations include changes in capacity and insulation losses due to the deposition of dust and damp between the vanes of tuning capacitors and on their insulators, on valveholders, coilholders, and coil formers. The use of a steady H.T. voltage from an eliminator unit or in a mains receiver will remove the frequency drift due to a falling voltage, but will not cure the other troubles.

There are other objections to bandspreading in addition to the instability troubles indicated above. With a low value capacitor in parallel with the main tuning capacitor as in Fig. 3, it is found that the amount of spread obtained is not the same on all wavebands. For example, on the 13- and 16-metre bands all the transmissions are crowded together in a few degrees, and in view of the frequency variations described above, accurate calibration is not possible. On the 40- and 49-metre bands the spread may be too large, and two settings of the band-setting capacitor are required. In order to obtain more even spread on all bands, more complicated systems have been devised. The bandspreader may be connected to a tapping on each coil, which is adjusted to give the right amount of spread for individual coils, or another variable capacitor may be placed in series with the bandspreader in order to vary the amount of spread (in this case two dials have to be set before tuning is carried out on the bandspreader). Other systems have been devised for commercial receivers employing switched coil units.

As already explained, the detector circuit of the receiver described has been designed to minimise frequency variations, and all the available accuracy can be obtained by using a 4in. dial, calibrated 0-180 deg., reading to 1/10 deg. If the dial is carefully calibrated, it is possible to estimate the frequency of an unknown transmission to within 10 kc/s on most bands, and to within 5 kc/s on the lower frequency bands, such as the 49-metre band.

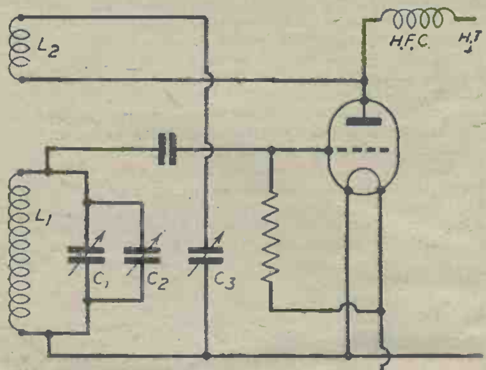


Fig. 3.—A triode bandspread stage.

Ticker-tapes and Television on Air Liners

TICKER-TAPE machines and radio-telephones for business men, with radio and television entertainment for their wives, will be among the amenities for passengers on British Overseas Airways' future air liners.

Working alongside B.O.A.C. experts engaged in planning world-wide routes are others whose first consideration is the comfort and convenience of the passenger.

These men have a mental picture of the day when a business executive on his way to the United States will receive the latest City information from a small ticker-tape machine installed at the rear of the liner's pressurised cabin (in which he is travelling comfortably at perhaps 20,000ft), and then ring up his confidential secretary in London on the radio-telephone. Or, if a radio 'phone call is not warranted, he will dictate a telegram which the radio officer on board will send for him to England in morse.

Meanwhile, his wife will probably be taking things more easily.

She may be sitting comfortably in an easy chair listening to the radio, knowing that the music she hears is no inconvenience to her husband, who is busy, or to her neighbour, who may be slumbering. Into the head-rests of her chair will be built a tiny loudspeaker, against which she simply leans her head and receives the programme perfectly, and when she is bored with listening, she will be able to switch off her own loudspeaker and read or rest as the mood dictates.

Should she be in one of the more advanced air liners, she will perhaps go to a specially-built cabin where one of the latest television reception sets is presenting the B.B.C.'s programme, or where a miniature news film is being shown.

British Overseas Airways signals experts believe that the air telegrams to England will be practicable in morse from almost any point on any world route. Alternatively, should contact with the G.P.O. receiving station in England be "out" when the aircraft are flying over, say, Newfoundland, the message will be sent to the local station on the island with instructions for its transmission to the United Kingdom.

Reception on board for the ticker-tape machine, B.O.A.C. experts foreshadow, will be possible almost anywhere in the world.

B.B.C. radio reception, too, should be possible anywhere. An additional attraction in the installation will be a "cut-in," which will enable the captain of the aircraft, or one of the crew, to broadcast for the passengers a description of the country over which they are flying, or to give them any special instructions.

Range of the radio-telephone communication with the ground will probably be 200-300 miles at first. That for television is more problematical at present, because no official announcement of possible range has been made.

But B.O.A.C. technicians know that television reception at 30,000ft. and higher is possible over a far greater distance than fireside reception.

A 5-valve Short-wave Superhet

Constructional Details of a Useful Short-wave Receiver

By F. G. RAYER

ALTHOUGH a T.R.F. receiver is very satisfactory when 'phones are to be used for listening, or when a speaker is to be used only for the more powerful stations, long-distance speaker reception is not easy with such a set. The addition of R.F. stages will improve matters, but for best results these must be tuned, and in this case it is just as simple to decide upon a superhet circuit instead. With these points in mind, it was decided to see what could be done to construct a S.W. superhet which had few complications, but which was, nevertheless, fully sensitive.

After some experiment the circuit shown in Fig. 1 was arrived at, and this has the advantage that "straight" components are used, except for the two I.F. transformers —which makes it an ideal receiver for constructors who have built T.R.F. receivers, but would like to try their hand at a superhet without excessive initial outlay.

Circuit Details

From the circuit it will be seen that a separate oscillator valve is used, and this is helpful in obtaining smooth oscillation over all the S.W. ranges. The signals are mixed in a S.G. valve to produce the I.F. signal. Variable bias is not applied to this valve, but to the I.F. stage only, and this gives ample control of gain.

As the desired frequency difference between the radio signal circuit and oscillator circuit is obtained with only a very small wavelength difference, a standard .00016 mfd. two-gang tuning condenser is used with a trimmer across the aerial section. As the tuning of the aerial section is not particularly critical this is quite satisfactory and it is easy to turn the trimmer (a panel-mounted control) for maximum sensitivity upon any part of the tuning range.

After the I.F. stage a leaky-grid detector is used for maximum sensitivity and this is followed by a R.C.C. pentode. There is no reason why a transformer should not be used to couple the output stage to the detector if desired, although there is sufficient L.F. amplification for good speaker reproduction without this.

LIST OF COMPONENTS

Resistors: Two 10,000 ohm. One each 25,000, 60,000, 100,000 ohm. .5, 2, and 3 megohm. 50,000 ohm pot.
Capacitors: .0001, two .0002, .0003, .05, three .1, 2 mfd. .0002 mfd. pre-set. 2 x .00016 mfd. S.W. variable. .000025 mfd. trimmer.
Three 4-pin and one 5-pin standard valve holders.
4-pin ceramic holder.
Coilholders and pairs of coils (Premier Radio).
Two I.F. transformers.
High-ratio reduction drive.
Flexible coupler.
Knobs and dial.
3-point switch.
Component-mounting bracket.
Two-way anchor bracket.
Two-way terminal mount.
Chassis 11in. by 8½in.
Ceramic stand-off insulated terminal.

Chassis Layout

This is shown in Figs. 3 and 5. The output, second detector, I.F. and oscillator valveholders are ordinary paxolin types mounted upon the chassis as questions of U.H.F. losses do not arise here. But the aerial coilholder and S.G. valveholder are mounted above the chassis by means of screwed rods and are of ceramic. This gives short wiring and low losses where this is wanted.

The oscillator coilholder is mounted vertically so that the coil is horizontal when inserted. The coil should be about 1in. or more above the chassis, as shown in the illustration. This method of mounting avoids the possibility of undesired coupling effects

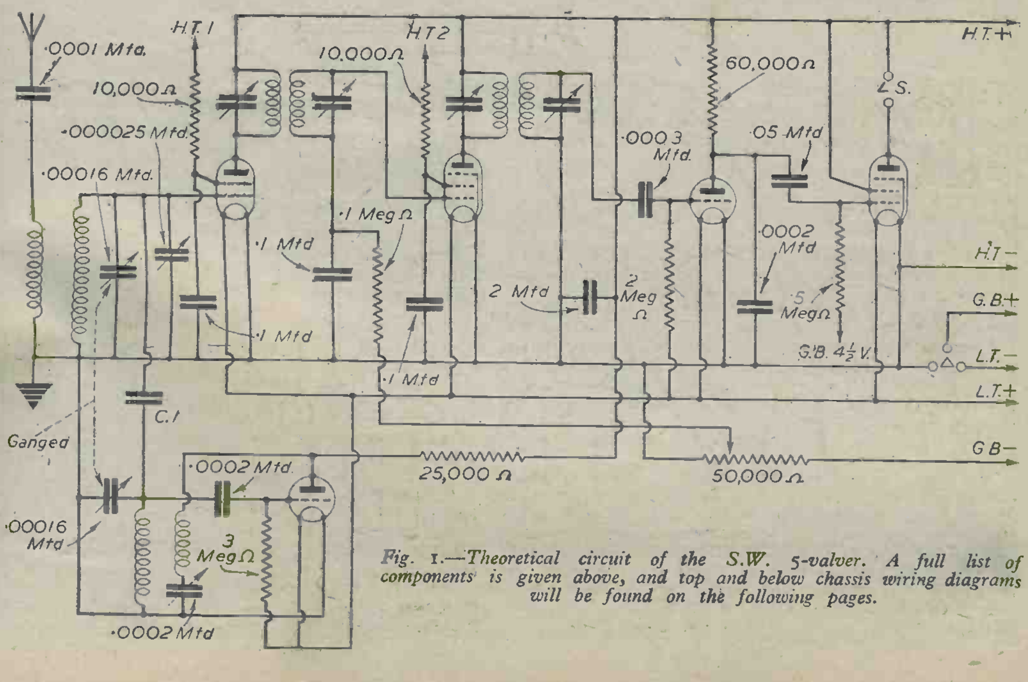


Fig. 1.—Theoretical circuit of the S.W. 5-valver. A full list of components is given above, and top and below chassis wiring diagrams will be found on the following pages.

between the coils without any screening being required.

A small stand-off insulator is used for the aerial, and a two-way insulator block for speaker connections.

The two intermediate-frequency transformers are mounted above holes so that the leads from the windings may be taken through the chassis as required. Note that both the leads which appear through the top of the cans are for anode connections to the valves, as shown.

The tuning condenser is fixed upon brackets in the position shown to shorten wiring. The reduction drive should, for preference, have a ratio of at least 50 : 1 and a 4in. diameter milled knob will also help to facilitate tuning.

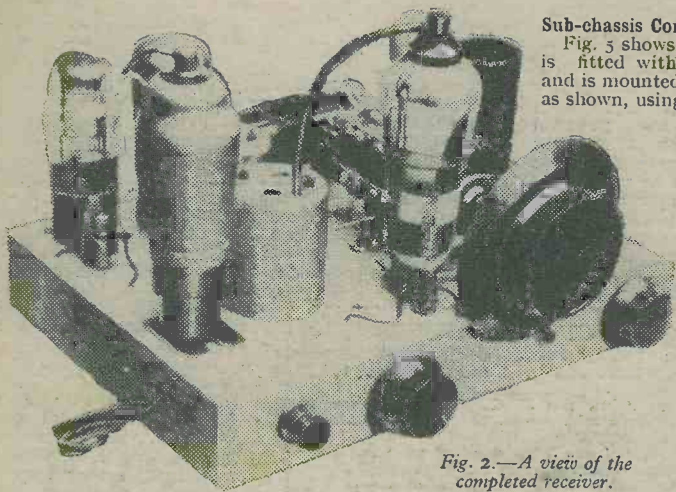


Fig. 2.—A view of the completed receiver.

Sub-chassis Components

Fig. 5 shows the location of these. The aerial trimmer is fitted with an extension spindle to shorten wiring and is mounted upon a bracket. Other parts are secured as shown, using small bolts. The on-off switch is in contact with the metal chassis, but the I.F. gain control spindle is insulated unless it has a "dead" spindle.

Near the centre of the chassis a two-way insulated anchoring tag is used to support the negative grid bias leads.

All the smaller components are suspended in the wiring, care being taken to see that they cannot touch the chassis. In some cases lengths of wire must be soldered to the resistors to enable connections to be made and insulating sleeving should be added where wires pass through the chassis or are in danger of touching other wires.

Grid leads and the wiring in the oscillator stage should be kept away from other wiring, as shown. Lengths of flex are fitted for battery leads and taken through a hole near the on-off switch.

The I.F. transformer connections should present no difficulty if they are checked as follows:—Anode leads above chassis go to the beginning of the primary windings; leads marked 3 below chassis go to the end of the primary windings. Leads marked 1 go to the beginning

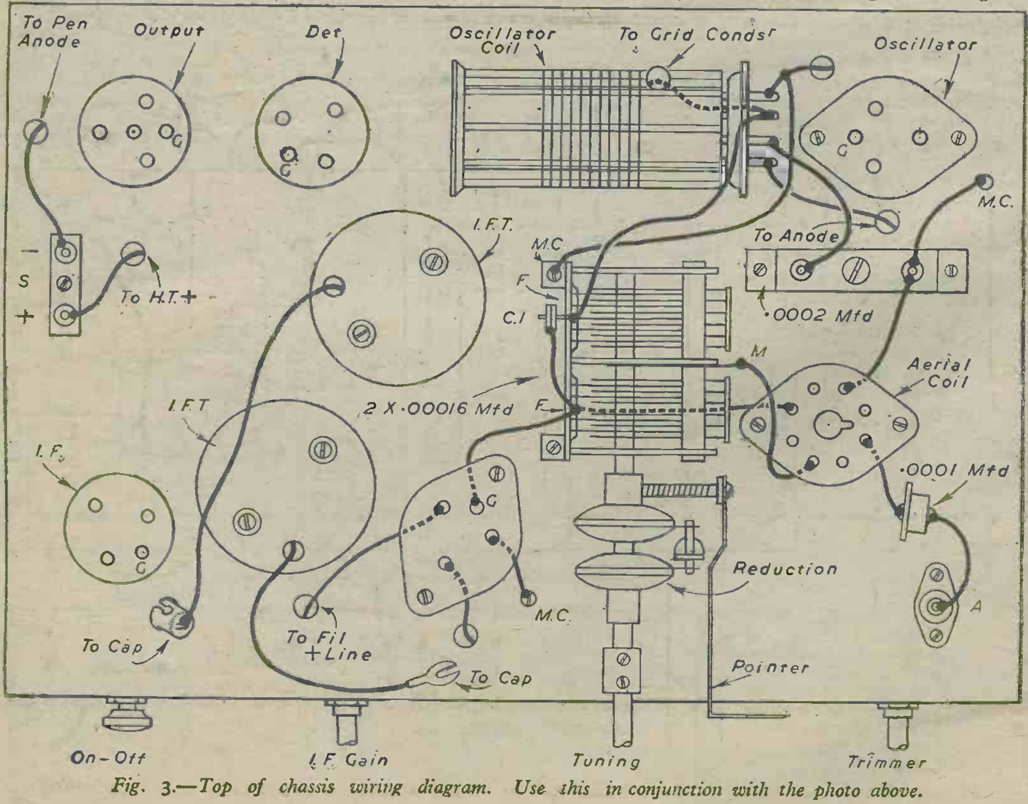


Fig. 3.—Top of chassis wiring diagram. Use this in conjunction with the photo above.

of the grid windings, and leads marked 2 to the end of the grid windings. No leads in the receiver are screened.

It will be seen that no value is shown for C1. This is made by allowing the connection from the oscillator coil to the tuning condenser to project about ¼in. through the soldering tag before soldering. A length of rubber-covered 22 S.W.G. or similar wire is now soldered to the tag of the second section of the condenser and the free end twisted three times around the projecting end. A capacitance of about .000005 is wanted, and this may be adjusted when the receiver is tried.

Operating Details

Two similar coils should be inserted in the holders. The valve types are not particularly critical, but a valve must be used in the oscillator stage which will oscillate throughout the wave-ranges to be tuned; an Osram HL2 is suitable. In the mixing stage a S.G. is required, and either a straight or V.M. type will work satisfactorily. A V.M. pentode such as the Cossor 210VPT is used in the I.F. stage. A medium-impedance detector and high-amplification L.F. pentode completes the valves.

No signals will be heard unless the oscillator is oscillating. At first the .0002 mfd. condenser should be screwed down and the tuning dial rotated until some signal is received. The I.F.T.s should then be trimmed. To do this adjust the first trimmer screw to about midway position (using an insulated screwdriver for preference). The second trimmer should then be turned to obtain an increase in volume and peaked for maximum volume. The second transformer is then treated in a like manner, e.g., turn the first trimmer for maximum volume and then the second for maximum volume. In the case of it being found that one of the trimmers is

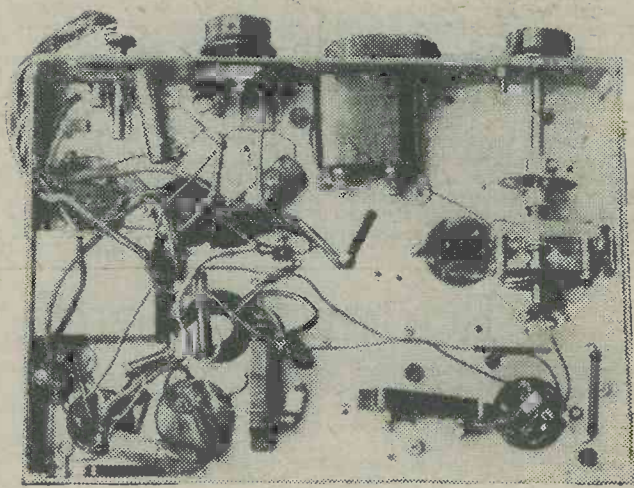


Fig. 4.—Photograph of the underside of chassis.

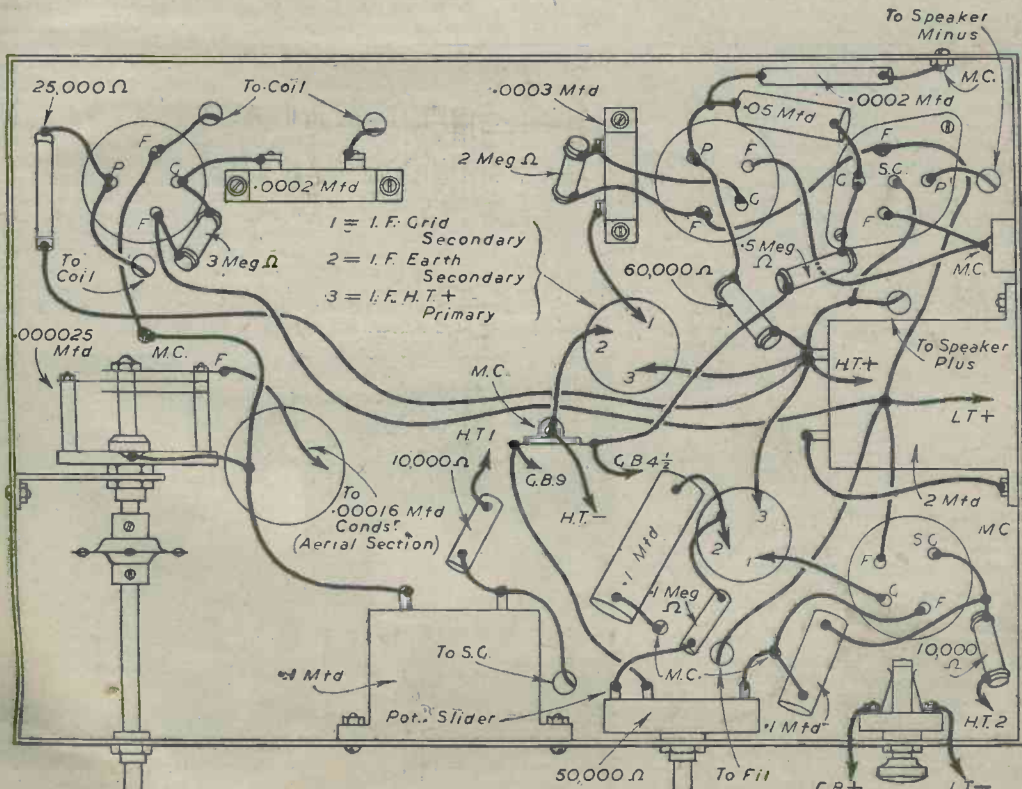


Fig. 5.—Under chassis wiring diagram, which may be compared with the photographic illustration above.

fully opened—or fully closed—without the peak being found then the first trimmer upon the first I.F.T. should be set to another position and the procedure repeated until all the trimmers can be peaked properly.

It is not necessary to arrive at any particular frequency for the I.F.T.s because the arrangement of the radio-frequency and oscillator stages permits of any normal frequency within the intermediate frequence range being generated. With a tracked oscillator, setting 110 kc/s I.F.T.s to, say, 120 kc/s would cause trouble, but with this circuit no trouble will arise, as the aerial trimmer will produce the 120 kc/s I.F. when peaked for maximum sensitivity. Trimming the I.F.T.s will cause a great increase in volume and it should be kept low during trimming by the V.M. control.

With signals coming through loudly the .0002 mfd. pre-set should be adjusted until easy oscillation (but not too violent—as indicated by spluttering noises) is obtained throughout the tuning range.

For best results C1 may require adjusting. If the capacity here is unduly small, volume will be reduced. But if too large, altering the aerial trimmer will also slightly alter the setting of the tuning condenser, due to the capacity of the oscillator section of the gang condenser being varied *via* C1. However, little difficulty should arise in arriving at a suitable value, unwinding or winding up the connection, as described, forming the method of altering C1.

With the layout as shown, no additional trimmers were required, the aerial trimmer requiring to be approximately half-way shut for maximum volume. If any additional stray capacities are introduced through running the wiring close to the chassis, or from other causes, it may be necessary to connect a small value pre-set across one of the sections of the gang condenser to permit of proper trimming.

When adjusted, the receiver should be inserted in a cabinet, so that the pointer comes flush against a scale secured to the front.

Radar in Merchant Ships

HUNDREDS of merchant ships will soon have radar—scores of liners already have it. But undoubtedly it is a mistake to think that all radar sets necessarily give a constant indication on all bearings of all dangers to navigation. The first type of Admiralty instrument was analogous to, and very like an "echometer" used for sounding the sea bed—with the complication that a manually swung steering wheel resembling that of a motor-car controlled the direction of the radio beam, and it took about a minute to examine every degree of the compass card once. It will be realised that with such apparatus on a fast pair of ships going in opposite directions and with slight necessary laxity amounting to minutes on the part of the operators, disastrous collisions might in the extreme case still occur.

The far more useful ship radar is the recently developed "PPI" (Plan Position Indicator) type, which examines all points of the compass up to four or five times a second and projects the results as a small circular "chart," with the ship always at the centre and a blindspot due to sea reflections within the last few hundred yards of the installation. This type of set gives good warning of land, aeroplanes, icebergs and floe ice, all types of sea craft, buoys, shoal water, rain squalls, or even flights of birds, continuously. Earth curvature limits range, of course—but anything of the size of a buoy or larger will theoretically appear on the screen if it is above the optical horizon of the aerial of the set, so that larger vessels with tallest radar masts will automatically have longest range.

If such map radar equipment could be watched by the navigating officers and look-outs—the latter trained as radar watchers—the extra cost over that of the earlier type would be more than balanced by the saving of expense of operators otherwise necessary as extra crew members. Watching a glowing chart carefully for echoes is, however, an eye-strain which might well lower the efficiency of the radar look-out if continued for hours by one person. Perhaps the solution lies in the automatic switching-on of the picture for five seconds or so every two minutes.

Obviously, the reliability desired of the new instruments will be of the highest. "Unit-system" building, so that a spare unit can be replaced in a matter of seconds, will be worthwhile if, under new rules, ships with radar out of action have to slow down. (The Regulations for Preventing Collision at Sea at present compel all ships to proceed at "reasonable speed" in bad visibility.) The Services achieved peak efficiency not by brilliant radar staff members—though they picked Matriculation standard candidates as radar mechanics when they could—but by specialisation.

This last will be unsound economically in most Merchant Service cases, and it seems, therefore, that the training of Radio Officers in future will have to place more emphasis on electronic apparatus servicing. In the past the rare occasions when radio gear has been out of action till arrival at port through lack of technical repair skill have seldom had drastic results. But inefficiency of servicing of radar gear, which may have to lie idle for months at a time and then face days of sudden continuous use, may have serious results or even incur heavy time-charter losses. Under the new naval ruling R.N.R. training will be given to selected members of the Radio Officer profession, but all should get standards of instruction in training at present seldom achieved. The easing of the terms of changeover from Radio to Deck Officer—only, of course, in the matter of time before elegibility for standard examinations—might result in a higher percentage of Radio Officer newcomers being good type secondary schoolboys, who at present avoid what is known in itself as a dead-end, though officer, sea appointment.

This photograph (courtesy "Daily Sketch") shows a Cossor research engineer demonstrating mercantile navigation equipment during a recent test run by M.V. "Atlantic Coast."

An Unique Radiogram

How to Build a Modern-style Radiogram Cabinet and Incorporate a Standard Receiver

By "EXPERIMENTALIST"

WHY not build your own radiogram? The ultra-modern cabinet illustrated at Fig. 1 need not worry you, as it has been specially designed for the amateur woodworker possessing only a few wood-working implements, such as a saw, hammer, chisel, brace and ⅜in. dowel bit, a smoothing plane, glue, glass-paper block and strong, medium and fine grades of glasspaper.

With regard to wood, ordinary deal shelving and flooring boards suffice. This wood, of course, can be stained and polished mahogany, walnut, oak, ebony, etc., as preferred. No plywood is necessary. The only fittings consist of six 2in. brass butt hinges, a lid stay and the handles, although the latter can be easily made from wood.

The cabinet, needless to say is a good, strong, solid one. There is nothing "utility" about it. And you do not have to build a special radio set for it. The cabinet is, in fact, a disguise for an existing receiver, possibly a model you are tired of looking at, or one which is not too attractive.

The cabinet will house most battery sets and mains sets in the compartment provided, this measuring 22½in. long by 17in. high by 15in. wide. A large Mullard superhet mains-operated receiver is shown in the compartment at Fig. 3.

The Gramophone Motor

The cabinet also takes a large, powerful, double-spring Garrard gramophone motor, having a 12in. face plate and turntable. It is quite likely that you will be able to pick up a second-hand motor cheaply at a store. The writer managed to buy a "Junior E" Garrard model, complete with nickel-plated face plate, automatic stop, turntable and a handle. And whilst almost any kind of motor can be fitted, the one mentioned is ideal for the cabinet.

The cabinet possesses three compartments for 8in., 10in. and 12in. records. Each compartment takes about two dozen discs. The cabinet is backless, at the lower compartment, so the receiver can be easily plugged into the mains supply socket in a wall skirting. This cuts out the need for plywood backing and also enables the doors to be kept closed after the set is switched on. Incidentally, the doors can be constructed in three simple ways and you can adopt the method best suited to yourself.

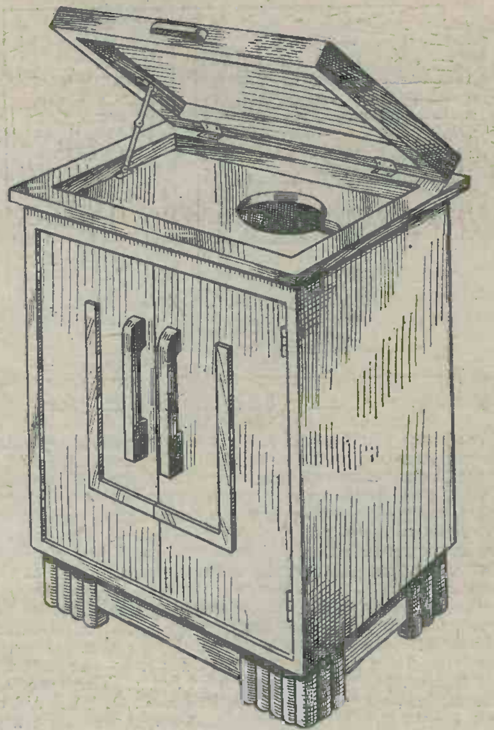


Fig. 1.—The modern cabinet, polished and ready for the radio set and gramophone fittings.

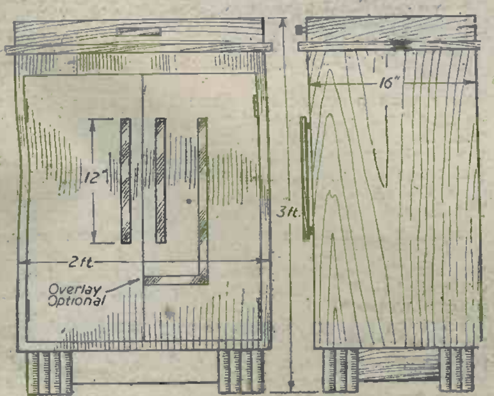


Fig. 2.—A plain front and side elevation, showing overall sizes.

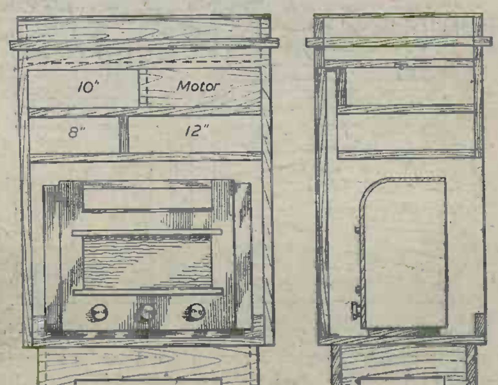


Fig. 3.—A stripped front view, with sectional side view.

Carcase Construction

The sides of the carcase are prepared first. To make up the width (16in.), two 8in. wide by ⅞in. thick planed boards—or one 10½in. wide length of shelving and one 5½in. wide length of flooring — are either rub-jointed or dowelled together. In the former case, the edges of the

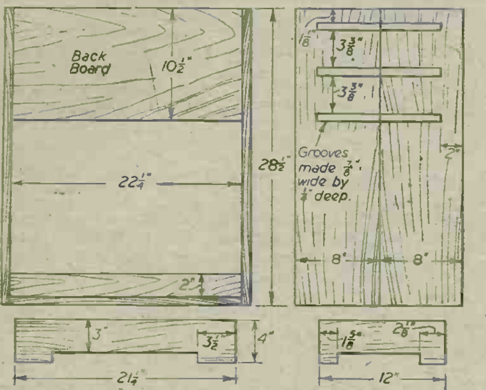


Fig. 4.—Detail of back, sides and base pieces.

boards are planed dead straight and square (a try-plane is necessary or a finely-set iron jack-plane), the widest board being finally clamped in a vice, planed edge uppermost, then both joining edges coated with thin, hot glue, brought together and the excess glue pressed out by rubbing the boards together from side to side, keeping them even with the fingers. Such a joint, properly done, becomes stronger than the unjoined parts of the boards.

You need two sides. When the glue sets, the sides are cut and trimmed exactly 28½in. long, following which the joint is levelled with a smoothing plane. Grooves for the three shelves are routed across the interior sides to a depth of ¼in., as shown at Fig. 4. These grooves are made by setting them out in pencil, with the aid of a set square. The width is cut with a small tenon saw. The grooves are stopped 2in. at the ends inwards. You could, however, make them run right to the back edge, then plug them in 2in. with ¼in. wood. By doing so, the cutting of the grooves with a tenon saw, and the removal of the waste wood with a chisel or a router, will be more convenient. A simple alternative to all this

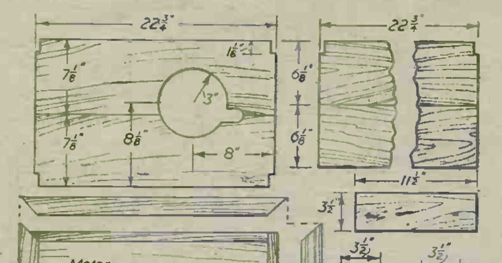


Fig. 5.—Motor board, shelves and divisions, with top plan.

work is merely to pencil the motor board and shelf positions on the sides and attach these parts (like the bottom piece) between the sides with glue and 2in. oval nails.

Bottom, Shelves, Etc.

If the latter method is adopted, the ¼in. long tenons cut on the ends of the motor board and shelves (see Fig. 5) need to be removed. The motor board, of course, is built up to width from ⅞in. wood, this also applying to the bottom piece and the shelves, the former measuring 22¼in. by 16in.

Having cut the motor aperture in the motor board with the aid of an 1¼in. centre bit and a keyhole saw, the parts are assembled together with glue and nails. The heads of the nails require to be punched slightly and the resultant holes stopped with plastic wood or a wax cement.

The back board and back edging strip (see rear view at Fig. 4) are attached to be flush, including a top, front 2in. wide piece (see sectional end view, Fig. 3). Try to have the ends of all horizontal members cut and trimmed dead square and to the exact length, thereby avoiding faulty joints.

The shelf divisional pieces detailed at Fig. 5 are affixed between the motor board and shelves as shown at Figs. 3 and 6. When attached, run over uneven

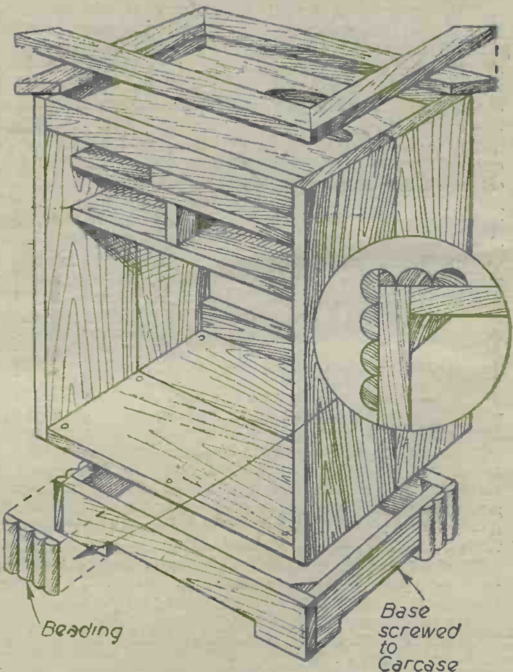


Fig. 6.—A helpful constructional view.

joints with a smoothing plane then attach the top ledging upon which the lid rests. This consists of 1¼in. wide by ⅞in. wood cut to form a mitre at the corners; the ledging is kept flush at the inside and thus projects ⅜in. all round, as shown in the top plan, Fig. 5.

The Base

The base parts are shown at Fig. 4, two of each shape being required. Cut all four from ⅞in. wood and glue and nail neatly together. There is no need to sink the nail heads as you will cover these with beading strips of wood.

Refer to the constructional view at Fig. 6. Note that the end base pieces go between the front and back pieces. When glued and nailed together, see that the work is square, then glue corner blocks to the inside.

The beading is made from strips of wood 1in. wide by ½in. thick. Four pieces 3ft. long are cut out and one side made semi-circular with the smoothing plane, then thoroughly glass-papered. The strips are cut 4ins. long.

Glue and panel nail the four front strips to the feet at the front first, as shown in the inset detail at Fig. 6. The side strips consist of two and a half strips each, with three strips each at the back feet. All this is clearly shown in the constructional view.

The Doors

As previously mentioned, the doors can be constructed in three different ways. One method is to make the

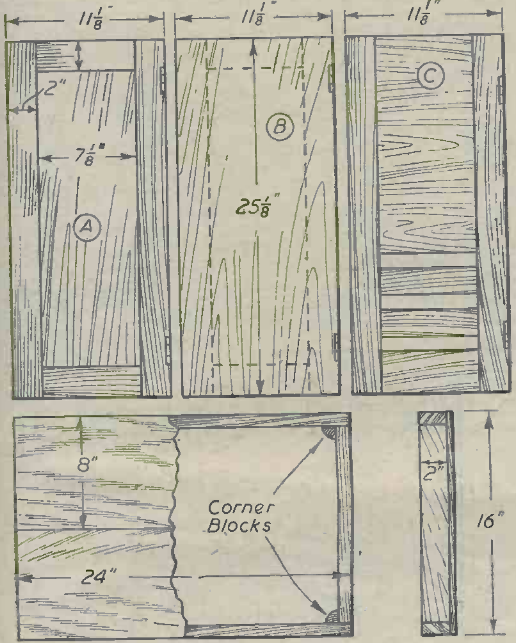


Fig. 7.—The doors and top plan of lid.

stiles (uprights) and cross-rails from 2in. by ⅞in. stuff, the parts being bored for ⅜in. dowelling and grooved *afterwards* for a ¼in. thick panel. Having inserted the dowel stumps into the ends of the cross-rails, the latter are affixed to one upright, the panel inserted, then the opposite upright fixed on and the framework cramped, or malleted, home and tested for squareness.

The two panels required can be obtained from a single board of shelving material, such as 1in. thick unplaned stuff. The board will need to be taken to a machine-shop to be circular-sawed in half, then rotor-planed to a finished thickness of ¼in. If planed board (which is usually ⅞in. thick) is used, the resultant thickness of the panels may be 3/16in. or ⅛in. thick. A good piece of timber should be selected, free from "heart" and black, loose knots as much as possible.

The above remarks apply to the panelled door, A. A much simpler door is B. This consists of a framework made from ⅝in. thick wood, the stiles and cross-rails being either assembled by dowelling or half-lapping and screwing. The panel required is longer and wider than that needed for the door A. The best plan here is to use ¼in. fretwood, or have this machined from deal boards, using two pieces which are planed for rub-joining together. The panel is ultimately glued and nailed upon the framework.

The door, C, is the easiest one to construct. It also, by the way, provides three "louvres" so the doors, when shut, will in no way "baffle" broadcast items. As can be seen, the door consists of two uprights, three cross-rails and an extra wide cross-rail piece. The uprights are 2in. wide by ⅝in. thick.

The bottom cross-rail is 3in. wide, while the two upper cross-rails are 2ins. wide. The topmost cross member requires to be made up from two widths of material. The best plan is to rub-join, or dowel, two boards together to make up the desired width of 15⅛in. The lengths of the boards should be 15in. The wood, cut across the centre, provides the two portions needed for making both doors.

The pieces must be neatly planed at the ends to measure exactly 7⅛in., this being the finished length of the three narrower cross-rails. It is only a matter of dowelling the uprights to the cross members, following which the joints are levelled with the smoothing plane at both sides.

Fitting the Doors

Having carefully fitted both doors in position, 2in. brass butt hinges are sunk in the stiles to be almost flush, then the doors hinged to show a ¼in. break, i.e. they sit in ¼in. all round (see view of finished cabinet)., The doors require to be stopped, at the inside, with small squares of thin wood, as may be seen in the sectional side view.

The left-hand door should be fitted with a hook and screw-eye at the inside. A ball-catch should be sunk in the closing edge of the same door, with the socket plate in the other door, or vice versa. The ball-catch is fitted by merely boring a ⅜in. hole about ½in. deep and tapping the ball-catch in with a mallet or hammer. The socket plate needs to be sunk to lie flush in the closing edge of the other door.

The Lid

A top view of the lid is shown at Fig. 7. Having built the framework from 2in. by ⅞in. stuff, add the top, this being ¼in. fretwood rub-joined together, then glue corner blocks at the inside.

Sink two 2in. brass hinges at the back edge of the lid and attach with screw to the carcase to be in alignment with the rest of the structure. A brass lid-stay is attached to one side to keep the lip open, as shown.

The Finish

The finish should not be applied until the gramophone motor and its accessories, plus the lid and door handles, have been fitted and removed. The door handles can be cut to shape from ½in. wood, or ¾in. thick stuff; they are attached by driving screws into them via the back of the doors.

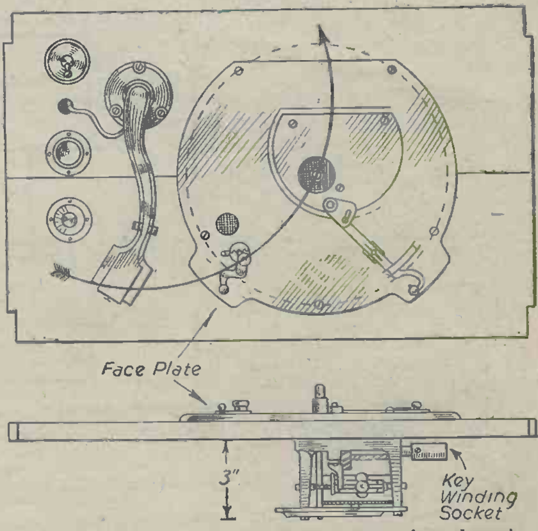


Fig. 8.—How the gramophone motor face-plate is mounted on its board, with approximate position of pick-up, switch and needle holder cups.

See that the wood is smoothly glass-papered and that all nail holes and slight crevices in joints, etc., are filled with stopping. Have the glasspaper wrapped around a flat piece of wood or the proper glass-papering cork. You will only dub over edges and produce a rather amateurish job if you merely rub the wood with pieces of glasspaper, held folded in the fingers.

As deal is soft and the grain easily raised with the use of a water stain, use a spirit stain, or, alternatively, go over the wood with a damp cloth first. This will raise the grain. Rub it down (when dry) with glasspaper to be smooth again and apply your spirit stain.

When the stain dries burnish the surface with a piece of hessian, then brush on a thin coat of french polish. Give a second coat, allow to dry, then rub it lightly with a "flour" grade of glasspaper. Dust off and apply a third coat of polish, using a soft mop, or, if you prefer, the proper polishing pad. There is more to it than this, but you should get fair results if the finishing is carried out as explained. The interior of the cabinet, such as the shelves and receiver compartment, needs only to be stained.

The Motor and Pick-up

The gramophone motor face plate is attached with flathead screws so the spindle is central with the motor board. The key winding socket may not clear the underside of the board, as shown at Fig. 8, and to enable it to do so, extra washers can be inserted between the motor and its plate.

The correct position for the pick-up is found individually. The approximate position is shown in the top view, Fig. 8. Note that the base of the pick-up is so placed that, when the arm is swung round across the turntable, the needle is in line with the motor spindle (follow the arrows).

Most large mains-operated and battery-operated radio sets are fitted with gramophone sockets and a change-over switch. Thus, it is only necessary to lengthen the pick-up leads and fit them with plugs for insertion in the receiver sockets ; no motor board switch is necessary. It is easy to reach in behind the set—when the latter is tilted forward—and flick down the switch lever to cut out the radio circuit.

If the set is not fitted with sockets and a switch, it is a simple matter to introduce such a feature. Purchase a valve-holder adaptor and insert it in the detector stage of the set, the terminals on the adaptor serving as pick-up terminals. It is only necessary to remove the detector valve, insert the adaptor, then replace the valve.

One wire runs from the pick-up to one of the adaptor terminals. The second wire runs from the pick-up to the switch (on the motor board) and from the switch to the second terminal on the adaptor. One could fit a change-over switch so that, if necessary, an extension microphone (or loudspeaker, such as a moving-coil type, which serves as a mike) can be brought into use.

The Short-wave Frequency Changer

An Explanation of Some of the Various Superhet Schemes for S.W. Working.

In any superhet receiver an efficient frequency changing stage is most important, and with a short-wave set this is especially so, as towards the high-frequency end of the tuning range the frequency changer may even cease oscillation. When this happens, the receiver will not function, and so for reception on wavelengths below 12 metres or so careful attention must be given to this stage.

Because of this it is intended to consider some of the more usual types of frequency changers used in S.W. sets, together with means of getting them to operate satisfactorily.

Converter-type Unit

The simplest frequency changer circuit is shown in Fig. 1. Although this has certain advantages—such as the simplicity of operation and the ease with which it will oscillate upon even U.S.W.—it is little used to-day. The I.F. is generated by tuning the receiver to a frequency different from that of the desired station, and as a result each transmission will be received at two points upon the tuning dial. But for this disadvantage the circuit is well worth using.

It requires little note, except that the H.F.C. must not be of all-wave type, and that sufficient reaction must be used to keep the valve continually oscillating.

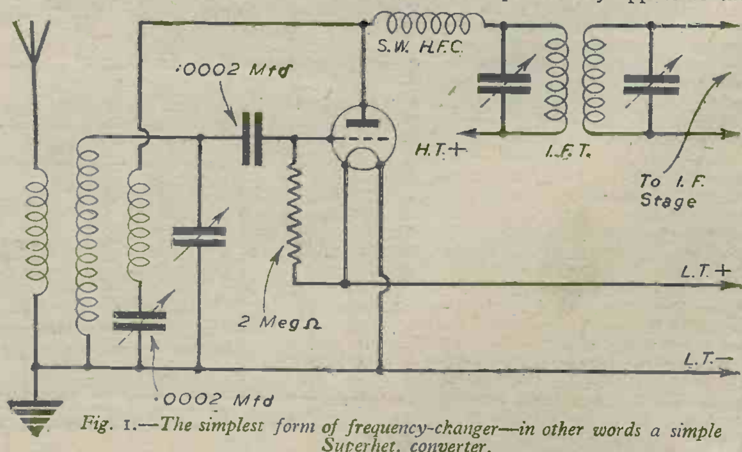


Fig. 1.—The simplest form of frequency-changer—in other words a simple Superhet. converter.

Electron-coupled Oscillator

Although the circuit depicted in Fig. 2 is for mains operation, a battery circuit can be built up along similar lines. In this case one filament lead will go to the cathode tap, and a filament choke should be inserted in the other filament lead.

It will be found that this circuit has numerous advantages, one of the most important being the ease with which the oscillator valve can be made to oscillate over all normal short wavelengths.

Resistor values shown may require modification with some valve types, and this particularly applies to the value of the bias resistor R1, the value of which is not shown. C1 by-passes this component and in some cases it may be desired to remove both components and operate with the cathode at earth potential.

The tuning condensers are not ganged, although ganging is not difficult if the coils have a similar number of turns each and a trimmer is used across the aerial coil.

If reception over a considerable frequency coverage is wanted, the .000005 mfd. coupling condenser may with advantage be replaced by a small-value pre-set which can be adjusted for best results.

slightly lower H.T. voltages are in use. As a further step towards obtaining smooth oscillation, the .0001 mfd. reaction condenser may be replaced by a pre-set if desired.

To sum up this type. Where a single valve is to be used it is found that such a circuit is very satisfactory. It is especially easy to obtain good results from it when reception upon very low wavelengths is not required.

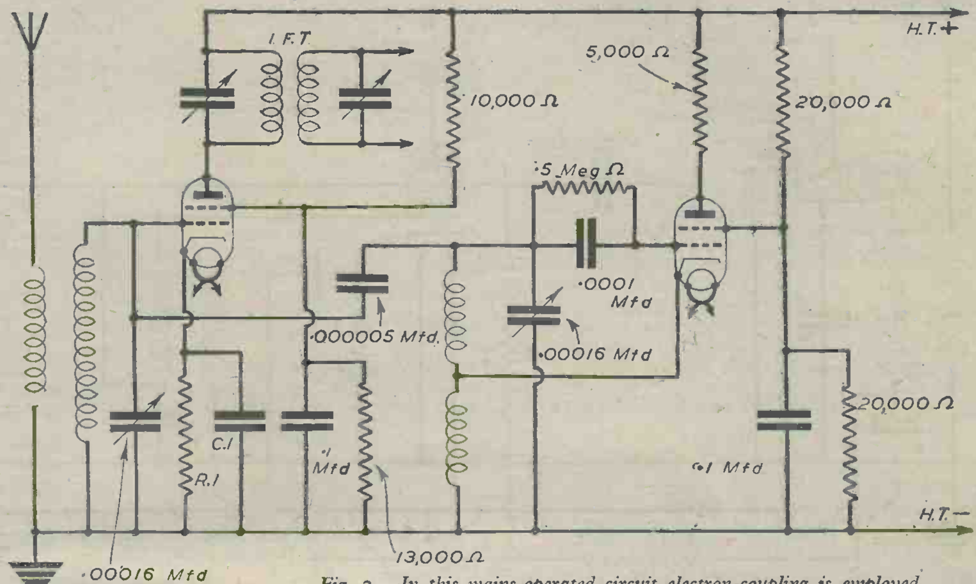


Fig. 2.—In this mains-operated circuit electron-coupling is employed.

This type of frequency-changing circuit is well worth using where the extra current drain of the second valve can be tolerated. Communications-type receivers often have a separate oscillator arranged somewhat after this fashion.

Triode-pentode

This circuit (Fig. 3) is built around a valve type of comparatively recent origin and has much to recommend it. Easy oscillation can be maintained in the triode section if operating conditions are correct and mixing is satisfactory without any feed-back to the aerial circuit (this, perhaps, is the only fault which can be found with the circuit in Fig. 2).

Again, the tuning condensers are not ganged, but they may be ganged as before if a trimmer is added to the aerial section of the condenser. The reason for not adding the trimmer to the oscillator section is two-fold. Firstly, the oscillator section should tune to a higher frequency than the signal frequency circuit, and adding extra capacitance will have the opposite effect. Secondly the oscillator section tunes more sharply, and has a much greater influence upon the volume of a station when slightly off tune, than does the aerial section. Trimming the aerial section will increase volume, but trimming the oscillator section requires the main tuning control to be re-adjusted and is consequently undesirable.

It should be noted that the oscillator anode resistor value of 50,000 ohms may be too high for some valves, and may be reduced to 25,000 or even 10,000 ohms if

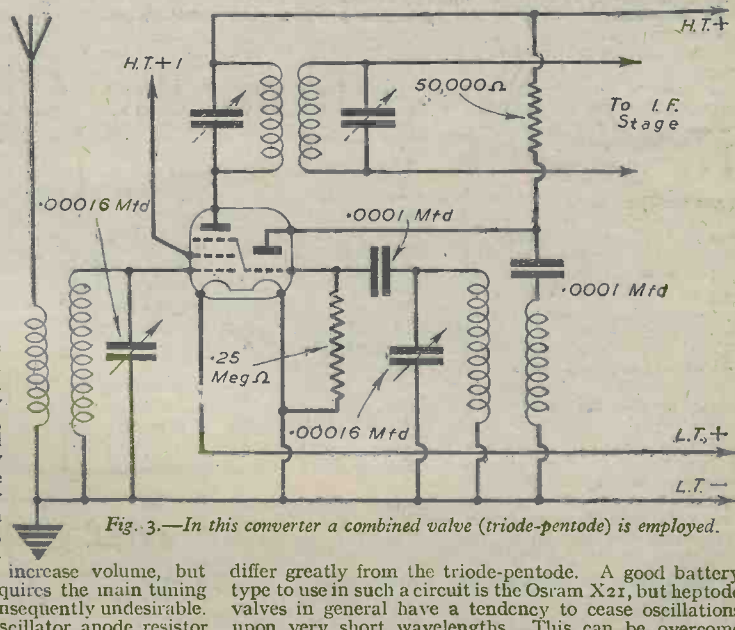


Fig. 3.—In this converter a combined valve (triode-pentode) is employed.

The Heptode

Ignoring for the moment the R.F. stage shown in Fig. 4, it will be seen that the heptode circuit does not differ greatly from the triode-pentode. A good battery type to use in such a circuit is the Osram X21, but heptode valves in general have a tendency to cease oscillations upon very short wavelengths. This can be overcome by connecting a normal triode detector in parallel with the oscillator section of the heptode.

Normally, quite a low voltage only will be required at the H.T.2 point—about 50 or 60 volts.

The R.F. stage also shown in Fig. 4 is not necessarily or use with a heptode only, of course. But, as in this considered when a tuned stage preceeds it as shown.

In conclusion, it should be noted that the circuits shown are not the only possible frequency-changer circuits, but they are the most frequently used. Various

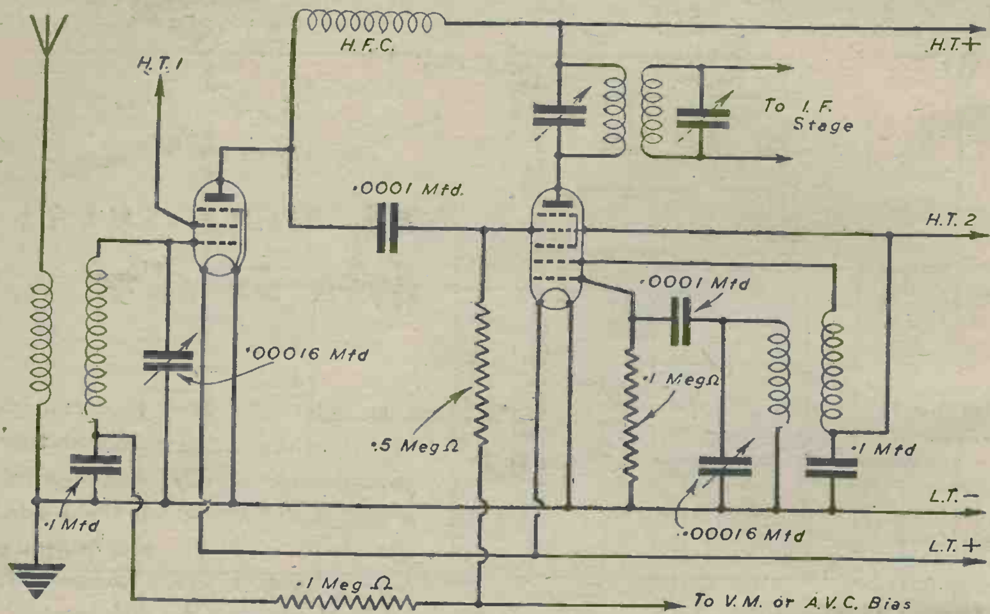


Fig. 4.—A heptode valve is used in this circuit, with the addition of an H.F. stage.

circuit, when it is desired to keep down the number of variable tuned circuits, the grid circuit of the frequency changer may be untuned. Actually it is possible wholly to omit the R.F. stage and still leave the grid circuit untuned, tuning the oscillator circuit only. But leaving the signal grid untuned is not entirely satisfactory and is best only superhet receivers could be built up from them, remembering that the frequency-changer portion of the circuit should be built upon low-loss, S.W. lines, while the I.F. and L.F. sections follow normal long- and medium-wave practice. R.F. stages, if used, should also be designed to avoid losses.

News from the Clubs

Cheltenham & District Amateur Radio Society

THE above society was recently formed with an initial membership of 33. At present meetings are held at the Lypiatts Technical College every Friday evening at 7.15. A series of lectures has been drawn up and a Morse Class has started. The Hon. Sec. is H. A. Brislin, 52, Cleevemount Road, Cheltenham, and the club will be pleased to welcome new members and also any amateurs who may be in the locality.

Slade Radio Society

THIS well-known pre-war society has restarted its activities and meetings are at present being held on the last Friday in the month at its H.Q. in Bloomfield Road, Erdington, Birmingham. Full details of the society may be obtained from the Hon. Sec., L. Griffiths, 47, Welwyndale Road, Sutton Coldfield, Warwickshire.

Stockport Short-wave Society

THIS society is being re-formed and all interested may obtain particulars from A. W. Hewitt, Hollybank, Row of Trees, Alderley Edge, Manchester.

Medway Amateur Transmitters Society

AFTER a period of nearly six years the M.A.T.S. which was one of the largest of provincial radio societies has recommenced activities.

The committee have arranged a full programme for the ensuing year together with a number of U.H/F field days. The society is the possessor of some very fine silver trophies which can be competed for by both transmitting and receiving members.

Members of the Radio Society of Great Britain can find the club headquarters an excellent meeting place, the M.A.T.S. being affiliated to the National Society.

Meetings are held on Monday evenings at 7 o'clock in the Forresters Hall, Kings Street, Gillingham; all intending members will receive a hearty welcome.

Impressions On The Wax

Owing to pressure on our space this month we regret that we are unable to publish our regular feature under the above heading. This month's record releases will, however, be included in next month's review.

The Push-pull Amplifier

How to Improvise a Push-pull Circuit and the Various Forms of Inter-valve Coupling.

By W. J. DELANEY

THERE is still considerable difference of opinion as to what is the best form of amplifier. Some amateurs prefer the triode, others a pentode or tetrode, and yet others a double-ended or push-pull arrangement, all of which may yet be modified by the addition of negative feed-back schemes. There are arguments in favour of all of these types, but in the opinion of the writer the push-pull scheme has a balance in its favour. Apart from the elimination of second harmonic distortion, it is possible to effect certain economies in the mains unit (due to the balancing out of hum), and if really large triodes such as the PX25A are employed, together with resistance-capacity coupling there is little left to be desired in the way of quality for normal domestic requirements.

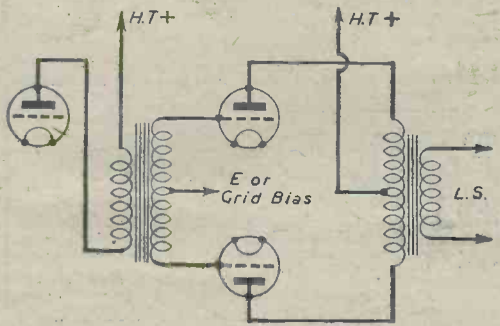


Fig. 1.—Skeleton circuit of the push-pull arrangement.

There are, however, so many different ways of employing the push-pull stage that many amateurs have failed to try it out, being in doubt as to what scheme would best suit their requirements, and also on the ground of expense. It is possible to try push-pull working at the cost of two simple resistances, provided that valves are available, and that ordinary transformer coupling is provided in a standard set, and it is proposed to give in this article the various standard forms of push-pull circuit. Firstly, for those who are not familiar with the theoretical considerations of the arrangement, it may be briefly stated that the signal from a given stage is applied across a load, the electrical centre of which is "earthed." This leaves the two ends of the load at high signal potential, but each 180 degrees out of phase with the other. The input to the two push-pull valves is taken to these high potential ends, and, in its original form, an L.F. transformer with the secondary centre-tapped formed the coupling as shown in Fig. 1.

Using an Ordinary Transformer

It will be seen from this that the signal developed across the secondary, in the usual way, is applied to the two valves, but the earthing of the centre enables the required out-of-phase signals to be applied to the following grids. This arrangement may be obtained artificially with an ordinary L.F. transformer, by connecting two high-valve resistors across the secondary and earthing their common ends, as shown in Fig. 2. Values not lower than .25 megohm should be employed, and for the purposes of trying out the arrangement any values on hand may be used. Although, theoretically, they should be absolutely identical, due to their being in parallel with the transformer secondary winding, the usual slight differences found in standard commercial components will not have much effect on the circuit. In the case of battery operated circuits, the bias should be applied to the junction point, whilst in mains equipment the usual cathode bias should be employed. Normal bias is applied except where one common bias resistor is employed in the heater windings of the two push-pull valves. As in that case twice the normal anode current will flow, the value of the resistor will have to be halved to provide the normal bias voltage. The transformer fitted to most loudspeakers is provided with a centre-tap and this should be connected to H.T.+ and the two anodes joined to the ends of the transformer.

Avoiding Iron Distortion

Although it is possible to use quite small transformers on the input side of the push-pull circuit, there is a risk of certain forms of distortion creeping in. On the output side, of course, the removal of direct D.C. from the primary does cut out one of the main troubles of the output stage and there is little risk of saturation causing difficulty. To avoid the cost of high-quality input push-pull transformers, and also to remove certain forms of distortion, there is an increasing tendency nowadays to use resistance-capacity input coupling. This is sometimes known as "paraphase" coupling, "combined cathode-follower coupling" and other fancy names. In general it merely consists of the employment of a resistance as the load, and in some cases two separate triodes (or a combined double-triode) are R.C. coupled to provide the required out-of-phase signal for the output stage, and in others the load resistance is split into two, and one half is placed in the cathode circuit of the input valve. Dealing with these arrangements individually, in Fig. 3 we have a pair of triode valves V1 and V2 acting as the driver. The output from V1 is fed to V2 as well as to one of the push-pull pair. This means that the output of V2 can then be fed to the other push-pull valve, as it will be 180 degrees out of phase with the output from V1. However, this is not an ideal arrangement as the signal from V2 will be given additional

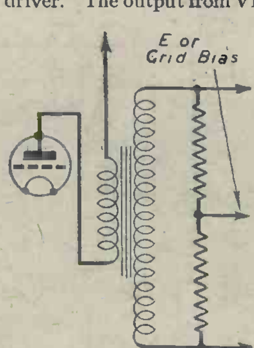


Fig. 2.—Improvising a centre-tap on an ordinary transformer by means of two resistors.

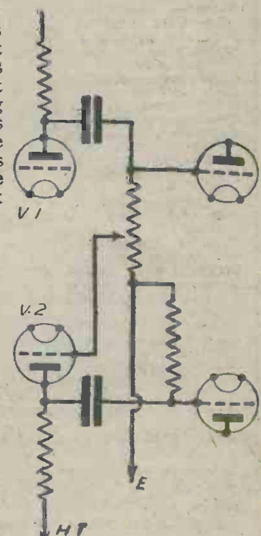


Fig. 3.—Skeleton circuit of the paraphase push-pull arrangement.

amplification and will thus be stronger than that from V1. Furthermore, the circuit is not symmetrical from an electrical point of view, and whilst it is admitted that it sounds quite good there are theoretical reasons why it is really unsound. Attempts to balance up the circuit are not very successful, but the inclusion of an oscilloscope in each of the output valve circuits will show that actually there is quite a difference in the signals they each have to handle.

The Cathode Follower

A popular arrangement now being given great prominence is the cathode follower, wherein the load resistance is in the cathode circuit instead of in the normal position at the anode. Again, however, there is quite a difference in the signal available, as, apart from the phase difference, the signal voltages at the anode will be greater than those at the cathode. This may be overcome to a certain degree by using a low value resistance for the load, but there will still be a discrepancy in the types of signal. However, when fed to the two push-pull valves there is no doubt that this scheme does give us a signal which is preferable from a musical point of view to the normal straight single-ended type of circuit, and those readers who are mathematically minded might care to work out the actual signal which is applied to each of the output valves when this combined single-valve driver is employed.

Class B and Class AB

The details so far given have applied merely to the straightforward or Class A type of push-pull amplifier. There are modifications of this, but they have merely been designed to overcome difficulties of power supply. The Class B push-pull amplifier, for instance, is merely an over-biased push-pull stage, where the standing or normal anode current is cut to zero and thus the drain on a dry battery is reduced until the signal is received. Again, arguments may be started as to whether or not the total "average" current is not greater than with a normal push-pull arrangement, as the peak currents at Class B may be quite high. Class AB is a compromise between the two schemes, in other words the bias voltage applied is half way between complete cut-off and the normal value.

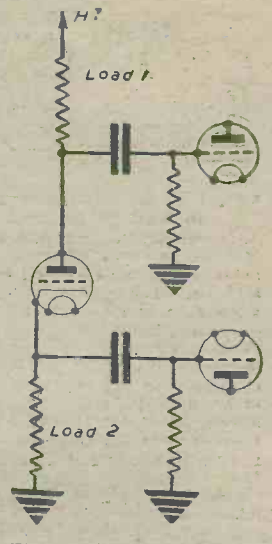


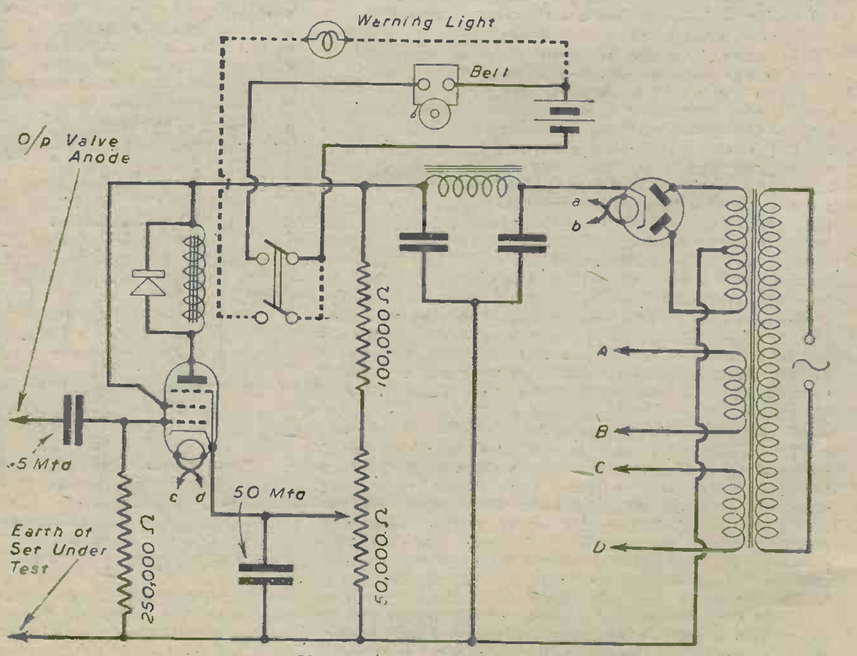
Fig. 4.—A single valve acting as a phase inverter stage.

An Intermittent Fault Detector

THE intermittent fault is undoubtedly the Serviceman's biggest problem. To eliminate the laborious process of having to pay constant attention to a set running for long periods, and to enable the engineer to devote all his attention to another set, the following device was produced. It consists of an automatic warning system which enables the set under test to be run with the speaker secondary disconnected.

In operation a modulated R.F. signal is fed into the aerial, and the output signal of the set under test is fed into the input of the warning unit. The 50,000 ohm potentiometer is then adjusted until the relay just closes, thereby opening its contacts. When the output from the set drops the relay opens and its contacts close, operating a bell or buzzer. Several sets can be tested at the same time if additional relay circuits are employed. In this case double contact relays are necessary, one contact operating a bell, and the other a warning light to indicate which set has failed.

The circuit is uite cheap and easy to build. The relay used was a 5,000-ohm D.C. type (contacts normally closed), slugged with a metal rectifier, a 6AC7 valve was used, although any available type with similar characteristics could be employed. Full circuit details are given in the accompanying diagram, the additional relay point for the warning bell being shown by the broken lines. (H. M. COKER.)



Circuit of the fault detector.

ON YOUR WAVELENGTH

By THERMION

The Cost of Progress

THE proposed increase in the cost of a wireless licence has been criticised in the daily Press. I think, most unfairly. It has always been my opinion that ten shillings per year is too small a sum to enable the B.B.C. to do justice to the artistes, and the public, especially in view of the large sums they have to pay out to the Treasury. If a person cannot afford a pound a year for 365 days of entertainment, 18 hours a day, he cannot afford radio at all. Yet most of these critics who squeal because they are going to be charged another ten shillings can be seen, I am sure, in their local taverns, drinking whiskies and gins at half-a-crown a nip—people who before the war boggled at paying more than 4d. for a glass of beer. Most of them have spent many guineas on their radio receivers and will gladly spend 17s. 6d. or more on a new valve. They will even go into the Black Market and pay fantastic prices for spares.

It has always been my opinion that we should value radio programmes far more if we had less of them. In the old days of Writtle (2MT) we thoroughly enjoyed the once-a-week half-an-hour programme and keenly looked forward to it. We were not so critical then, but we have since become sated with programmes radiated from all countries. I do not think that even one pound per year is enough. I make no apologies for quoting from the "Sunday Graphic" the following verse by Mr. A. P. Herbert, M.P.

Is it really too much to pay—
Two-thirds of a penny a day?
Forty hours, more or less, for a penny—
Which, I should have said, was too many.
Forty hours of continual sound,
Of music, profane or profound,
Of laughter and ditty and play,
With the news of the nations all day.
At home in your humble abode
Are Churchill, and Handley—and Joad,
The tenor, the crooner, the sage.
The stars of the senate or stage.
His Majesty calls, now and then;
And there, by your bed, is Big Ben.
No need, no temptation to roam:
For you have a planet at home.
Where else, may I ask, do you touch,
For so very little, so much?
And the chap at the studio end
Has also a stomach, my friend.

The television licence is to cost two pounds. The cost of putting on television programmes at present is really enormous, for no one has yet produced a satisfactory method of recording high-definition television. Also, the very limited range means that a large number of provincial transmitters will have to be erected. Transmission via the co-axial cable is still full of difficulties. Ordinary sound transmissions of plays can be recorded on steel tape and the artistes can sit round a table and read their scripts. With television, scenery must be provided and the artistes must be in costume. The people who are groaning about having to pay two pounds a year for hundreds of hours of television programmes do not object to going to a London theatre three or four times a year and paying 15s. for a seat in the stalls. I, therefore, think that these criticisms emanate from the new generation which has sprung up in the last ten years which expects something for nothing, which is another way of saying that they are the parasitic appendages to the energetic people who work hard in order to pay heavy income tax to carry them. They should be denied the privileges of radio if they object to paying so small a sum per year for it.

Queries

ALTHOUGH it has been announced many times in this journal that the query service has been suspended for the time being, readers are continuing to address queries to this journal and some are addressing them personally to me. I regret that I have not the time to take over the suspended query service. Some of the questions are quite unreasonable. One reader will submit a list of components which he has found in his junk box and ask me to design a circuit for him utilising them. I regret that I have not the time to spend three or four hours answering one letter.

Another reader wants me to adapt a commercial receiver for the reception of short waves. He apparently doesn't realise that I should have to write to the manufacturers for a copy of the circuit (presuming they would be so obliging as to let me have one!) and that I should probably spend a couple of hours endeavouring to incorporate the short-wave section in the existing layout. I am afraid that I cannot undertake to do this either.

Another annoying type of query is that which comes from the inevitable "regular reader from No. 1," who asks a query which is probably answered by an article in the current issue or was dealt with in the previous issue. We do expect readers to go to a little trouble looking up things for themselves. Certainly, I have not the time to turn up past issues. We issue indexes for every volume.

Another queriest invites me to publish a free advertisement asking for certain components, back issues or technical books. If I undertook to do this for one reader I should have to undertake to do it for all readers, and the journal would become a passable imitation of the miscellaneous advertisement section of our daily newspapers.

Bun-fights at B.B.C.

PRESS Item.—B.B.C. executives have been instructed to cut their expenditure in view of the revision of the B.B.C. Charter this year. A special budget will have to be made when the cost of the B.B.C. is discussed in Parliament.

"Austerity" will mainly affect the entertainment allowances of the officials concerned. "Tea and buns" instead of cocktails are likely to be offered to their guests in future!

Go slow on "hospitality,"
Revision's drawing near!
You'll have to cut the cocktails out—
Not even offer beer!
And when your guests have done their stuff,
And it's time for them to run,
The most that you must offer them
Is cup of tea and bun!
Soon auditors with eagle eyes
Will go through our accounts!
And it might cause them much surprise
To find such large amounts
Of revenue just fade away
When guests are entertained,
And licence-holders might demand
Such wastage be restrained!
So draw it mild, you festive lads,
Stick to the cup that cheers—
Just tea! And much austerity
To still the listeners' fears!

TORCH.

Pulse Communication—II

Concluding the Explanation of Pulse Formation and Circuit Analysis

By P. FREEMAN, B.Eng.

Rectangular Wave Shapes

A SIMPLE "peak clipping" circuit by means of which a sine wave is shaped into a pulse of trapezoidal form is shown in Fig. 10. The output voltage increases with input voltage until the instantaneous applied voltage is equal to the bias voltage of the diode A. Current then flows through the diode, but the voltage drop in the resistance prevents any further rise in output voltage until the applied voltage decreases and diode current ceases. The negative half cycle of the input wave is clipped in a similar manner by diode B. The solid curve shows the trapezoidal wave-form. Diode A used alone will generate positive pulses or diode B negative pulses. To produce a more truly rectangular or square pulse the output voltage from this first clipper stage must be passed through a series of similar peak clipping stages in cascade which will make the edges of the trapezoidal wave vertical.

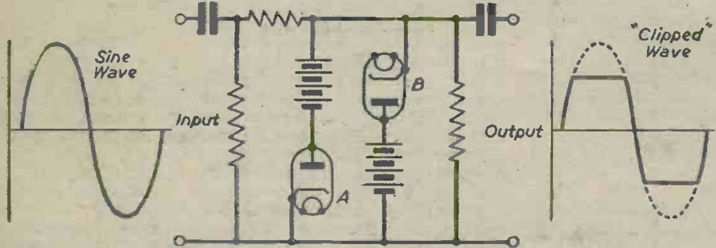


Fig. 10.—A "peak clipping" circuit and its effects shown diagrammatically.

Triangular Wave Shapes

Another type of wave-shaping circuit is the triode limiter shown in Fig. 11 (a) which can be used for the production of various forms of triangular pulses. If, for example, the triode is biased beyond cut-off (Fig. 11(b)), a positive rectangular pulse applied to the grid will produce a saw-tooth wave. This is due to the fact that the leading edge of the applied pulse causes a rush of plate current to flow and the condenser C discharges through the valve. During the interval between pulses the condenser discharges linearly and comparatively slowly through the resistance R. On the other hand, by giving the valve zero bias and applying a negative rectangular pulse to the grid, a symmetrical triangular pulse is produced (Fig. 11 (c)). This is because the triode is conductive throughout the intervals between applied pulses allowing the condenser to discharge linearly. During negative pulses, the valve is biased back, preventing conduction through the valve and permitting the condenser to recharge.

Sharp Pulses

The pulses of extremely short duration used, for instance, in radar, and for sounding the upper atmosphere, are produced when a square wave is applied to a differentiating circuit. This has already been illustrated in Fig. 9.

Practical Circuit of Pulse Generator

Fig. 12 shows the circuit and component values of an easily constructed circuit for generating three types of pulses, square, triangular and sharp, at a fixed frequency of 50 cycles. As will be seen, the power transformer serves the dual purpose of supplying power for the rectifier and a large A.C. voltage to the grid of the "clipper" valve. The power supply from an A.C. mains receiver may be connected up for this purpose. The mains transformer should have a 350 volt secondary and the smoothed D.C. output should be about 250 volts. The clipper valve is a short grid base R.F. pentode operated with zero bias and low plate voltage. When a large A.C. voltage is applied to the grid, the negative peaks block the valve, while the positive peaks drive it into saturation. Thus both negative and positive peaks are clipped. The output pulse from V1 is square; through the differentiating circuit it is shaped into a sharp pulse or through the integrating circuit it is shaped into a triangular wave. A cathode follower stage isolates the clipper output from the cathode ray oscillograph. The input to V1 should be gradually raised by varying VR1 until the optimum wave shape is obtained.

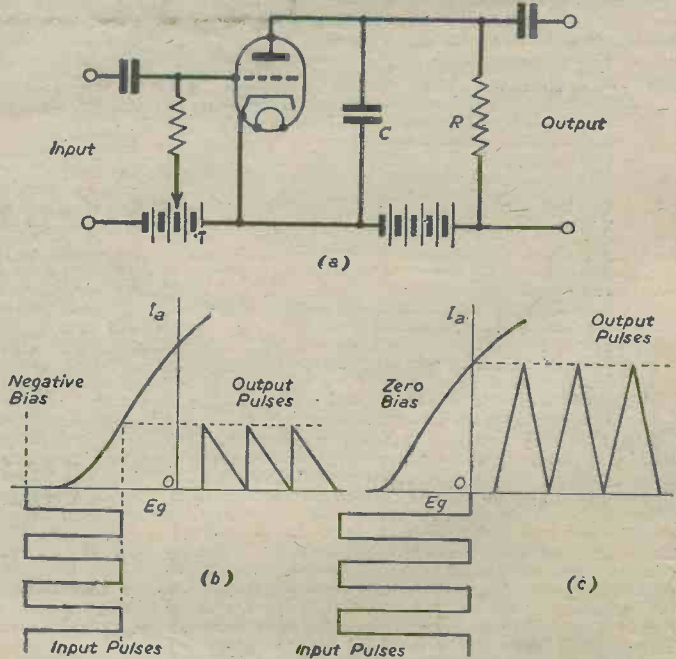


Fig. 11.—Another type of wave-shaping circuit for triangular pulses.

Applications of Pulse Transmission

In conclusion some brief references will be made to a few of the uses to which pulse transmission may be put.

Pulse transmission was first used in research on the electrical constitution of the upper atmosphere by generating sharp pulses at regular intervals and noting the time lag at different frequencies between the original and reflected pulses from the ionised layers. This technique led to the development of Radar, in which sharp pulses of great intensity on ultra-short waves are directed outwards from the transmitter and, by observation of their echoes on a cathode-ray oscilloscope, the outline and distance of objects outside the range of visibility can be determined.

Another notable use of pulses is in the automatic navigation system known as Gee. Master and slave radio beacons in fixed geographical locations transmit synchronised pulses which are received on the screen of the cathode-ray tube with a calibrated time base. By comparing the time displacement of pulses from master and slave stations and knowing that the pulses reach him at 186,000 miles per second, the navigator is able to compute his position and course with exceptional accuracy even though hundreds of miles from base.

Pulse communication enables the most complicated operations to be performed by remote radio control on a single frequency channel, as for example, the landing of planes in darkness or fog, the firing, guiding and aiming of rockets or the synchronisation of the scanning circuits of television receivers.

A more practical use of pulses, which must interest every service engineer of the future, is the use of square-wave signal generators in the testing of radio and television receivers. As a square wave contains in itself every frequency from the fundamental to infinity, it will be realised that no better or simpler response test could be devised than that the amplifier should faithfully reproduce a square wave.

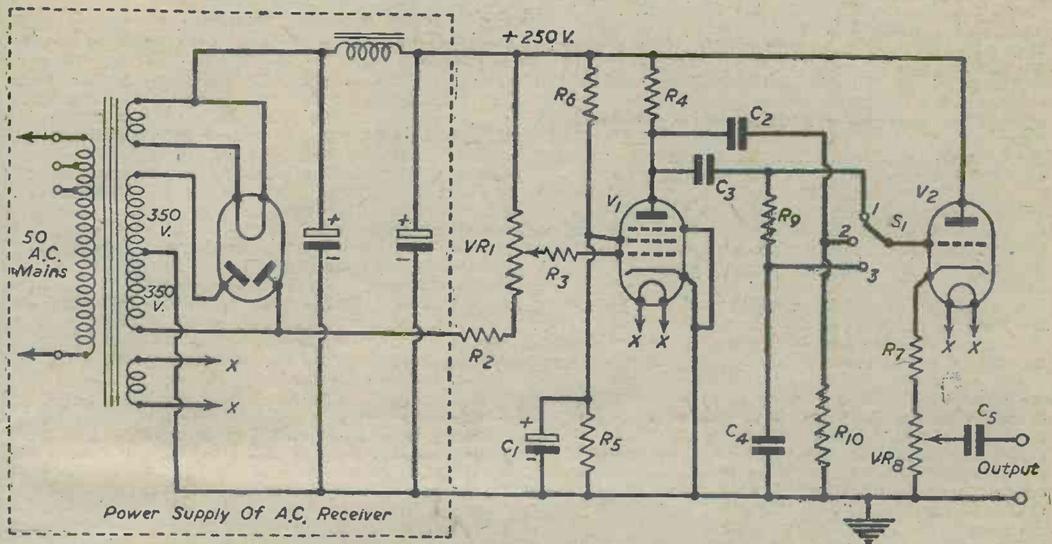


Fig. 12.—Pulse generator. Note: Switch S1 in position (1) gives square wave output; in position (2), sharp pulse output; and in position (3), triangular wave output.

LIST OF COMPONENTS

- VR1, 2 megohms variable.
- R2, 5 megohms.
- R3, 1 megohm.
- R4, 100,000 ohm.
- R5, 100,000 ohm.
- R6, 100,000 ohm.
- R7, 500 ohm.
- VR8, 2,000 ohm variable.
- R9, 4 megohms.
- R10, 1,000 ohm.
- C1, 8 mfd. 250 volt electrolytic.
- C2, .005 mfd. 500 volt, mica.
- C3, .5 mfd. 500 volt, paper.
- C4, .1 mfd. 500 volt, paper.
- C5, .5 mfd. 500 volt, paper.
- S1, 3-pole selector switch.
- V1, SP4 (4 volt htr.) or 6J7 (6.3 volt htr.).
- V2, 354 V (4 volt htr.) or 6J5 (6.3 volt htr.).
- 250 volt D.C. smoothed power supply from mains transformer having 350-0-350 secondary and full-wave rectifier (shown within dotted line in Fig. 12).

Programme Pointers

This Month MAURICE REEVE Discusses NICKNAMED MUSIC

MY readers may have wondered from time to time about the authenticity of the titles of some of their favourite compositions. And well they might, for many of them have been bestowed without the slightest authority from the composer, and have usually been inspired by nothing more than some—we hope—well-meaning admirer's reaction to the piece in question.

Nicknames may be divided into three classes, two only of which carry any authority. Of these one class bears the name or title of the dedicatee: e.g., Beethoven's "Archduke" Trio or "Waldstein" Sonata (the Archduke Rudolph and Count Waldstein respectively); whilst the other either carries the composer's authentic title, such as Beethoven's Pastoral Symphony or Vaughan Williams's "London," or such an obvious tag as Schubert's "Wanderer" Fantasie (the middle section of which is based on the composer's great song "The Wanderer"), to which the composer probably turned a blind eye or a deaf ear.

The third, and totally unauthorised, category is as already mentioned—works such as Beethoven's "Moonlight Sonata" or Chopin's "Butterfly" study, making up their number.

Perhaps some remarks on this subject may be of interest. Firstly, I will briefly mention the two main branches into which music is divided—"Programme" and "Absolute." The former is where the composer deliberately sets out, usually within the framework of a classical form, to portray some scene, emotion, event or imaginative vista, to which he appends the title and thus leaves no doubt of his intentions on the ears of the listener.

Authentic examples which readily come to one's memory are Mendelssohn's "Midsummer Night's Dream" music and "Fingal's Cave" Overture, Grieg's works, "Norwegian Bridal Procession," "Sketches of Norwegian Life," "Butterflies," etc., etc., almost the entire output of Debussy—"Gardens in the Rain," "Fireworks," "Goldfish," "The Sea," etc., etc., as well as hundreds of other examples too numerous to mention.

The only thing left for the listener to do is to determine whether the pictures or scenes depicted are faithful representations or not. This usually requires the help of the executant making the presentation; if he cannot produce any difference between a tempestuous sea, a gale of wind or an express train racing through a tunnel, the unfortunate composer will probably have to take the rap by being dubbed "modern" or "mad."

In the purely imaginative examples, where a composer sets out to write about "The Thames By Moonlight" or "La Gioconda," we must try to hear the piece with his ears and appreciate it as best we may.

The second, or "Absolute," category of work is where the composer writes to the principles of formal beauty and without any pictorial design or intent whatever. This group contains all the "classical" masterpieces of Bach, Beethoven and Brahms, etc., etc., fugues and chamber music, and are at once the nightmare of the unmusical and the despair of the uncritical. It also contains most of the works which to-day carry a totally unwarranted title to mislead the public and to detract inevitably from the work's intrinsic value.

"Moonlight" and the Critic

Beethoven's "Moonlight," "Pathetic" and "Appassionata" and "Pastoral" Sonatas are titles without warrant, fact or foundation. The "Moonlight" should read "Sonata quasi una Fantasia, Op. 27, No. 2." The critic Rellstab, however, thought that the opening movement reminded him of "Moonlight on the Lake of Lucerne," put this into print, and there it has remained ever since. Anything less like moonlight than the third movement cannot be imagined. It has also been styled the "Laube" Sonata, this being German for "arbour" or "bower," where the work was believed to have been written. Again without any warrant.

The "Pastoral" was bestowed by the publisher Cranz, presumably by the supposed neighing of a donkey and other country-like similarities; he also styled the Op. 57 the "Appassionata" apparently because of the tempo indication of the first movement which is ordered to be played "allegro appassionato." If the title "Pathétique," the Op. 15, was given to it because of the rather obviously sad and doleful character of its second movement, then we can only say it was very pathetic.

The title to the sonata in E flat, "Les Adieux," is, however, perfectly authentic. The three movements are styled respectively "Adieux," "Absence" and "The Return," and they realistically describe the composer's emotions when he once had to say farewell to his great friend and patron, the Archduke Rudolph, to whom the work is dedicated. The finale opens with an imitation of the postilion galloping up the street with news of the Archduke's return, followed by Beethoven's joy, which is as realistic a piece of tone painting—prior to Debussy—as can well be imagined.

Acceptable Titles

Titles like "Unfinished" to Schubert's Symphony seem inevitable, and are quite acceptable in view of their obviousness. Dvorak's Symphony No. 5, known as "The New World," from the fact that it was written there and contains some native Red Indian themes given to the composer during his visit, is another instance which can be readily forgiven, though it is without Dvorak's authority. Beethoven's "Archduke" trio and "Rasoumoffsky" quartets are classic examples of works becoming known by the fame of their illustrious dedicatees. Prince Rasoumoffsky was Russian Ambassador in Vienna, whilst the Archduke was the aforementioned Archduke Rudolph.

The "Eroica," like the Pastoral—Symphony No. 6—was Beethoven's own title to his third symphony. But the naming of the Fifth Piano Concerto, the "Emperor," is spurious.

Amongst Haydn's and Mozart's works are some curious titles, authentic and otherwise. Such of the former's symphonies, as the "Drum Roll," the "Military," the "Hen," the "Clock," etc., are only descriptive of certain movements or even figures in them. The set known as the Salamon are so named after the London violinist and impresario of that name; the "London" and "Oxford" because they were first performed in those places. Mozart's "Prague" and "Linz" were named for similar reasons, the Haffner because it was written in a fortnight to please his friends of that name. The "Coronation" concerto because it was first performed at a concert in celebration of the coronation of Joseph II. Unauthorised is "Jupiter" for No. 39.

Schubert's "Trout" quintet is so named, like his "Wanderer" fantasie, because the slow movement is a set of variations on his song of that name. The same applies to his quartet, "Death and the Maiden," Mendelssohn's Songs Without Words, styled "Bee's Wedding," "Spinning Song, "Spring Song," and "Funeral March," are so named quite falsely, but the titles, "Gondola Songs" (three), "Duetto" and "Folk Song," are genuine.

None of Chopin's "titled" pieces—"Cat," "Dog," and "Minute" valses, "Raindrop" prelude, "Revolutionary," "Butterfly" and "Winter Wind" etudes, etc., are correct. All his works are "absolute" music, devoid of any vestige of "programme," none more so

(*Continued on page* 204.)

German Airborne Radio

A General Survey of Some of the Main Features of German Equipment

A STUDY of the layout of a typical wireless operator's instrument panel, such as that of a Ju. 88 shown in Fig. 1, reveals immediately several superficial differences, both in appearance and in the installation of the equipment, from the more familiar British and American counterparts.

Electrically, the differences are slight, the most noticeable being the comparatively rare use of crystals for frequency stabilisation. Mechanically, however, the differences are profound and instructive, and a great feature is made of standardisation. The latter is more particularly noticeable in the employment of the same type of equipment wherever possible, and in the minimum variety of style of design, than in the components. The principle is manifest, too, in the system of installation.

Installation

Further reference to Fig. 1 will show that the system involves two essential parts.

(a) The fixed, or built-in portion.

(b) The actual radio units themselves.

The fixed installation permits permanent wiring to be built in during aircraft construction, and carries quick-release mounting frames to which the detachable radio and power units are attached. The resulting clean and tidy appearance of the panel, free from loose and straying cables, can be appreciated.

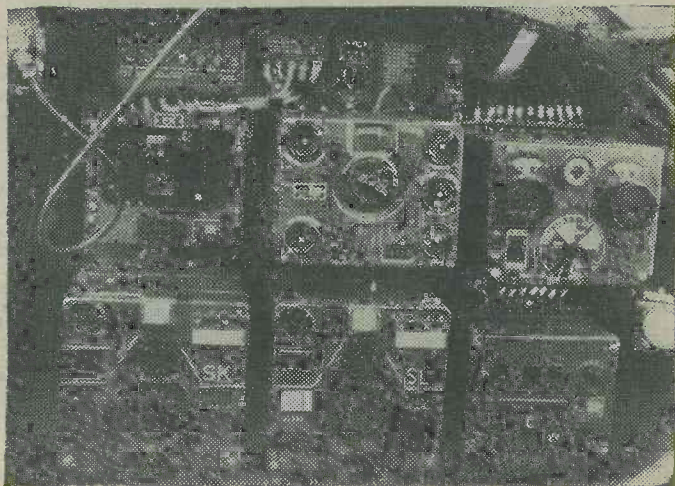


Fig. 1.—Wireless operator's instrument panel (JU. 88). The M.F. communication equipment, FUG LOP, is visible, the modified long-wave receiver, E Z6, occupying the top centre position. The short-wave receiver (top left) has been removed to show its mounting frame. The D.F. set and the V.H.F. R/T equipment are remote controlled.

The FuG 16 (Fig. 2), for example, has two mounting frames; the upper for the transmitter-receiver unit and the lower for the power unit. The frame for the radio unit is rubber mounted, using metal-rubber bonded blocks and carries hooks (F) which support the unit while quick-release catches, locking in the slots (H) provided, secure the unit in position. Blocks of spring contacts connect with similar rows of knife plugs, recessed in the back of the radio unit, as the latter is lowered into position. The sockets on the frame are not connected directly to the permanent wiring as this might impede the flexibility of the mounting. Instead, they are taken by flat multicore cables, resembling straps, to a large junction box shaped for mounting beneath the suspension frame, without touching it. The permanent wiring is connected to terminals in this junction box within which a further elaboration occurs in the provision of sockets (G), permanently connected to the terminals, into which are plugged the strap connections from the frame sockets.

The lower, power unit, mounting is connected direct to the external wiring aud is not mounted on rubber since it is the practice to mount the motor generator on rubber pillars within the power unit. Fig. 4 illustrates a typical power unit. Also included in the fixed installation are: an input barretter (N) for the motor generator; filament compensating resistances (P); H.T. fuses and an R.F. socket to take the end of the aerial concentric cable.

Fig. 3.—Example of die-cast chassis construction.

Construction

Die-castings of magnesium alloy are used for the chassis of these sets. Two or more such castings, often labyrinths of intricate design, bolt together, with plug and socket connections to permit easy dismantling. Neatness and space saving have been carefully studied resulting in radio units of striking compactness for their function and performance. The receiver section of FuG 16, shown in Fig. 3, is typical of this technique and, as further illustration of the policy of standardisation, this same die-cast chassis has two other applications: as the receiver in the V.H.F. set FuG 17 and in the Beam Approach receiver EB1 3.

Components

The quality is uniformly high. With the exception of valves, standardisation is not very noticeable and there is no suggestion that production has been cramped in any way by this or any other consideration.

The use of ceramic material to a great extent, for formers, insulators and condenser dielectrics, is the most notable feature of the transmitters, whilst the receivers have tuning condensers whose plates are formed from one piece of solid material, and dust-iron cored, permeability tuned, I.F. units, both of which are particularly attractive components. Furthermore, R.F. coils are frequently built by depositing silver in a helical groove on a ceramic former, resulting in a coil of high "Q" and great stability.

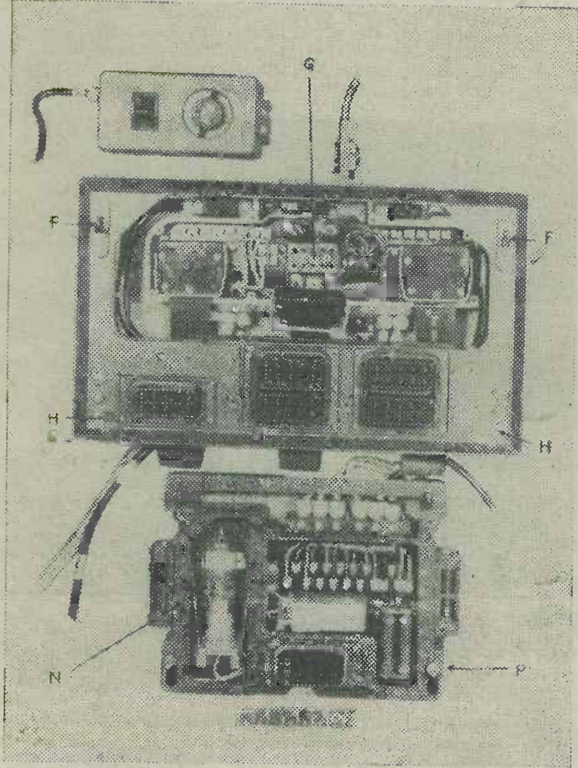


Fig. 2.—Mounting frame for V.H.F. transmitter receiver. Cover plates removed to reveal the salient features. For the legend, see text.

Tuning Devices

Directly calibrated scales, read through a magnifying window, with coarse and fine tuning controls (backlash-free) and, usually, four adjustable click-stops comprise the standard arrangement.

Remote tuning is much in evidence owing to the limited cockpit space available on many German aircraft, and this frequently takes the form of an electric motor which turns the dial between click-stops or, in the case of fine-tuning, rotates the knob until halted in the correct position. This is a clumsy, and, in some cases, ineffective method.

Frequency Stabilisation

Crystals are very seldom seen. The frequency stability is greatly assisted by the use of special ceramic dielectric for fixed condensers which, paralleled with the tuning condenser or variometer, compensate for temperature changes. This device, coupled with the general stability of performance given by a die-cast chassis, good quality components and fine workmanship, gives the frequency stability required without, of course, equalling that obtainable with crystals.

Valves

A remarkable degree of standardisation has been achieved in the use of valves and, in airborne equipment of recent design, the irreducible minimum has been reached.

The most noteworthy example of this standardisation is the small valve, type RV12P2000. Within its comparatively small glass envelope is enclosed a radio-frequency pentode with top-cap grid connection and ring-sealed base. This valve is effectively used for both R.F. and A.F. circuits and, by "strapping" various electrodes, can be employed as a diode, triode or pentode, as required. By way of example of its use, the V.H.F. transmitter-receiver, FuG 16, already mentioned, employs eleven of these midget pentodes; the only other type of valve used in the set being the two 30 watt pentodes (RL12P35) used as master oscillator and power amplifier in the transmitter.

No particular eccentricity of circuit design is necessary and no deterioration in performance can be observed as a result of this feature of standardisation.

Power Supply

The source of all H.T. and L.T. is, primarily, the aircraft "24 volt" D.C. system. A nominally 24-volt system was standardised for all aircraft prior to the outbreak of war and,

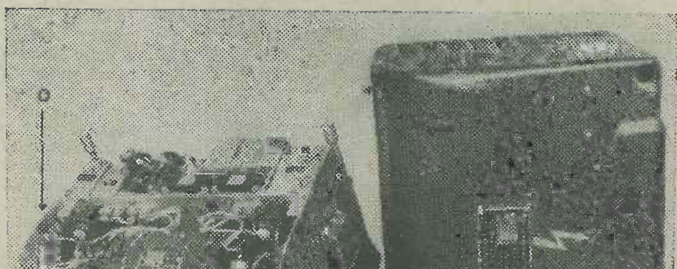


Fig. 4.—Motor generator power unit (FUG 16/17).

with the exception of a few obsolescent machines not used operationally, this system has been adhered to rigidly.

One or more engine-driven generators feed a floating battery system from which all aircraft electrical services, including radio, are powered. Thus, the actual voltage maintained on the system is about 29 volts, the 24-volt battery in use being either an unspillable lead-acid or nickel-iron accumulator. The nickel-iron batteries were first introduced into operational service with the Focke-Wulfe 190 single-seater fighter in 1942.

L.T. supplies for valve heaters are taken direct from the "24 volt" line and, since a 12.6 volt heater is practically universal for airborne use, they can be connected in series-parallel, with a compensating resistance used where odd numbers of valves are involved.

Mention has already been made of the power units, e.g., Fig. 4. These are provided on a generous scale with separate units for the supply of the transmitter H.T. and of the receiver H.T. They consist of a motor generator mounted together with smoothing chokes and condensers to form a separate unit. Input and output stabilisers may be included, and sometimes A.C. is generated, in addition to D.C., to provide for the operation of remote tuning by 'selsyn' motors.

These power units are well designed, being noticeably free from "hum" and with an excellent performance. For example, the power unit type U8 (used for D/F receiver H.T.) produces an output voltage on load which varies only from 206 to 214 volts for an input variation from 18 to 29 volts.

Aerials

A remote aerial winch, electrically operated, is fitted to all medium or large aircraft in addition to two or more fixed wire aerials. The fixed aerial mast is made of metal, insulated, and used as an aerial for the Beam Approach main beacon receiver. Similarly, the FuG 17 aerial, used on close support aircraft, is a 1-metre metal rod enclosed in a streamlined fairing 7in. deep at the base. Whip aerials have never been seen on German aircraft.

It is normal practice to fit an aerial matching unit at the point where the aerial (or lead-in) enters the fuselage. If this has to be retuned in flight, a remote control is fitted if the unit is inaccessible. Some of these matching units enable the aerial to perform a dual function, as in the case of the FuG 16 (V.H.F.) fixed wire aerial, which is also used for the same aerial of the separate D.F. receiver operating on medium frequencies.

Local Station Quality Receiver

Interesting Circuit Details of an Easily-built Five-valve Set.

By Major D. MANSEL

IT was with the object of obtaining high quality on "locals" and gramophone records, without excessive cost, that the set described here was designed and built in the writer's spare time in 1944.

The basic requirements which had to be satisfied were as follows:

(a) The set was to be used in the London area and choice of Home and Forces programme only was required.

(b) A great part of the listening time would be spent playing gramophone records.

(c) Quality of reproduction had to be as good as possible within the limitations of available components, time which could be spent on the set, and cash available.

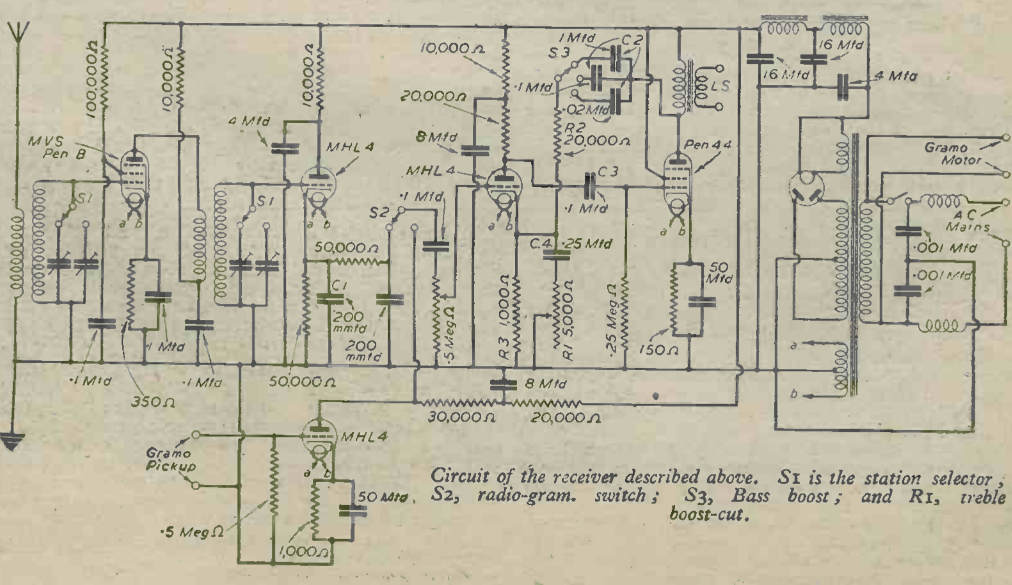
The set described below does to a very large extent satisfy these requirements.

The circuit employed is shown in the accompanying diagram. A R.F. stage is used to obtain adequate selectivity and also to ensure that sufficient voltage is delivered to the detector for the proper operation of the latter with minimum distortion. A change-over switch with pre-set capacitors allows either of two programmes to be selected.

The detector is of the cathode follower or "infinite impedance" type. This has two main virtues:

(a) It is at least as free from distortion as a good diode.

(b) Unlike the diode it imposes little damping on the preceding tuned circuit. In fact, if the value of C1 be reduced by a certain amount, depending on the value of the valve grid-cathode capacity, the damping will become negative, and the circuit will oscillate.



Circuit of the receiver described above. S1 is the station selector; S2, radio-gram. switch; S3, Bass boost; and R1, treble boost-cut.

The usual disadvantage of this circuit, in that A.V.C. voltage cannot be obtained as it stands, does not apply in this instance since A.V.C. is not required.

The design of the A.F. stages was conditioned by the following factors:

(a) Since the set was to be used in a smallish living-room, a very large A.F. output was not required.

(b) An efficient system of variable tone compensation giving treble and bass boost and cut was considered necessary.

(c) A good single-ended output transformer was available.

The Output Stage

It was decided to use a large pentode (Pen. 44) as the output valve, with negative feedback over the last two A.F. stages to reduce harmonic distortion and increase the damping factor. Use of a pentode of this type as opposed to a triode of equivalent output results in a considerable economy in power supply components, because of the higher power efficiency of the pentode. Thus, chokes and condensers of smaller rating can be used, and this factor had considerable weight in 1944 due to the general shortage of components at that time.

The method of negative feedback used lends itself to a simple and effective method of tone compensation by variation of the frequency response of the feedback circuit. Negative feedback takes place from the anode of V4 through C2 and R2 to the cathode of V3. With C2 = 1 mfd., the reactance of the latter is low compared with R2 and R3 in series, therefore bass and treble frequencies are fed back to much the same degree, and the response curve is reasonably flat. With C2 switched to 0.1 mfd., its reactance to bass frequencies is appreciable, though its reactance to treble frequencies remains negligible. Thus, less negative feedback (and hence more gain) occurs in the bass, though the treble remains at the same level as before. Still more bass boost can be obtained by further reduction of the value of C2 to 0.02 mfd.

It is not an easy matter to calculate the response curve of a circuit of this nature, due to the complicating effects of phase shift, but these values of C2 were chosen as the result of trial and error and would no doubt vary somewhat with individual equipments and tastes.

It was decided finally that bass cut was not required with the particular reproducing system in use, so this facility was omitted. It could, however, easily be provided if required by switching smaller values of C3.

Treble boost is obtained by means of C4 and R1. With R1 = 0, C4 shunts R3 for treble but not for bass frequencies. Thus, negative feedback is reduced as the frequency increases, resulting in treble boost. This boost can be reduced by increasing the value of R1, which limits the effect of C4 as in the tone-control circuit commonly employed in commercial receivers in the anode circuit of the output valve.

With R1 at maximum, negative feedback occurs in the treble to the same extent as at other frequencies, therefore one would expect a flat treble response. Actually treble cut occurs, which gives a variation from boost to cut with a single control. This treble cut is due to two causes:

(a) Slight sideband cutting by the R.F. tuned circuits.

(b) The fact that loss of treble will normally occur in an A.F. amplifier with simple negative feedback. This can be proved mathematically.

This type of tone compensation has several advantages over more usual methods, viz.:

(a) The level of the middle register remains constant, the bass and treble being boosted or cut with reference to this level. Using normal methods, boost is obtained by cutting frequencies other than those to be boosted. This entails readjustment of the volume control each time the tone control is altered in order to maintain the same apparent volume.

(b) Few extra components and the minimum of switching are required.

It is important to ensure that the H.T. supply is exceptionally well smoothed, otherwise a hum level, which may be reasonably low without bass boost, will become intolerable when using maximum boost. Also, the reproducing system must be free from noticeable resonances and a really good output transformer using plenty of copper and iron is essential.

Results Obtained

A Baker's Selhurst triple-cone speaker was used with this particular set and was mounted in an "infinite baffle" cabinet measuring about 2ft. by 2ft. by 2ft. The walls of the cabinet were made with two layers of ⅝in. deal lined internally with about 3in. of felt. With this system speech could be reproduced without boom, even when using maximum bass boost, though, naturally, in this condition the balance of tone was not correct. This test does indicate, however, that bass resonance was not troublesome.

An extra stage of A.F. amplification for gramophone reproduction is used in order to ensure that the output levels with the switch at "Radio" or "Gram" are about the same, and hence to avoid a blast of noise on switching from "Gram" to "Radio" without adjusting the volume control.

The R.F. filter in the mains input was found necessary in this particular equipment to avoid modulation hum. It could probably be omitted in most cases, especially if a mains transformer with screened primary were used.

Results were well worth the time and trouble spent on the set. Quality on radio was limited by the war-time quality of B.B.C. transmissions, which consisted at that time of a very high proportion of recorded programmes. Bass boost was particularly valuable on gramophone records, especially certain records of piano music, where the use of maximum bass boost added considerably to the realism. Maximum treble boost was rarely necessary, and at night could not often be employed due to the prevalence of the usual heterodyne whistle. A really sharp 10 kc/s filter would have been valuable, but unfortunately the writer was posted overseas before he was able to grapple with this problem!

Programme Pointers

(*Continued from page* 200.)

than the finale of the B flat minor sonata, which follows the "Funeral March" without a pause, and has been called the rustling of the wind over the grave!

Tschaikowsky's Death

Tschaikowsky's Sixth Symphony has been named the "Pathetic," presumably because of its solemn quasi-tragic vein, which is probably over-emphasised by the fact that the composer mysteriously died three months later, whether by drinking tainted water—of which he had been warned—which led to cholera, or through shooting himself, is not known. The former was the official account.

Famous modern examples of orchestral programme music are chiefly in symphonic poem form, and set out to paint in tone colours famous literary subjects. Tschaikowsky's "Romeo and Juliet," and "Francesca da Rimini"; Elgar's "Falstaff" and "Frossiart"; Strauss's "Don Juan." Here the plots of these famous stories can be faithfully followed if we know them beforehand . . . Sir John snoring, Don Quixote tilting at the windmills . . . and all the other scenes are there to the life.

Works like Elgar's "Cocaigne" (London Life), Strauss's "Life and Death of a Hero," Debussy's "Afternoon of a Fawn" and "Cortege," Delius's "Paris" or "Walk to the Paradise Garden," etc., etc., are more controversial because more abstract. All our ideas of subjects like these must of necessity vary within very wide frontiers, just as they would in politics or religion. What we have to do is to get in tune with the composer and try to see eye to eye with him and appreciate his point of view.

All these titles are necessarily authentic because they are the works themselves.

Practical Hints

A Handy Source of A.F.

HERE is a method I have devised of having a source of audio-frequency handy on the work-bench.

This is very useful for checking output stages of sets, modulating oscillators, testing output of amplifiers and speakers, etc., for response on various frequencies. The records used are of speech, music, and a frequency record such as *Decca EXP*.55, which gives constant pure tones of 6,000 c/s down to 50 c/s and has a stroboscopic label.

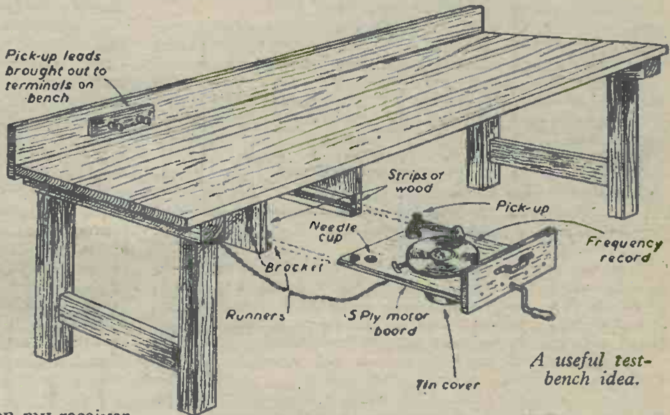
The sketch is almost self-explanatory, and I leave dimensions to individual requirements. The two pieces of wood (⅜in. thick) which carry the "drawer" are fixed to the underside of the bench by four shelf-brackets.

The motor's dust cover is an old circular biscuit tin cut down (leaving tabs to bend over to screw to motor-board).

There is a stop (not shown) to prevent the drawer being pulled right out.

The square section piece of wood, which fixes the "drawer"-front to the motor-board, should be made about 1in. shorter than the "drawer," so that the latter can go right "home." Similarly the "drawer"-slides should be about ¾in. less in length than the depth of the bench, so that the front of the drawer is flush with edge of the bench when closed.

An electric motor would be better, but clockwork models are more easily come by these days. The handle should, of course, be removed when not in use.—JOHN A. G. LAVENDER (Hounslow).



A useful test-bench idea.

Eliminator Switching

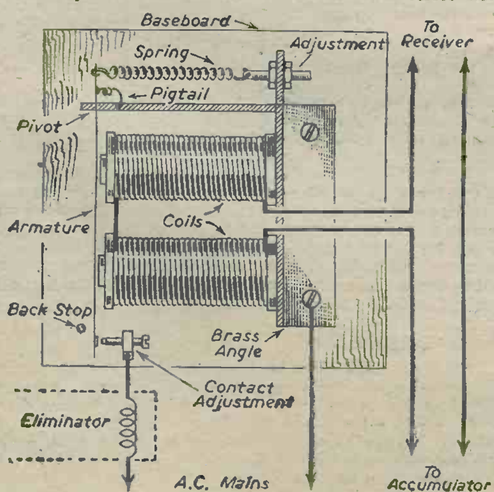
THE following device has been in use on my receiver for several months without the need arising for any attention whatsoever.

A relay was constructed for inclusion in series with valve filaments and L.T. supply, this coming into operation when set is switched on in normal manner. This relay closes mains feed to eliminator and H.T. is thus supplied automatically.

This has completely solved my eliminator switching problems, and ensures that at no time can H.T. be applied to valves before L.T. circuit is made and, of course, vice versa.

Many readers may object to the idea of a resistance, i.e., relay winding in L.T. circuit, but if a hefty gauge of wire is used (in my case No. 10 S.W.G.), and all other leads kept short, voltage drop is negligible.

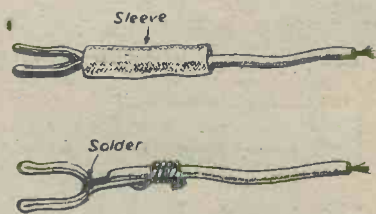
The relay was constructed from an old bell movement. This should cause no trouble to any experimenter.—P. CURTIS (Mans.-Woodhouse, Notts).



Mr. Curtis's idea for H.T. eliminator switching.

Home-made Spade Ends

THE accompanying diagram shows a simple tag which I have found very easy to make, besides being cheap, necessitating only a few inches of 18 T.C.C.



The spade ends made by Mr. W. J. Morris.

I find the few turns on the sleeves ensure a very long life to the lead. The test leads I use have the Systoflex bound with thread at the spade end.—W. J. MORRIS (Hayes).

Old Circuits Reviewed—1

This Article, the First of a Series, Deals with the Chitos, Ultra-Audion, Filadyne, and Cockaday 4-circuit Receivers

By W. NIMMONS

THE majority of present-day detector arrangements are based upon the Hartley circuit, and certainly this circuit is efficient, moderately selective when used under the proper conditions, and gives tonal purity. The host of other circuits which can be made to detect has gradually faded away from the memories of all save the oldest experimenters; whilst to the newer generation they might to all intents and purposes have never existed.

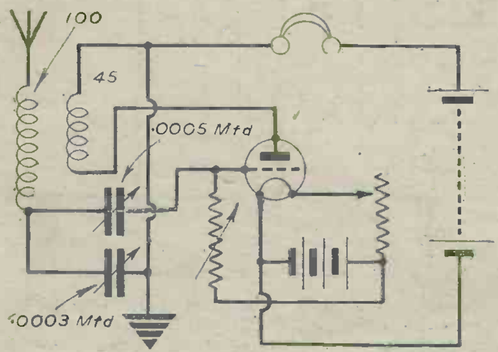


Fig. 1.—The Chitos circuit.

It is to this latter group that the present series is mainly addressed. Many profitable hours can be spent trying out old and almost forgotten circuits. There is the additional incentive in trying to make the circuits meet modern conditions, for when they were in vogue very different conditions obtained in the way of transmitters.

All the circuits given have been tested and tried by the writer in the past month or two, and where improvements suggested themselves these have been incorporated and a totally new circuit evolved. The old circuits used swinging coils to produce reaction effects, but no one nowadays would tolerate this clumsy method of varying the coupling. So I have taken the opportunity to make fixed coils and condensers do the work in the majority of cases. The exceptions are in a few circuits only, where owing to the peculiar arrangements reaction is controlled by dimming the filament. This is not an ideal method; in fact, in the light of modern knowledge it is strongly to be condemned, but it is the best that can be done under the circumstances.

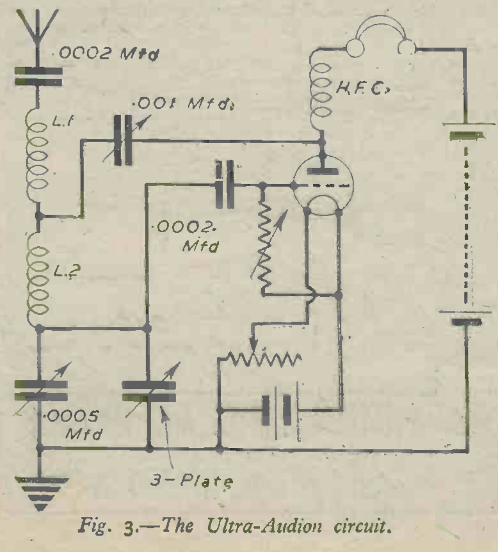


Fig. 3.—The Ultra-Audion circuit.

The Chitos Circuit

The first circuit which I propose to present is a simple but effective one. Known as the Chitos, it was much lauded in the wireless journals of twenty years ago. The original circuit is indicated in Fig. 1. It is described as a simple one-valve set that is selective and yet capable of bringing in distant stations.

As the circuit is one in which the aerial inductance should be as high as possible and the tuning capacity as low as possible, a larger coil than usual is used in the aerial circuit. This is tuned by the .0003 mfd. variable condenser, the .0005 mfd. condenser acting as a variable grid condenser. This is necessary, as it "peaks" to a station. Note the unusual earth connection. Reaction can be controlled with fixed coils by dimming the filament, or by means of a condenser used in conjunction with an H.F. choke (Fig. 2).

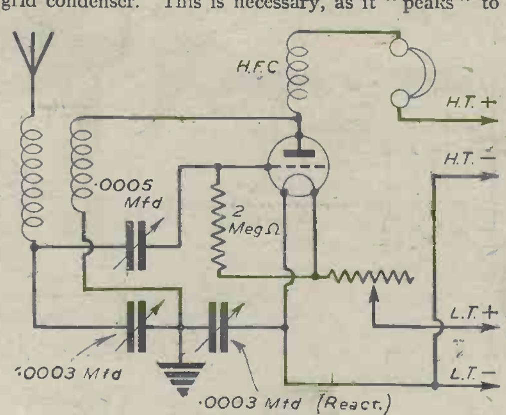


Fig. 2.—A modified Chitos circuit.

As might be expected with the aerial connection, selectivity with the Chitos is very poor—at least, in the writer's location, where there is a 100 kW. station about twelve miles away. Any attempt to sharpen up the tuning by putting a condenser in series with the aerial seriously affects the volume obtained. Perhaps others will be luckier in regard to location. As it is, the station spreads half-way round the dial.

The Ultra-Audion Circuit

The next circuit was known as the Ultra-Audion, and the original circuit is given in Fig. 3. This is a circuit in which the aerial inductance is connected in series with the tuning condenser, the latter being connected between grid and earth. On referring to Fig. 3 it will be observed that there are two condensers in this position, i.e., a .0005 mfd. and what is described as a three-plate condenser; this latter is really in the nature of a vernier, and can be dispensed with if the condenser is a modern one with slow-motion control.

Similarly, the variable grid leak can be replaced with a fixed one, 2 megohms being a suitable value. The .001 mfd. variable condenser originally specified for connection between the anode and the coil is evidently a mistake, .0001 mfd. giving plenty of regeneration. The grid condenser can be .0002 mfd. or .0003 mfd. A condenser can be used in the aerial circuit to improve selectivity.

The two coils, L1 and L2, can be wound on a 2½in. dia. former, both having about 60 turns of No. 28 D.S.C. wire. The space between the coils should be about ¼in.

This circuit proved so loud in the 'phones that a pentode was tried. The amended circuit is shown in Fig. 4. It will be observed that a differential reaction condenser is used, and that a variable (preset) condenser is used in the aerial.

At 100-volts on plate and screen, this circuit worked a loudspeaker at quiet volume, whilst with 150-volts the volume was satisfactory on the loudspeaker. Care should be taken with 150-volts not to tune away from the station, as the H.F. energy is then absent and the grid-leak becomes inoperative. This results in a rise in anode and screen current, and the valve might become damaged. The valve is, of course, an L.F. pentode, such as P.M.22A, an H.F. pentode having too high an A.C. resistance to operate a loudspeaker satisfactorily.

The Ultra-Audion as shown in Figs. 3 and 4, however, is not so selective as some of the other old circuits I have tried. This may be due to my location, with a 100 kW. station only twelve miles away, as previously mentioned. In fact, with Figs. 3 and 4 the Home Service on 285.7 metres completely swamped the Light Programme on 261.1 metres. This is not so bad as it sounds, however, as even the Reinartz circuit cannot separate

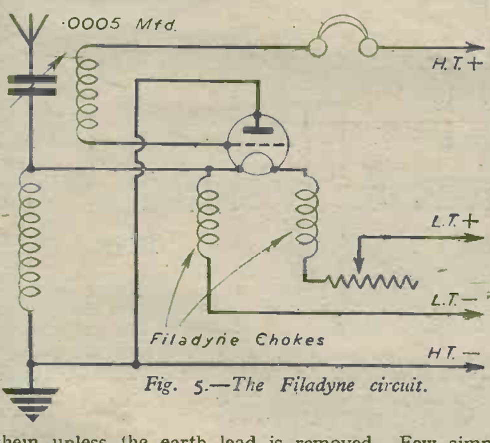


Fig. 5.—The Filadyne circuit.

them unless the earth lead is removed. Few simple circuits show much discrimination between wavelengths as close together as this, although as will be seen later, the Cockaday 4-circuit set not only separated them, but received a French station between them free of interference.

In the old days, of course, stations were few and comparatively weak. Hence we see that old circuits are designed for maximum sensitivity, with large aerial coils, no condensers in the aerial lead, etc. Nowadays, with more powerful stations, the need for selectivity rather than sensitivity is the overriding consideration in the detector circuit. Nevertheless Fig. 4 can be recommended as a one-valve loudspeaker circuit for those who live close to a station, providing the valve is given plenty of H.T.

The Filadyne Circuit

Next we come to the Filadyne circuit, as shown in Fig. 5. This is a very interesting circuit, and as will be seen, the main feature is the filament chokes inserted in each filament lead. These chokes are wound with heavy gauge wire to carry the necessary current without excessive voltage drop. By "heavy" I mean wire of No. 26 gauge, not the fine wire used for H.F. chokes which has too high a resistance. With the normal .1 amp. detector valve, which has a "hot" resistance of 20 ohms, we require a resistance of 20 ohms in series with the filament when used with a 4-volt accumulator to

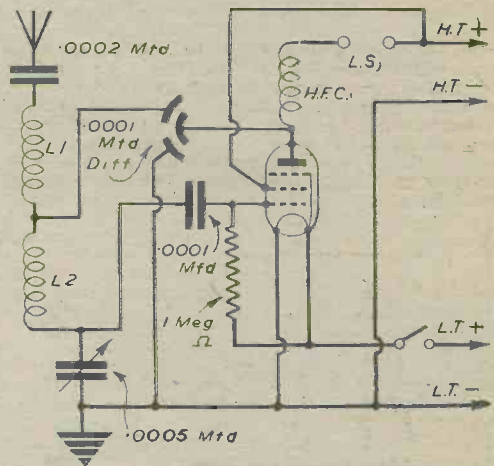


Fig. 4.—A modified Ultra-Audion circuit.

reduce the voltage to 2 volts. Obviously, it would be impracticable to employ really heavy gauge wire in an attempt to reduce the resistance of these chokes to negligible proportions for use with a 2-volt accumulator with a 2-volt valve, since they would be unduly bulky. By using a 4-volt battery the chokes which we require for the Filadyne circuit become reasonable in dimensions.

When originally designed we then used a "60" coil for the medium waves and a "150" for the long waves, with a "35" and "75" respectively for reaction, all plug-in, of course.

By using No. 26 gauge wire in conjunction with a 4-volt accumulator these considerations are greatly simplified. Twenty ohms of this wire are equal to 212 yards, and weigh a little over ½lb. So that two ¼lb. reels serve admirably for the chokes, one in each filament leg. They can be secured (about 6ins. apart) by passing a long threaded rod down the centre of the reel. In addition, a rheostat of about 20 ohms is needed to dim the filament.

If the valve you are using is opaque so that its glow

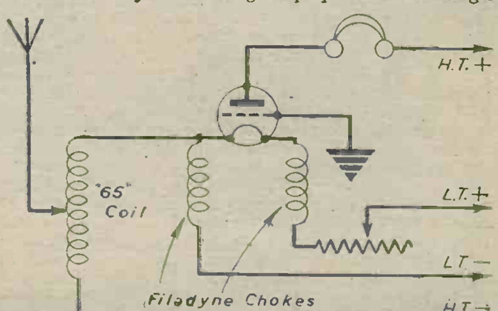


Fig. 6.—This Filadyne circuit receives the local station without tuning.

cannot be seen, use a voltmeter to ensure that it does not get more than 2 volts, or try one whose glow can be seen; it should not be brighter than when used with a 2-volt accumulator.

The Filadyne circuit is quite unconventional. As will be seen, instead of the H.F. impulses being fed to the grid of the valve they are passed to the filament. Therefore, the electron stream is controlled at its source. The writer regrets to report, however, that regeneration was not obtained, the conditions of negative resistance not being suitable with a modern valve.

Incidentally, by making the plate the collector electrode instead of the grid, we are left with the tantalising prospect of a valve with an untenanted grid. Fig. 6 shows it with an earthed grid, and the valve works this way; but why not feed the plate current to the primary of a transformer, the secondary going to the grid? The writer tried this, and got the usual morse oscillator type of howl, but there is room for experiment here, and someone may hit on an improved type of circuit.

By feeding the filament current through the tuning coil (Fig. 7) we can evolve a high-tensionless circuit, which gives good loud 'phone strength when the filament is at normal heat. In most cases the filament must be dimmed with this circuit, the actual operating temperature being quite critical.

Before leaving this interesting circuit I refer you to a more ambitious set. It employs a pentode H.F. stage, Filadyne detector, and a transformer coupled output pentode. The circuit will be given in our next issue.

It works off a 4-volt accumulator, and the two 2-volt pentodes have their filaments in series across the battery. The Filadyne detector has the usual filament chokes, which must have a resistance of 10 ohms each, or a total of 20 ohms when using a .1 amp. detector valve. The H.T. to the Filadyne detector is best determined by experiment, but is around 45 volts.

The Cockaday Circuit

The next circuit which I propose to deal with is the Cockaday 4-circuit set, which was once very popular. The set is quite easy to operate, but may be found a little difficult to build from brief directions, as the inventor laid great stress on exact spacing, etc.

The special feature of the circuit is the single turn inductance, A, connected in series with the aerial. This is coupled to the stabiliser coil, B, which, in turn, affects the tuned secondary circuit, C. The tuning of the aerial circuit was effected by a separate coil, D, which was varied by tappings.

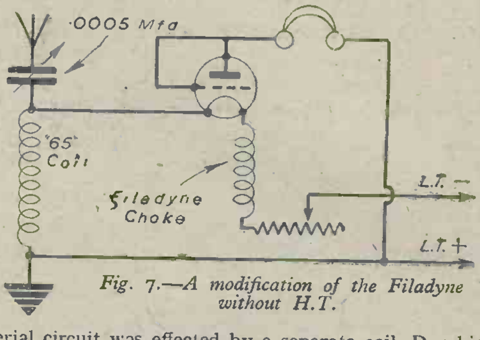


Fig. 7.—A modification of the Filadyne without H.T.

The coils A, B and C were wound on a 3½in. dia. former. A consisted of one turn of No. 14 bare wire; B of 34 turns of No. 18 S.C.C.; and C of 65 turns of No. 18 S.C.C. wire. B and C are first wound on the same tube, spaced a little apart, and then A is wound directly over the stabiliser coil B, at about ¼in. from the beginning of it.

The inductance D consisted of 43 turns of No. 18 S.C.C. wire wound on a separate former 3½in. in diameter, tapped at 1st, 3rd, 7th, 13th, 21st, 31st and last turns. The wavelengths covered range from 150 to 550 metres, when condensers of .0005 mfd. are employed.

This receiver gives excellent results in skilled hands, and was designed for areas with very bad jamming.

(To be continued)

Grinding Quartz Crystals

Getting Prepared for Amateur Transmission. By R. BALDWIN, G3WZ

A GOOD many readers must be very cheerful over the prospect of the early resumption of amateur transmitting. Those who held transmitting licences before the outbreak of the war are now being issued with licences covering 10 and 5 metres. But it is going to be weeks or months before the G.P.O. can make all the arrangements for licensing newcomers. Meanwhile quite a lot can be done against the day when your first rig goes on the air.

One of the most interesting of radio activities is crystal grinding, and the beauty of it is that the necessary gear is cheap. To grind ready-cut blanks of quartz from an oculist or crystal manufacturer (blanks come in flat discs the size of a shilling), all that you need is a piece of plate glass and, from any motor accessories dealer, a cheap tin of valve grinding paste as used for grinding the valves of petrol engines. Lastly, buy or borrow a micrometer screw gauge.

A crystal holder can be made of two brass discs the size of halfpennies or by grinding flat one side each of two foreign copper coins (Fig. 1). Fix one disc on a square base of insulating material with two terminals—one is for connecting to the base disc. Solder a long bolt and a piece of fine gauge copper wire to the one to be the top plate of the holder. Take the free end of the wire to the other terminal.

Next assemble a battery valve in the circuit shown in Fig. 2. When the anode condenser of the arrangement is brought to the resonant frequency of the crystal in the holder the meter needle in the anode circuit will "dip." The frequency of your unground blank is likely to lie in the MF broadcast band or below 200 metres. You can find out the approximate frequency by listening

(Continued on page 211)

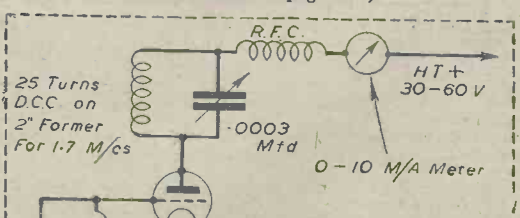


Fig. 2.—Test oscillator for the crystals.

(*Continued from page* 208)

to the oscillator on a simple receiver. The harmonics of the main frequency will fall at regular multiples right up to high frequencies. If you can identify these on a well-calibrated short-wave set you should be able to verify your primary frequency to within a kilocycle or so by dividing the tenth harmonic observed frequency by ten or the eleventh by eleven, for instance.

How to Grind a Blank

The best band to grind a crystal into, if you have had no previous experience, is the amateur band of 1,715 to 2,000 kc/s (pre-war). If you take your crystal to the L.F. end it will double down into the other amateur bands.

The method of grinding of a blank is simple. Smear some of the valve grinding paste on the plate glass, press your blank down with your fingers and rub it over the glass in irregular spirals. When the paste loses its power after a minute or two you can add more or re-test the frequency of your crystal by washing and drying it and putting it back between the holder and making it oscillate. Crystals are fragile! Be careful when testing with the micrometer to see that you are not getting bumps or hollows on the crystal, or grinding one end thinner than the other. Remember, by thinning up the crystal you can increase the frequency, but once you have gone past the frequency you are aiming at—you cannot go back. So beware!

At present you may find it very hard to obtain crystal blanks—but do not despair. Go to an optician and ask him if he has a stock of old lenses from broken-up spectacles. If he has any quartz lenses he will call them "pebbles" and there is quite a chance they are cut in a piezo electric plane and will oscillate. The author has often borrowed for testing the whole lens stock of an old gold dealer who breaks up spectacles—a big toffee tin full of lenses of every sort! It is possible to test such lenses with a polarimeter to see if they are quartz—but polarimeters are not exactly common and in any case there is a simpler way. You can use any set with an oscillating detector valve for the waveband 200 to 350 metres—most quartz spectacle lenses have frequencies in that band. Place a lens to be tested close to the grid coil of the detector. After making sure neither aerial nor earth is connected, let the set oscillate and rotate the tuning dial. Since a lens has a gradation of thicknesses each piezo electric lens will chirp as the detector oscillations excite it at a number of frequencies. Once heard the chirps are never forgotten—a quick spin of the tuning dial converts the chirps into a noise like the crunching of silver paper. Placed in the holder of the actual oscillator a lens may hop right out as the anode circuit is brought to resonance—you can see a series of little violet sparks if you get the crystal hopping in the dark. You can test plenty of lenses in half an hour with a little practice. The sort most generally quartz are the small oval Victorian type. Those with concave surfaces show signs of piezo electricity, but can never be made to function properly as oscillators for reasons which have never been cleared up.

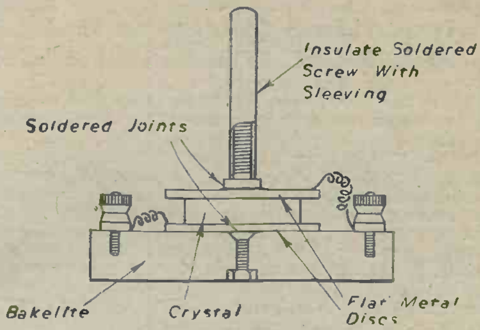


Fig. 1.—The crystal holder.

Grinding the Crystal

When you have got a good lens, grind off the flattest side, then start on the other, keeping the ground sides absolutely parallel and making frequent frequency tests. Your crystal will probably be cut parallel to one of the vertical sides of the quartz crystal matrix and will therefore be "Y" cut—but since the "X" axis has an intercept also in it, it will probably have two resonant frequencies, widely separated; one of these, the higher, will be a spurious one and should be kept in mind, but normally disregarded.

Remember that your test oscillator is technically a transmitter and should be built in a metal box. If you use only a few volts and a small battery valve it will have less power to transmit than a normal oscillating receiver and additionally it will have no aerial.

You will ultimately be able to get your crystals issued with a calibration certificate—acceptable to the G.P.O. in connection with granting transmitting licences—by sending them to the R.S.G.B. calibrating bureau, which hasn't yet restarted activity.

NEW CATALOGUES

Ardente Acoustic Laboratories

AN attractively printed 80-page catalogue has now been issued by the well-known makers of public address equipment. This fully describes some interesting "intercom" equipment; portable and stage amplifying equipment; "deaf aids" for theatres and cinemas; electronic carillon and organ for chapels and churches; "paging" equipment for hotels and restaurants and ship loud-speaking equipment. All of the products appear to be of the highest standard of design, and traders who are interested in the installation of P.A. systems may obtain details from the Ardente Technical Department, who are keen to co-operate by offering suggestions as to the type of equipment best suited to the work in hand.

The "Intercom" equipment supplied by Ardente is available in various different forms, each of which is designed to fulfil a special function, either in the factory, shop or home. This equipment is in unit form and with pre-designated cables, installation is very easy.

Eddystone

MESSRS. STRATTON & CO., LTD., makers of the well-known Eddystone short-wave equipment, have produced an 8-page booklet describing their radio-telephonic main station transmitter and mobile transceiver. The latter is designed to fit into the boot of a car, with the loudspeaker under the dashboard; the on/off control panel on the dash, and the hand telephone fitted in the left-hand cubby hole of the dash. This equipment is ideal for police, fire-brigade and similar bodies.

Bulgin

"1939-1945" is the title of a booklet issued by Bulgin, explaining how they turned from peace to war production, and giving details of some of their activities in cold figures. Amongst these may be mentioned that during the period in question no fewer than one and a half million lampholders were made in addition to two million switches, one million signal lamps, two million knobs, etc. These all had to conform to rigid Service specifications, and Messrs. Bulgin are now actively engaged in getting back to their old peacetime standard for the home constructor, as well as for the manufacturer.

Radar—1

Extracts from a Speech to the Physical Society on January 2nd, 1946, by Sir Edward Appleton, G.B.E., K.C.B., Secretary of the Department of Scientific and Industrial Research

I SEE that this lecture has been announced as being on Radar, but I imagine that every one of you will know that radar is the same thing as Radiolocation—a term I myself prefer, because it is almost self-explanatory and also because it is British.

Now, due to the need for complete secrecy concerning our radio plans before and during the war that has just ended, there must be many people who have asked the simple question: "What *is* radar?" and have been unable to obtain a satisfactory answer. Now, I always feel that the best way to answer the question "What *is* radar?" is to start first by explaining what radar is not, because there has been a certain amount of confusion on the subject.

We have long been familiar with radio methods of locating the positions of any particular agency which is itself emitting radio waves. If a ship is sending out radio waves it is possible to find its position using two direction-finders situated at the end of a suitable base line. For example, if two direction-finders determine the direction of arrival of the waves from the ship, it is possible to find the position of the ship by finding the intersection of those two directions. The same method would apply to the location of lightning flashes emitting atmospheric disturbances. Indeed, this particular application has been greatly developed during the war in connection with storm detection at a distance.

But, in preparing to defend ourselves before the war we knew that it was quite certain that enemy ships or aircraft would not announce their approach to our shores by transmitting radio signals which we could detect. A method had, therefore to be developed which would give us the positions of aircraft or ships whether they sent out radio signals or not. Such a method is provided by radar. Now a solid body reflects radio waves. It cannot help doing this, and it is by means of the waves it sends back that it gives away its position and can be detected. The process of radio reflection is therefore the basic feature of radar, and the problem to be solved is simply that of finding exactly where the reflection takes place.

Now it is of interest to note that Marconi, as far back as 1922, suggested that, since he had noticed the effects of distant reflecting metallic objects in his short-wave experiments, it should be possible for one ship to detect the presence of another by floodlighting it with a beam of radio waves and detecting the waves reflected from it. But you will see that in an experiment of this kind we should get only the bearing of the reflecting object and not its distance away, so that we should not get a complete specification of its position.

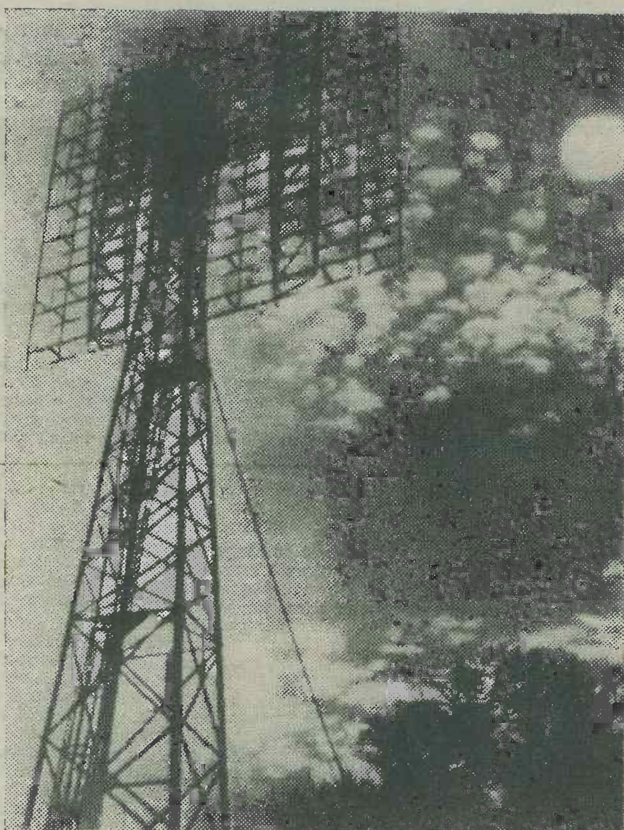
Speaking generally, we can specify the position of an object in terms of three co-ordinates. Azimuth is measured from north in the ground plan; elevation is measured from the horizontal. If, following Marconi's suggestion, we had a very narrow radio beam with which to search for reflecting objects, we could find both azimuth and elevation by finding the direction which gave us maximum reflection. But there is still one quantity missing—namely, range. That is the essentially new quantity determined in radar and that is how the name Radar is derived:—

*Ra*dio, *D*irection *a*nd *R*ange.

Radio Range Measurement

Now the floodlighting waves travel out from the sender and back with a known speed. If, therefore, we can time them on their journey there and back we can measure the distance. The question therefore is this: "How can we measure this small interval of time?" To do this it is necessary to put some sort of mark on the waves so that we can recognise them when they return.

In wireless language we say we must modulate the wave. Now, a radio wave has two characteristics,



Radar contact with the moon was made for the first time in January by the U.S. Army Signal Corps scientists. Pulses were sent at intervals of 5 seconds, and these were reflected back from the moon in about 2½ seconds. It is anticipated that surveys of the moon's surface will now be practicable by means of radar. The above illustration, received by radio from New York, shows the aerial on Evans Signal Laboratory at Belmar, New Jersey, from which the signals to the moon were sent.

namely, frequency and amplitude, and we can modulate either to enable us to measure time of travel. The result is that there are two different methods of radio distance measurement, one employing frequency-modulation and the other amplitude-modulation. The frequency-modulation method is of British origin while the amplitude-modulation method was first used in the United States, though it has been greatly developed since in this country.

In the frequency-modulation method the carrier frequency of a sending station is made to change uniformly through a certain interval, first increasing and then decreasing. Let's suppose that the graph of the frequency, in time, is shown by a continuous zig-zag line. Any local receiver would receive signals of the frequency variation shown by the continuous line. But now, if the waves *also* travel from the sender out to some reflecting object and back, and then arrive at the same receiver, it is easy to see that, since they arrive late, they will be, so to speak, always behindhand so far as their frequency is concerned. They therefore beat with the direct waves reaching the receiver. If we measure this beat frequency we can calculate the delay time and thus find the distance of the reflecting object.

The relevant formula turns out to be very simple and direct, namely :—

Beat frequency = (delay time) × (rate of change of carrier frequency).

The frequency-modulation method was first used in 1924 to find the position of the Heaviside layer in the upper atmosphere. We may therefore say that the first radiolocated reflecting surface was the Heaviside Layer.

Since we know the time scale of the record we can measure the beat frequency and using our formula we can calculate the delay time. For instance, if it is of the order of 2 milli-seconds, that means that the distance of the reflecting surface (F Layer) above the ground is 300 km.

But although the frequency-modulation method was developed and used for some years in this country since 1924, and was found to be specially suitable for the measurement of short delay times, it was found to have one serious disadvantage if multiple echoes were being received. You will readily see that it is easy to measure one particular beat frequency, but if two different beat frequencies, due to reflections from two surfaces at different distances, are being received, it is not easy to measure them both accurately.

It was for this reason that Dr. G. Builder and I, in 1931, turned over to the pulse- or amplitude-modulation method invented by Breit and Tuve in 1925. In this method of determining the distance of a radio-located object, short radio-frequency pulses are sent out at regular intervals. Each pulse travels out to the reflecting surface and on its return is detected. From the delay time the distance of the reflecting object can be measured, in just the same way as a seaman sometimes uses the echo from a sharp blast on a ship's whistle to determine roughly his distance from the face of a cliff.

Using the Oscilloscope.

It is, of course, inconvenient to have to develop a photographic record before the echoes can be detected and the ranges of the reflecting surfaces measured. It is far more convenient to have an echo display which can be continuously examined visually ; and for that reason Dr. Builder and I, in 1931, began to use, for our radio-distance measurement, a cathode-ray oscillograph with a linear time base which operated in synchronism with the radio pulse frequency. In this case the ground-ray or direct signal can be made to occur at the same place in the left-to-right sweep of the fluorescent spot, with echoes following according to their delay times.

Valuable improvements in the technique of synchronising the pulse frequency and the time base frequency with the electric mains frequency at 50 cycles per sec. were made by the late J. F. Herd, an Associate Member of this Institution, and also by J. A. Ratcliffe and E. L. C. White ; so that by 1933, the pulse method of distance finding with cathode-ray oscillograph display of the received echoes was the standard method of finding the range of a reflecting surface.

But before leaving this brief review of the two methods of radio distance measurement I feel I ought to draw your attention to an important feature of both of them. We saw earlier that Marconi, a true experimenter, foresaw that there might be some practical difficulty in detecting the reflections from any object because of the influence of the powerful primary beam. There certainly would be trouble if we tried to detect the reflected beam, with direction finders operating on continuous waves. In both of the two methods of distance measurement, however, we find that this difficulty is automatically solved. In the frequency-modulation method the amplitude of the received beats is independent of the direct radiation, while in the case of the pulse method the direct and echo signals do not occur together in time so that the latter can be observed however powerful the former.

In other words, and this is a point which I think needs great emphasis, the two methods of radio distance measurement are also, at the same time, excellent methods of echo-detection, in that they automatically reveal the presence of an echo, however weak it may be in relation to the primary radio beam.

Having now got our methods of distance measurement which automatically disclose the presence of echoes, we see that our fundamental problem of radiolocation is, *first*, to get enough strength in our primary beam to produce reflections which are detectable in the presence of the inevitable electrical noise in our receiver ; *second*, to use the well-known methods of finding the direction of arrival of the reflected waves at the receiving station ; and, *third*, to measure the distance of the reflecting object along that direction.

Radar helped the Dover Coastal Artillery to sink enemy ships on the blackest nights. The illustration shows an early Battery Fire Direction Radar Set on which the operator could watch the enemy ship's course.

I select first a particularly simple and easily understood example of radiolocation which is of use as an operational aid in flying. Just as we can radiolocate the Kennelly-Heaviside Layer by experiments made at ground level, so can we radiolocate the ground from an aircraft. We term the apparatus which enables us to do this an aircraft radio-altimeter. As I mentioned earlier, the frequency-modulation method is found, in practice, the more suitable method of radio distance measurement for short distances, and the designers of this radio-altimeter selected the f.-m. method as the basis of its design.

(*To be continued*)

Electronic Metronome

Operational Details of a Useful Instrument for Students of Music

By C. C. GRAY

THIS electronic metronome will be found very handy for all students of music, especially now when it is almost impossible to buy an ordinary metronome. It works on the principle of the multivibrator, in that it distorts the wave shape to produce a multitude of harmonics.

A multivibrator is essentially a two-stage resistance-coupled audio amplifier with the second stage coupled back to the first. By varying the size of the coupling condensers and grid resistors, oscillations—varying in frequency from the supersonic range to one or so per minute—can be produced. This instrument is so constructed that two frequency ranges are available, one in the range required for a metronome; the other suitable for a code practice oscillator.

The principle may be easily understood from Fig. 2. On the metronome range, audio output from the 6J7 is fed to the 6C5 grid. The 6C5 output is fed through a 0.5 mfd. coupling condenser back to the 6J7 grid through a condenser of equal size.

Variable 3-megohm grid resistors are provided. The frequency depends on the natural discharge rate of the resistor-condenser combinations, and if necessary can be calculated by the formula: $1/(R_gC+R'_gC')$ cycles per second. R_g, C, and R'_g and C' are the grid resistors and blocking condensers of the first and second valves respectively.

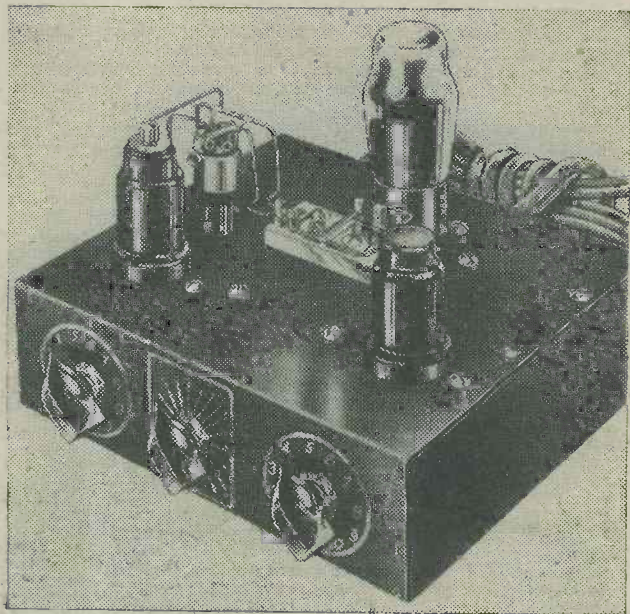


Fig. 1.—Electronic metronome. Tuning condensers are the trimmers in centre of chassis.

The 6J7 is connected also as an ordinary grid-tickler type radio-frequency oscillator, with one exception. The lower end of the grid coil returns to earth through a high resistance. When, as part of the multivibrator, the 6J7 is conducting, it oscillates at a broadcast frequency, determined by L_1 and C_1. Pulses of R.F are thus sent out at the multivibrator frequency.

The coil L_1, L_2, is an ordinary broadcast antenna coil; the low-impedance aerial winding is L_2, the grid-tickler winding. If this type of coil is unobtainable, you can wind your own, on a coil form 1½ in. in diameter. Wind 90 to 110 turns of No. 28 wire on this. The grid-tickler is composed of 15 to 20 turns of No. 30 or 32 wire. This should function satisfactorily with the two trimmer condensers in parallel, which serve as the tuning condenser, C_1, for the R.F. oscillator. No antenna is necessary, as there is sufficient radiation from this coil.

The multivibrator frequency range is much greater than can be obtained with a metronome. With the values shown in the schematic (Fig. 2) it is possible to obtain a beat as slow as 20 per minute. By switching in the .01 condensers the complete audio spectrum can be covered.

(Continued on page 216)

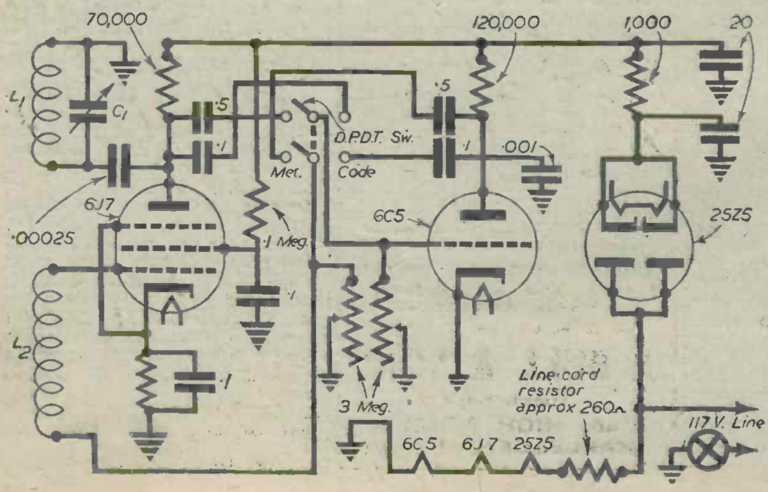


Fig. 2.—The metronome includes a multivibrator and an oscillator. It can be adjusted for widely different frequencies and even acts as a code oscillator. For higher frequencies the 0.1 condensers may be replaced by smaller (.01) units.

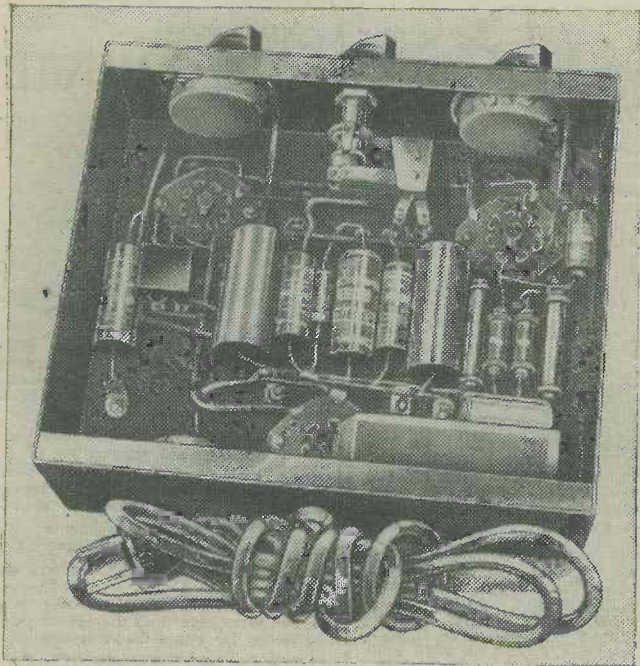


Fig. 3.—An under-chassis view of the instrument. Control in centre is the D.P.D.T. switch. Terminal strips help make a systematic layout and a neat wiring job.

(Continued from page 214)

When the .01 condensers are thrown in the circuit you have a morse practice oscillator that is different. A key can be inserted between the cathode and earth, and any desired tone can be obtained by varying the 3-megohm potentiometer.

Any suitable type valves can be used in place of the 6J7 and 6C5. A 6A7 would be particularly suitable, as you can use the plate and the No. 4 grid as the R.F. oscillator and the No. 1 grid for the multi-vibrator control. A type 76 works very nicely with a 6A7.

Operation of the metronome is simple. Just turn it on, tune it on your radio like a wireless gramo. oscillator, adjust it to the desired beat, and your radio will click out the rhythm while you proceed with your musical practice. One precaution: Be sure that you are not radiating such a strong signal that you are creating interference. The G.P.O. has established a definite ruling on that matter. *There must be absolutely no interference with other radio reception.* This is absolute. Should a neighbour in an adjoining apartment—say 30ft. away—hear your metronome or code oscillator while listening to a local station, your machine is clearly illegal.

(Should the same neighbour by tuning between two stations and turning up his volume control be able to hear the transmitted signals, this would probably not render the transmissions illegal as such reception could hardly be considered interference.) A simple formula for determining if your "transmitter" is illegal or not is:

$$\frac{157{,}000}{\text{frequency (kc/s.)}} \text{ ft.}$$

For example, if a device is operating at 550 kc/s. the permissible range is 157,000/550, or approximately 285ft.

(Reproduced from "Radio Craft.")

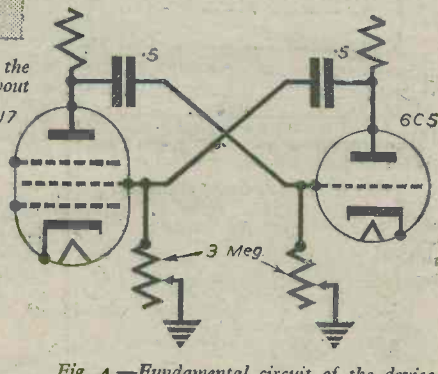


Fig. 4.—Fundamental circuit of the device.

Noises in Broadcast Receivers

Using a Counterpoise

The use of bandpass tuning and variable-mu valves is sometimes very helpful in reducing electrical disturbances as both tend to give a silent background. Another scheme is the use of a counterpoise earth. This has somewhat the same action as the frame aerial, although it is not so effective. In its simplest form it consists of an insulated wire similar to the aerial and placed directly underneath it. Naturally, this is not always a practical arrangement. The earth terminal of the set is joined to the counterpoise instead of to earth.

H.F. Interference via the Mains

It sometimes happens that most of the noise arrives via the mains, and not down the aerial. This can be tested by disconnecting the aerial. If the noise continues, then one can be fairly certain that the mains are picking up most of the unwanted impulses. Try a good H.F. choke in each lead with a fixed condenser across them. A .01-mfd. condenser (or larger in the case of D.C. mains) will be suitable.

Open to Discussion

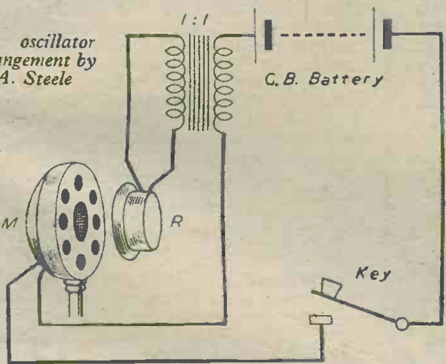
The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

Simple Morse Oscillator

SIR,—As a regular reader of your excellent magazine, I have noticed in your January issue the circuit and details of a morse practice oscillator.

While engaged as a radio mech. in the Army, I have constructed valve oscillators, but I have found that the most efficient and easily built morse practice set is of the regenerative type, using only a small carbon

The oscillator arrangement by A. Steele



microphone, one low resistance headphone, 1 : 1 transformer, key and a G.B. battery. The pitch of signal can be adjusted by altering the distance (usually about ¼in.) between the microphone and receiver.

The circuit is simple, as shown here.—A. STEELE (B.A.O.R.).

Rangoon Radio Schedule

SIR,—It occurred to me that some of your readers who are interested in DX work might be interested to have the schedules of Rangoon Radio, so I give them herewith (as they stood at December 17th, 1945).

00.15 to 01.00 6.04 mc/s. (49 m. band).
02.00 to 02.30 11.85 mc/s. (25 m. band).
05.15 to 06.00 6.04 mc/s.
06.15 to 06.45 11.85 mc/s.
12.30 to 14.00 11.85 mc/s.

All times are G.M.T. (7½ hours behind local time). Announcements begin "This is Rangoon Radio."

The times given are of the English programme, and I understand that the station has been received quite well in England recently. Thanks for keeping up the standard of your excellent magazine during the war.—JOHN A. R. GARNER (S.E.A.A.F.).

A Beginner's Log

SIR,—I have recently built a triode valve o-v-o, using a standard circuit. I use a 50ft. aerial and a good earth. Although I have an eliminator, I use an H.T. battery, as the freedom from hum makes it possible to log very weak signals. Here is my log up to date :

- 16 m. band : Leopoldsville ; WLWL Crossley Corp. ; CKNC.
- 19 m. band : WGEO ; WLWK ; CHTA ; WOOC ; WRUA ; American Forces Radio Service.
- 20 m. band : Radio Moscow WNRX.
- 23 m. band : WNRI.
- 25 m. band : Radio Brazzaville ; Radio Moscow ; American Forces Radio Service ; Switzerland.
- 26 m. band : Voice of America from Africa.
- 26.60 m. : CHOL Sackville.

The coil is wound with 16 s.w.g. wire. Although I have dabbled in wireless for four years, I am only fourteen. When I started I may have been Britain's youngest experimenter. I share Thermion's hate of jazz and swing, and I always read his article. When starting up I found ancient issues of PRACTICAL WIRELESS which my father had saved very helpful.—J. LENG (West Hartlepool).

Component Shortage

SIR,—Congratulations for your bold editorial commentary in the February issue of PRACTICAL WIRELESS, concerning the shortage of components ; I heartily endorse much of what you have to say. Whilst there is a limited number of components available, they are largely of a cheap and tawdry nature, and it is almost impossible to obtain components of any quality.

Despite their advertisements of late, one well-known firm were only able to supply a small proportion of a list of components I sent them recently, although the list included such commonplace items as resistors and 4 BA nuts and bolts. Some smoothing chokes from another firm are now more than six weeks overdue, and it would seem that they are so short of staff that they have, as yet, been unable to answer my letter of inquiry as to what progress is being made. These are just two recent examples of my own experiences.

I feel that the position is, to a great extent, due to the all too numerous Controls of both men and materials, for which we have only to thank Government administration. If men and women were given the freedom for which we have worked or fought for six years, conditions would improve rapidly.—P. W. FEESEY (Harrogate).

Amplifier-rectifier

SIR,—On reading "Open to Discussion" in the November issue, I was rather amused by the letter from J. Allen. I use the word amused with all respect to our friend, as I have had a similar experience myself, and it puzzled me for some time.

The reception of Klagenfurt transmissions on an amplifier is well known to us out here now, in fact I often make use of this freak reception when repairing the theatre amplifiers. I have no real evidence as to why this freak reception should occur, but I offer my own theory for criticism.

Klagenfurt puts out a fairly strong signal, and I assume that our friend is within 100 miles of the transmitter, if not less. Detection takes place due to stray capacity and resistance leakage most likely across the valve-holder. That, I think, will be accepted as being quite feasible. The next matter concerns the grid circuit. I expect J. Allen has a microphone transformer connected in the usual way with the secondary between grid and earth or grid and bias point. I suggest that the natural inductance and capacity of the secondary is such that the secondary alone will resonate at or near the medium wave frequency of the Klagenfurt transmitter, and thus acts as a tuning circuit. I should be interested to know whether J. Allen can receive this transmission on his amplifier with his mike in circuit. He did not state that he got this freak reception with his mike out of circuit, but I assumed this to be the case as I think he will find that with the microphone circuit completed the reflected impedance of the transformer primary will make this freak reception impossible.—E. J. COOPER (C.M.F.).

International Radio Language

SIR,—May I be forgiven for stating that Mr. Hardman's letter recalls the fact that Samuel Morse had to spend six years travelling in the U.S.A., Britain and Russia, trying to persuade governments and private corporations to take up his "dot and dash" invention before he finally overcame prejudice to his new idea?

Does Mr. H. seriously think that we Englishmen could be justified in pushing our own language as *the* international medium of communication, thereby compelling all Slav, Latin, Nordic, Semitic and Oriental radio fans to learn two languages while we Britishers would be called upon to learn only one?

Fortunately for hundreds of thousands of overseas serving men and women and their relatives at home our G.P.O. did not call upon them to incur heavy costs by compelling them to telegraph all messages in full in plain English, but devised a numeral code which enabled them to transmit certain fixed popular messages at charges which their men could afford. Why not then examine the proposal of any inventor who thinks he could provide a system whereby messages covering any subject could be transmitted in half the time required to tap out the same message in any national language?

I am so glad that Mr. Hardman agrees that world-wide benefits would accrue from an international language, and I plead with him to support those of progressive minds who are prepared to give pioneers an opportunity to have their inventions impartially examined.—REGINALD J. G. DUTTON (Skegness).

Cart Before Horse

SIR,—Surely the recent announcement that Radio Licences are to be increased from 10s. to 20s. a year is putting the cart before the horse? Surely this is a matter which should have been discussed in Parliament during the coming revision of the B.B.C. Charter instead of being put into operation by a mere order of the Ministry of Information?

Or is this the last dying kick of said Ministry before its long-promised abolition? Let us remember that this proposal, if carried through, will add another £5,000,000 in round figures to the amount we are already paying for a most unsatisfactory service. The payment of this increased charge is much less likely to bring us any better programmes than to ensure the retention of the B.B.C.'s present bloated staff of over 11,000, as compared with the Columbia Broadcasting Corporation's 800 employees.

The increase will be a severe hardship on many thousands of licence holders who now find practically their only relaxation and enjoyment through their radio sets, and who have to save up the cost of their licence a few coppers at a time. And what is in the offing? Is it intended that the B.B.C. shall be converted from a Public Corporation into a fully State Controlled Government Department . . . is that where our boasted freedom is to end?

Well, it has been truly said that a People gets the Government which it deserves, and it is really our own fault whatever happens to us if we tamely submit to every fresh form of imposition laid upon us. The revision of the Charter should come first, and be settled upon, before there is any suggestion of increasing the cost of the licences! Let the "customers" see what is going to be offered to them before they are ordered to pay twice as much for something they know nothing about.—K. T. HARDMAN (Birkenhead).

A Reader's Suggestions

SIR,—May I take this opportunity of making a suggestion which I feel sure will meet the approval of all your readers who like to retain their copies for reference.

No doubt, when paper restrictions are eased, you will be revising your cover design. May I suggest that, when you do so, provision is made for a short list of the special articles in the particular issue. This should preferably appear in the vicinity of the top left-hand corner for easy reference when searching and need only mention such things as constructional instructions or other technical articles.

Another thing I should like to suggest is that you use all your influence with the powers-that-be to get 10 k/c separation of stations internationally standardised, also so arrange matters that all channels used are a multiple of 10, so that manufacturers can engrave their dials accordingly, viz. 60, 61, 62, etc., channels. To the uninitiated this would be a great simplification as a station could be expected on each of these numbers and would be easily remembered, whereas those whose interest goes further would just add a nought and call it kc/s.

This would surely end the everlasting wavelength v. frequency war and benefit everyone all round.

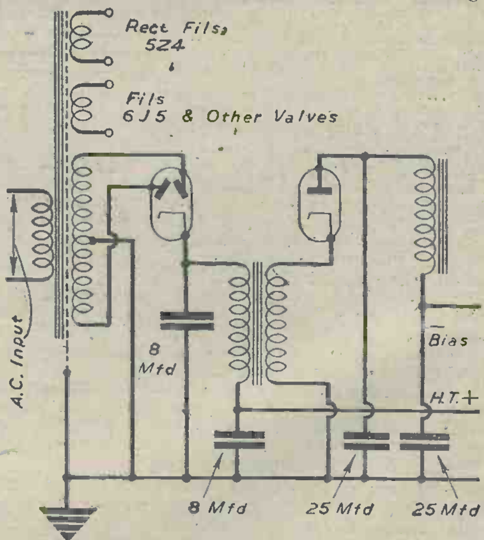
Finally, a little point of constructive criticism. I have noticed that not all your contributors are careful to state in their technical articles, the precise values of the symbols they are using, and the reader is often left to find out for himself whether L., F. and C. are in μH, μμH, kc/s, mc/s, mfds. or pfds., etc.

I am sorry to say that this annoying habit manifests itself too often also in some otherwise excellent textbooks, and I have even found cases, though here I am not referring to your journal, where the writer actually changes from one value to another in the middle of an article. It is all very well for the expert, he has no need to read it, anyway, but it is nothing short of a headache for a poor tyro like myself, trying to learn something.—C. JAS. BORWELL (Norwich).

[*What do other readers think of Mr. Borwell's suggestions?—Ed.*]

A Useful Power Pack

SIR,—I am a radio mechanic serving with the Fleet Air Arm in the Pacific, and until recently aboard an aircraft carrier. In addition to my normal duties I take a keen interest in radio and was wanting to build a power pack suitable for either a transmitter of low power or a receiver, but incorporating a negative bias line. I evolved a circuit of which the following is



The power pack referred to in P. O. Dean's letter.

the basis. One important feature is that as the H.T. load current increases, the –ve bias voltage increases. Thus, should a valve go "soft" or develop some other similar fault the bias will be increased and the circuit components safeguarded.

The values obviously depend upon the ratio of the transformer used. In the circuit I used, the bias was about 10 volts with a small load (a matter of a few mA.) increasing to 30 volts at 60 mA.

I pass this on for the information and interest of yourselves and readers.—P. O. DEAN (c/o G.P.O.).

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AMATEUR RADIO PRODUCTS have now available a 4-waveband Coil Unit, already wired and switched for a 2-valve S.W. battery Receiver. Coils, 9.8 to 24, 18.7 to 45.4, 38.4 to 95, and 92.3 to 206 metres. Only four wires to be soldered. Complete Unit with blueprint, 30/-. All coils have reaction winding. Individual coils, 3/3 each.—Amateur Radio Products, 50, Glasslyn Road, Crouch End, London, N.8. Phone : MOUnt View 4745.

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