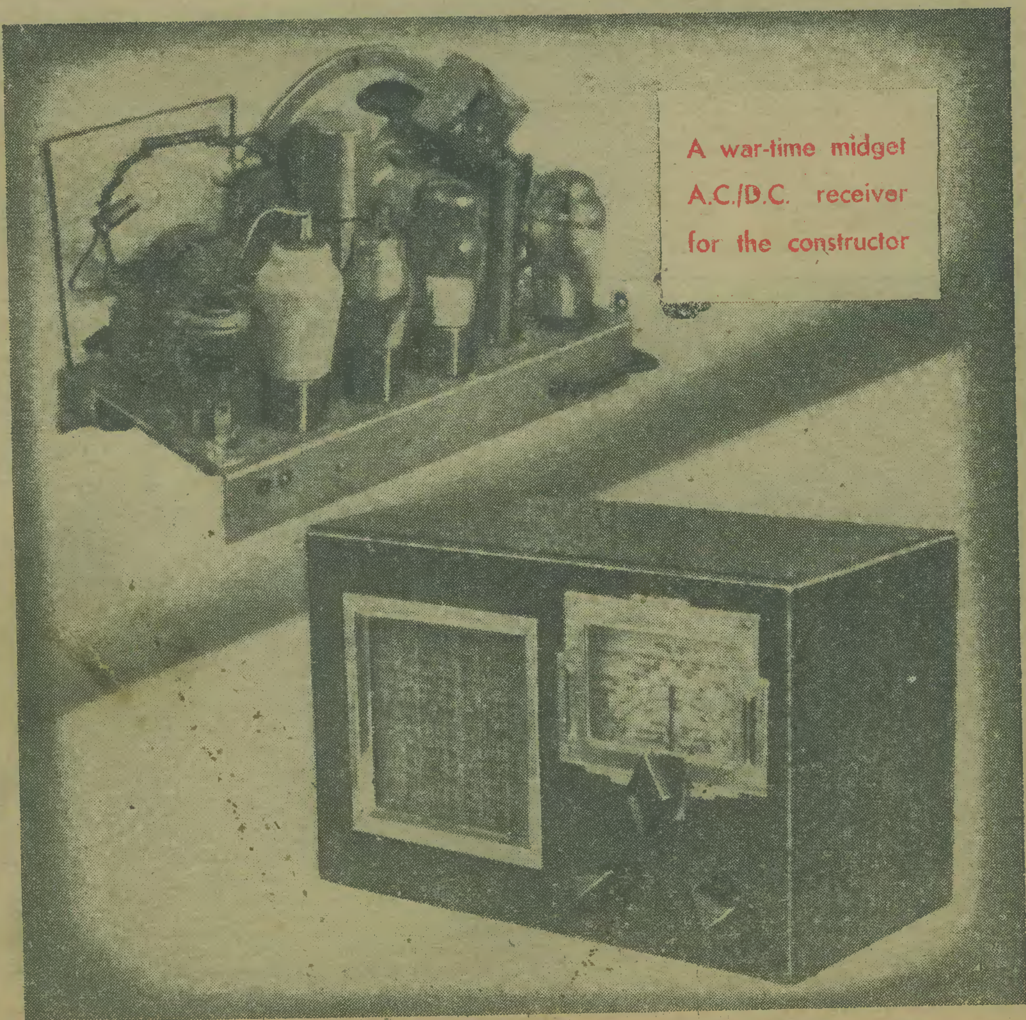
ATTENUATORS AND FILTERS

Practical Wireless

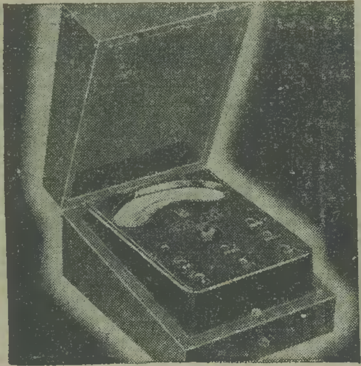
9D EVERY MONTH

Editor F. J. CAMM

Vol. 19. No. 439. NEW SERIES. JANUARY, 1943



A war-time midget A.C./D.C. receiver for the constructor



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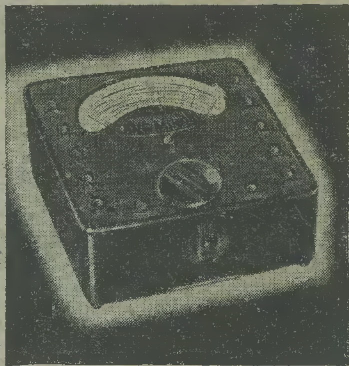

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Extensively used by radio manufacturers, service engineers and throughout industry, they set a recognised standard of accuracy and fine workmanship by which other instruments are judged.

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CLASS "B" UNIVERSAL OUTPUT CHOKE. Total D.C. resistance approx. 400 ohms. Ratios
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Price 7/6.

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Then purchase one of the new practice Oscillators.

Supplied complete with valve, on steel chassis 27/6

Practice Key, 3/3 ; TX Key, 5/9.

Super Model, on Wooden Base, 11/6.

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Will match any output valves to any speaker impedance.

11 ratios from 13-1 to 80-1, 5-7 watts, 20/-. 10-15 watts, 26/-.

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4-volt A.C. types, 5-pin. ACHL, ACSG, **5/6** each.

PREMIER 1 VALVE DE LUXE

Battery Model S.W. Receiver, complete with 2-volt Valve, 4 Coils. Covering 12-170 metres. Built on steel chassis and Panel, 55/-, including tax.

I.F. TRANSFORMERS

Iron-cored 450-470 kc/s. plain and with flying lead, **5/6** each.

ELECTROLYTIC CONDENSERS

Tubular wire end type, 8 mf. 125v., **1/6** each ; .25 mf. 25v., **1/6** each ; 50 mf. 12 v., **1/6** each ; 50 mf. 50v., **3/-** each ;

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Moving-coil Mike. Permanent Magnet model, requiring no energising. Response 90-5,200 cycles. Output .25 volt. average. Excellent reproduction of speech and music. **63/-.** Super Model, **£5 5s.**

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Mains Resistances. 660 ohms, .3 A. tapped 360 + 180 + 60 + 60 ohms., **5/6.** 1,000 ohms .2 A. tapped at 900, 800, 700 600, 500 ohms. **4/6.** 1 ohm ± 1 per cent., suitable for Bridges, **5/-** each.

2 **Way Line Cored Resistance.** 50 ohms per foot. Price **1/4** per foot.

Valve Screens, for International and U.S.A. types, **1/2** each.

Push-Back Connecting Wire, 2d. per yard.

Resin-cored Solder. 7½d. per coil.

Systoflex Sleeving. 2mm., **2/6** per doz. yards.

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Practical Wireless
and PRACTICAL TELEVISION
Vol. XIX. EVERY MONTH No. 439. JANUARY, 1943.
Editor F. J. CAMM
Staff: L. O. SPARKS. FRANK PRESTON.

COMMENTS OF THE MONTH BY THE EDITOR

Cadetships in Engineering

THE new scheme of engineering cadetships, leading to technical commissions in the Fighting Services should be of interest to many of our readers. Introduced by the Ministry of Labour and National Service it applies to boys between the ages of 16 and 19, who are invited to apply for engineering cadetships if they left school before October, 1942, are not employed in any branch of engineering, and have obtained at least the school certificate with a credit in mathematics or general science or physics. Boys satisfying these conditions who make application for engineering cadetships will be considered for interview by a selection board on which all three Services will be represented. Those judged by the board to have the personality and other qualities required for potential technical officers will be accepted for cadetships subject to medical examination. On acceptance, cadets will be required to sign an undertaking to complete their training. This undertaking must be countersigned by the cadet's parent or guardian.

The training of cadets will be carried out under the directions of the Education Departments. So far as can be arranged, each cadet will attend a technical college near his home. Cadets will cover during their courses in the technical colleges the basic engineering science required in the Associate Membership examinations of either the Institute of Mechanical Engineers or the Institution of Electrical Engineers. During his training a cadet will be a member of one of the pre-Service organisations or of the Home Guard. Membership of a particular organisation will, however, not necessarily determine the service in which a cadet will be commissioned upon the completion of his training.

Cadets will attend periodic lectures by Service officers and visits will be arranged to technical units and workshops.

Tenure of an engineering cadetship will be subject to satisfactory progress and conduct. Training will, as a rule, continue until the age of 20.

Length of Training

THE length and character of the training of cadets will be adjusted to their age and educational qualifications. In general, cadets aged 18 or 19 will attend courses of training at technical colleges for 18 to 24 months; cadets aged 17 will attend similar courses for 2 years and 6 months.

Boys of 16 will receive preliminary instruction at an appropriate technical college or other institution.

When the grant of new engineering cadetships ceases, a cadet who has not then completed his training may be called upon to do so; if not so called upon and he wishes to complete the course which he has begun, his cadetship will be continued to enable him to do so.

The Government will pay the necessary educational fees and allow each cadet a maintenance grant of £140 a year (in London £160 a year) if he has to live away from home, or £75 a year (in London £90 a year) if he lives at home.

Upon the successful completion of his cadetship a cadet will become a member of one of the Fighting Services and will receive special training in that Service. He will then be qualified to receive a commission as a technical officer. Every successful cadet will be equipped to give outstanding service to our cause in time of war and to obtain for himself a foundation for a professional career in time of peace.

Forms of application can be obtained from the Ministry of Labour and National Service, Sardinia Street, London, W.C.2, or from any of the Appointments Offices at the addresses shown below. Requests for forms of application should be marked on the envelope "Engineering Cadetships."

London: Sardinia Street, Kingsway, W.C.2; Brighton: 74, The Drive, Hove, Sussex; Tunbridge Wells: 31, Upper Grosvenor Road, Tunbridge Wells, Kent; Cambridge: Regional Office, Sidney Sussex College, Cambridge, Colchester: 31, John Street, Colchester, Essex; Norwich: 48, Prince of Wales Road, Norwich; Oxford: Exeter College Annexe, Turl Street, Oxford; Reading: 10, Kendrick Road, Reading, Berks; Southampton: 10-12, Westwood Road, Southampton; Bristol: 1, Apsley Road, Clifton, Bristol 8; Plymouth: 1, Thorn Park Villas, Mannamead, Plymouth Birmingham: 66½, Corporation Street, Birmingham 2; Coventry: 12, Manor Road, Coventry; Wolverhampton: 3, Queen Street, Wolverhampton, Staffs; Nottingham: 40, Parliament Street, Nottingham; Bradford: Britannia House, Broadway, Bradford; Hull: Fitzwilliam Buildings, Alfred Gelder Street, Hull; Leeds: Lloyds Bank Chambers, Vicar Lane, Leeds; Sheffield: The White Building, Fitzalan Square, Sheffield; Liverpool: Cotton Exchange, Bixteth Street, Liverpool; Manchester: Royal Exchange Buildings, Bank Street, St. Anne Square, Manchester; Preston: 32, West Cliff, Preston, Lancs; Newcastle-on-Tyne: 38, Great North Road, Newcastle-on-Tyne 2; Aberdeen: 80, Union Street, Aberdeen; Dundee: 30, Meadowside, Dundee; Edinburgh: 41, Manor Place, Edinburgh 3; Glasgow: 145, St. Vincent Street, Glasgow; Cardiff: 49, The Parade, Cardiff; Swansea: Metropole Chambers, Salubrious Passage, Wind Street, Swansea; Wrexham: 30, Grosvenor Road, Wrexham, Denbighshire.

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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

Fire-fighting by Radio

THE use of radio for fire fighting purposes was recently demonstrated during a Gateshead fire. Telephone wires are often among the first casualties in a fire, and learning from past experience, the Newcastle Fire Brigade have decided to adopt a system of radio communication, and this will soon be in operation throughout the country. Fixed transmitters at static points will be used to broadcast over a certain radius, in co-operation with mobile units.

Broadcasting System on Battleship

IT is now revealed that the 35,000-ton battleship *Anson*, which was recently announced to be at sea, took five years to build. The electrical equipment in the ship would serve to light a large town. There is a cinema, a room for the ship's band and an internal broadcasting system. Telephone exchanges serve some 500 telephones throughout the ship, and there are postal services with pneumatic transmission. Two and a half million rivets were used in building the ship.

The commander of an Armoured Brigade in Libya 'phoning a report on a field telephone.

Voice Letters

EVERY purchaser of two dollars' worth of American war stamps in New York is given an opportunity to make a disc recorded voice-letter, which is mailed free to any man or woman in the United States Forces anywhere in the world.

New B.B.C. Headquarters

IN order to study West Indies' needs the B.B.C. have established new headquarters in Kingston, Jamaica, to study the needs of radio audiences in Jamaica and other Caribbean islands.

"Hitch Hike"

NOW that petrol restrictions are even more stringent, most of the traffic on the highways of Britain consists of heavy lorries. One of those lorries formed the background for a short musical show recently in the Forces programme, when Ernest Longstaffe produced "Hitch Hike," written by Clifford Lewis.

The programme told the story of a lorry, its genial, philosophical old driver and the assortment of passengers, A.T.S. girls, munition workers, soldiers, etc., picked up on its journey. The lorry driver was played by our old friend Syd Walker, with Cheerful Charlie Chester, on special leave from the Army, as his mate, and the passengers to whom he gave a welcome lift included Miriam Ferris, Margaret Davison, and the Four Clubmen, also a small orchestra conducted by Ernest Longstaffe.

Birmingham Police Radio

IT is reported that police cars fitted with two-way radio-telephone equipment have been in use in Birmingham for about a month and already have been responsible for effecting several quick arrests. Credit for this successful innovation, it is said, is due to Inspector G. Brown, who was an experienced radio engineer before he joined the city War Police Reserve.

Earlier Closing for Canadian Radio

TO reduce wear on equipment Canadian Broadcasting Corporation stations now go off the air earlier—at 11.30 p.m.

Mrs. Roosevelt's Blitz Record

THE United States President and Mrs. Roosevelt will shortly be able to hear in the White House a recording of a heavy raid on Bristol.

The record, which was made by B.B.C. sound engineers, runs for about 20 minutes. It starts and ends with the sirens, and includes the whistle and crash of high explosives and incendiaries and the deafening noise of the barrage.

It has been presented by the B.B.C. to Mrs. Roosevelt, who took it back to America for use during her lectures.

Songs from the Cartoons

QUITE a number of film cartoons have been adapted for radio, and recently, in the Forces programme, listeners had a chance to hear once more some of the best songs from these cartoons, ranging from "The Big Bad Wolf" through "Snow White," "Pinocchio," "Gulliver's Travels" and "Dumbo," right up to the latest Disney film "Bambi." The programme was planned by Henry Reed and was introduced and compèred by John Watt.

B.I.R.E. Meeting

ON Saturday, November 21st, at a members' meeting of the British Institution of Radio Engineers, an interesting paper on "The Technical Basis of Sound Reproduction" was read by L. E. C. Hughes, A.M.I.E.E. The meeting took place at the Institution of Structural Engineers, at Upper Belgrave Street, S.W.1.

Nine Hundred Years' Service

HOW old is the electrical industry? Not much more than half a century. Ediswan is in its sixty-second year, and Sir Felix Pole is still making presentations to Ediswan employees who remember Edison's "Jumbo" being installed at Holborn Viaduct—the first central station in this country. Sir Felix presented gold watches to Messrs. J. Davidson and E. Paul for 50 years' service. Actually, this industry, an integral of modern civilisation, was only seven years old when Mr. Davidson became cost clerk in Swan's lamp works at Ponders End. Eighteen such presentations have now been made—a total of 900 years of service given to the building of the electrical industry.

Desert Radio Talks

THE British Army now has its own broadcasting unit in the front line in North Africa.

The first recording by an officer observer who accompanied a fighting patrol into no-man's-land was broadcast from the Egyptian State Broadcasting Station in Cairo recently.

With recording apparatus built into a lorry, the observer took the microphone to the limit of its half-mile of cable, and, standing near enough to touch the wire of a minefield, described the departure of the patrol.

Newly appointed officer observers will be the commentators in these front line broadcasts.

Comfort for France

"IF there is resistance in France it is thanks to the B.B.C." These words of M. André Philip constitute the highest tribute that could have been paid to the B.B.C. French service. Each week of growing tension in France, the importance of this link becomes more evident. Thus, by a happy coincidence, within the hour, the latest appeal by M. Laval for France to hug the chains which Germany has bound about her prostrate body found a prompt *riposte* in one of General de Gaulle's most compelling broadcasts on the theme of French unity—against the Reich. This challenge described the "multitude of Frenchmen, all together, on the way to general resistance" and deriving from that unity a sense of comfort, a kind of deep-seated confidence and a sort of "terrible joie."

Remembrance Day

"THE Unknown Soldier," a play for Armistice Day by Clemence Dane, was produced on November 11th by Val Gielgud in the Home Service with Leon Quartermaine as "Meflin" and Marius Goring as "The Soldier." Muir Mathieson directed the orchestra.

This year the British Legion celebrates its coming-of-age. It looks back upon a remarkable record of service to the soldiers of the last war and looks forward to acting as a shield for the millions of ex-Service men and women after the present war which has already taken a quarter of the population into the Services.

Calling Forces Overseas

MEN and women of the Services in the Middle East and Africa, and those serving them, now have a seven-hour continuous broadcast entertainment programme daily, specially designed to meet their needs. This new transmission began on November 2nd. Not merely is its audience widely scattered but its listening conditions are totally different from those of civilians.

Crowded together in canteens, on board ship, in aircraft and in many other places, often in circumstances of danger and nearly always in considerable discomfort, such listeners need good, light entertainment "on tap." The B.B.C. aims to give it to them, interspersed with news flashes, sports items and very brief talks by popular speakers, talks suited to them personally, serving as a link with home and a reminder that their wants and anxieties are not being forgotten.

Based on programmes chosen to meet the expressed needs of men and women serving overseas, the new service will utilise a number of the most popular current features in the Home, Forces and Overseas programmes, including "Bebe, Vic and Ben," "Songtime in the Laager," "Tommy Handley's Half-hour," "Record Time," "Itma," and Newsletters from Australia, New Zealand and South Africa.

Intricate Planning

MUCH intricate planning, imagination and skill on the part of the producers will be required to put over these programmes to the best advantage in order to meet the day-to-day needs and ever-changing conditions of this vast and varied audience.

Included in this audience at any time are many who are in hospital or who are forced to spend long periods of monotonous waiting in lonely places. To such it is hoped that the light music in these programmes will come as an especial boon, soothing and restoring tired minds and weary spirits.

The service will be continuous from 3.45 to 10.45 p.m., G.M.T., with special transmissions serving the Middle East from 3.45 to 9.0 p.m., G.M.T., and West Africa from 8.0 to 10.45 p.m., G.M.T. Gibraltar, Abyssinia and Aden will also be covered.

A.T.S. twin sisters M. and V. Hills, testing portable wireless sets used by the Army.

Wireless Sets in France

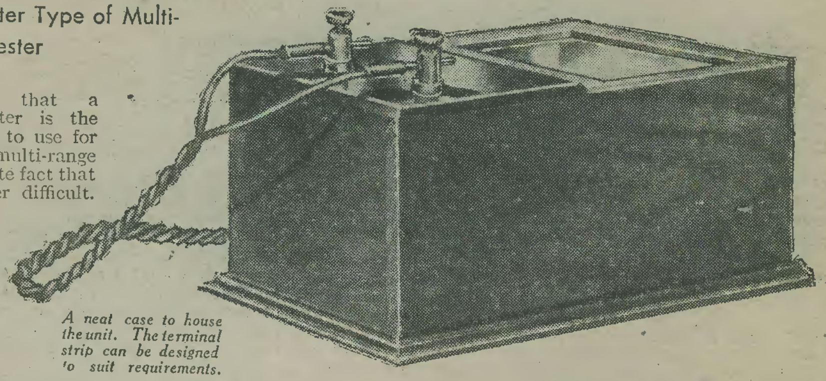
ACCORDING to a recent report, wireless sets are still obtainable in France, and repairs are possible. Reliability, however, is not always obtainable, especially in home-constructed sets, in which a kind of celluloid has to be used, instead of a more durable plastic. This gets very hot in use and limits the life of the set to about six months.

A Short-wave Superhet: A Correction

IN the theoretical circuit of this receiver—page 5, December issue of PRACTICAL WIRELESS—the H.F. stopper resistor was omitted. This is shown on the plan wiring diagram—page 6—as R11, and is connected between the grid of the output valve and the moving arm of the volume control R10. It should have a value of 50,000 to 100,000 ohms.

An Inexpensive Meter

A Simple Galvanometer Type of Multi-range Tester



A neat case to house the unit. The terminal strip can be designed to suit requirements.

WHILE realising that a moving-coil meter is the best instrument to use for the formation of a multi-range meter, it is an unfortunate fact that its construction is rather difficult. The meter described below can easily be made by any constructor; it has three current readings, their maximum deflections being 10, 1 and .1 mA., and it measures voltages up to 100, taking only 1 mA. on 100 volts—which makes it a useful instrument for many purposes. It could easily be modified to have a resistance of 10,000 ohms per volt.

Construction

The spool to hold the windings is made by fitting two cardboard cheeks on a ¾in. section of the outside cover of a matchbox. The cheeks should be of such a size as to give ½in. winding depth. The movement consists of a compass needle to which a thin bristle about 3in. long is fixed at right-angles so that it provides a pointer about 2½in. in length on one side, a small blob of wax on the other end of it being used to balance the movement. The compass pivot should be fixed in the centre of the core; a small block of wood is glued above the compass needle to prevent it slipping off its point should the meter be tipped over. It is very important to note that there should be no iron or steel in the instrument other than the compass and its pivot. A wooden box about 3in. by 4in. by 2in. deep will be suitable for housing the meter, but iron nails or steel screws must not be used in its construction. A strip of ebonite holding a terminal and four sockets should be fixed on the top of the case near the bobbin, and the remainder of the top then covered with a piece of glass to protect the movement from draughts and dust. (Fig. 2.)

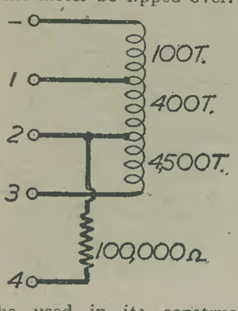


Fig. 1.—Shows the winding data and how the tapping points and resistor are connected.

Winding Details

Wind 100 turns of 36 D.S.C. wire on the bobbin, passing the ends through small holes pierced in the cheeks. Cover with a length of insulating tape and wind on 400 turns of 40 enam., finish as before. Place another layer of insulating material upon this winding and finish the bobbin with 4,500 turns of 48 gauge enam. The beginning of all windings should be marked I and the end O, and care taken to wind all sections in the same direction. The ends of the windings should be soldered to tags fixed to the base, connecting the ends so that the sections form a continuous winding so that the following number of turns can be selected: 100, 500 and 5,000. Fig. 1 will make this clear and shows how to connect the 100,000 res. used for voltage measurement.

Calibration

The case should be placed so that the pointer can take up an east-west position. The common minus terminal is always used. To calibrate range 2 and 4: connect leads to minus and 4; apply various voltages from an H.T. battery and note scale readings and voltage. The same readings will apply for mA. on range 2, i.e.: 100 volts = 1 mA., 80 volts = .8 mA., 60 volts = .6 mA., etc. Calibrating range 1: connect to minus and 1 with a 10,000 ohm series resistance in one of the leads; apply H.T. as before. The current readings will be: 100 volts = 10 mA., 80 volts = 8 mA., 60 volts = 6 mA., etc. Calibrating range 3: use H.T. battery and .5 mΩ series resistance. Readings will be as follows: 50 volts = .1 mA., 24 volts = .05 mA. (about), etc. When calibrated the 10,000 and .5 mΩ resistors should be removed.

It is best to fit the instrument with a plain scale reading 0-50; a graph can then be prepared for each range. The meter should be connected to 3ft. or so of flex so that it can be placed away from speaker-magnets and such undesirable influences. If a 1 or 2 mfd. condenser is to hand it can be connected across the leads. When calibrating, as described above, the resistance of the meter is so small in comparison with the 10,000, 100,000 and 500,000 values used that no notable error is introduced. It would not be wise to use a 1,000 resistance and lower voltages for calibrating.

The scale should be raised upon a block of wood so that it is close to the pointer.

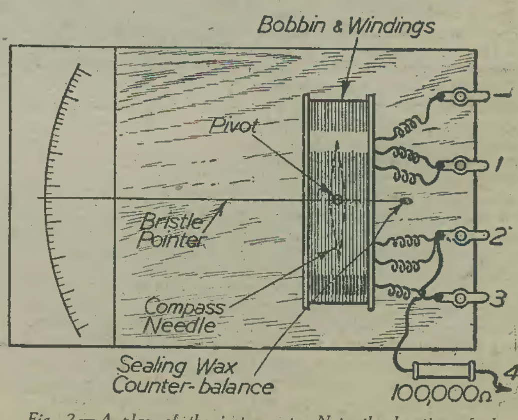


Fig. 2.—A plan of the instrument. Note the location of the compass needle, the pointer and scale.

One-valve Loudspeaker Circuits

Economical Receivers Which Provide Useful Material for Experiments

THE present scarcity of valves and components revives the interest in 1-valve loudspeaker sets. At one time these were very popular, but then there was no scarcity of either valves or components, and so the ordinary constructor was not tied down in any way. The result was that more elaborate circuits prevailed and the one-valver was allowed to lapse into obscurity.

Just how successful is a one-valve loudspeaker set? Well, it depends upon what you would call loudspeaker signals. If by loudspeaker results you mean signals that can be heard out on the road, then obviously the one-valver will disappoint you; if, however, you mean that the voice can distinctly be heard in any part of an ordinary living-room, and that the music is sufficiently robust for enjoyment without being above the level of conversation, then you will find the one-valver well worth experimenting with.

Loudspeaker Input

A word about the loudspeaker before passing on to a consideration of the various circuits. One sometimes reads in the loudspeaker manufacturers' literature that a speaker is suitable for inputs of, say, $\frac{1}{4}$ to 6 watts. This does not mean that the speaker will be inoperative at inputs less than $\frac{1}{4}$ watt. In point of fact, $\frac{1}{4}$ watt—250 milliwatts—is a fairly considerable input; it is all that an ordinary power valve can supply when going all out on the local station, and it is safe to say that for the majority of stations the input will be much less.

The figures given refer to a balanced output from the speaker, i.e., one in which the high and low notes are in their proper proportions. In a one-valve loudspeaker set, the volume is so low that it is impossible to get the low notes out properly. This is its only drawback, and having made this point clear we can proceed.

The first, and most easily wired circuit, is the amplified crystal detector. This is shown in Fig. 1, where it will be seen that a crystal detector is in series with the primary of an L.F. transformer from the top of the coil to earth. A fixed condenser of .0005 mfd. is connected across the primary to by-pass the H.F. currents, but this is not strictly necessary since the self-capacity of the winding is usually sufficient. An L.F., power or pentode valve can be used, the latter giving the best results. A good make of permanent detector should be used to obviate fiddling with the crystal contact.

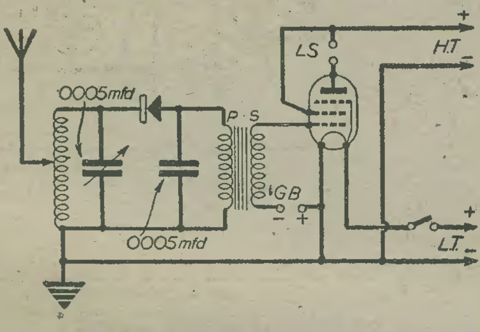


Fig. 1.—A normal crystal detector circuit followed by a pentode L.F. stage. A good set for reception of the local transmission, but a high degree of selectivity must not be expected.

Anode-bend Rectification

If a crystal is not desired, a steep-slope L.F. pentode may be used as a combined detector and output valve. Anode-bend rectification is employed, the grid being biased negatively by experimentation until the best results are secured. Reaction will help to bring up the signal strength. With 150 volts on the anode, and a reasonably efficient aerial and earth system situated fairly close to a station, fairly good loudspeaker results will be achieved with this circuit, which is shown in Fig. 2.

We now come to more complex valves, and in the D.D.T. valve there is a ready means at hand. Referring to Fig. 3, it will be seen that the two diodes are working as a full-wave rectifier. The coil consists of a simple H.F. transformer with the secondary centre-tapped. This secondary is shunted by the usual variable condenser, and the two ends go to the two diodes, the rectified output coming from the centre-tap. This is fed to the primary of the L.F. transformer, which takes the place of the usual load resistance. Across the transformer primary is a .0005 mfd. condenser to by-pass the H.F. currents. The secondary takes the stepped up signals to the grid of the triode section of the valve, and the rest of the operation is then straightforward. If a D.D.T. valve, the triode section of which has a rather low impedance, is chosen, the outfit will give good loudspeaker results.

Pentode Output Valve

A double-pentode valve, such as is used for Q.P.P. amplification, can also be pressed into service. In this

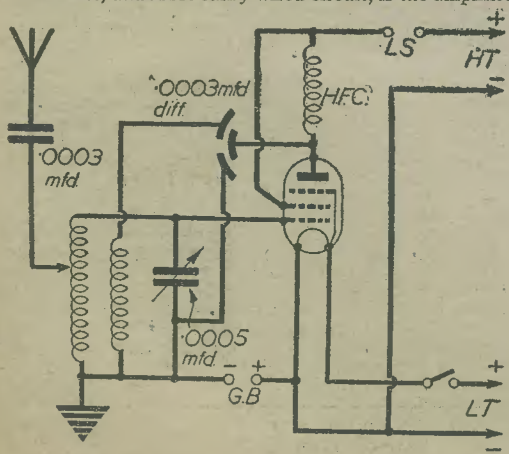


Fig. 2.—An anode-bend detector arrangement, which utilises a steep-slope pentode.

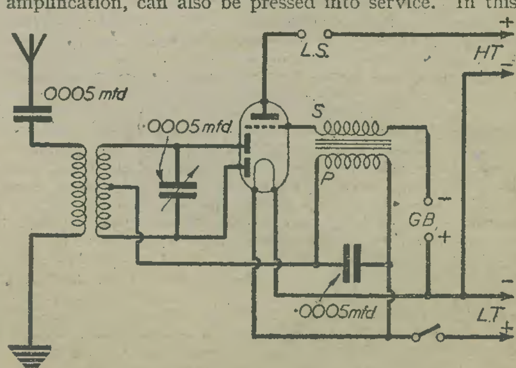


Fig. 3.—Using a D.D.T. valve as diode detector and triode L.F. amplifier.

case one of the pentodes is used as a rectifier, either anode-bend or leaky-grid, and the other is used as a straightforward L.F. amplifier and output valve. Fig. 4 gives the details of the circuit. It should be noted that if leaky-grid rectification is employed it is unlikely that the full H.T. voltage can be used, and that a resistance should be used to cut it down somewhat—or else the lead supplying the detector portion of the valve taken to a tapping on the H.T. battery. In general a voltage of round about 80 should be applied to the detector anode; the detector auxiliary grid should be given as high a voltage as is consistent with satisfactory reaction effects—generally about 40-60 volts. This means that the L.F. part of the valve is limited to this voltage on its auxiliary grid (since the two auxiliary grids are strapped together inside the valve) but its anode may be given the full H.T. voltage available.

In the case of anode-bend rectification, however, the anodes and auxiliary grids may be given the same voltage, and this may be anything up to 150 volts.

Finally, it should be mentioned that some mains pentodes, having a steep slope, are very sensitive and will give a loudspeaker output when used as a detector. Such valves require but a small voltage on the grid to develop their full output power, and this may be achieved, at least in part, by the power-grid system of rectification if situated sufficiently close to a station.

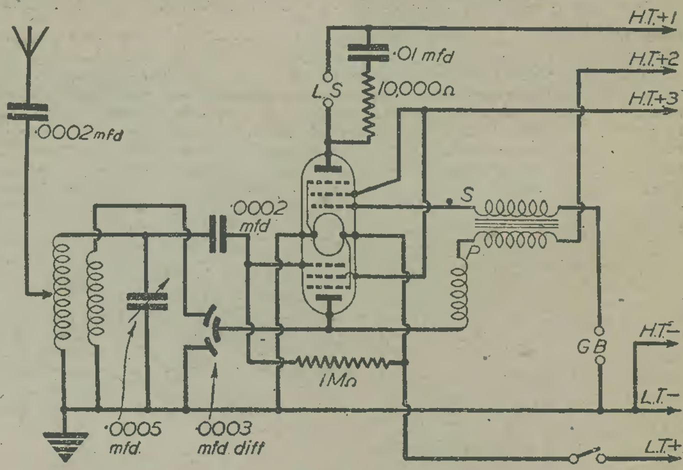


Fig. 4.—The two pentode sections of a Q.P.P. valve are used in this circuit as detector and L.F. stage.

Overhauling "All-dry" Battery Sets

Many All-dry Battery Sets are in Use with the Services, and this Article by "Service" Explains How to Keep Them in Order

THE replacement of worn-out valves often presents a serious difficulty nowadays, when large numbers of new valves are constantly being required by the Services. This is especially the case in respect of "all-dry" valves, which were employed in enormous quantities in many of the small portable receivers made just before and during the early part of the war.

Valves of this type were fitted in most of the receivers supplied free of charge to the Services for the private entertainment of the men. Consequently, a large proportion of all the valves of this type which are now made are required as replacements in these receivers. Add to this the fact that these "all-dry" valves—which require a filament voltage of only 1.4—have had a very "raw deal," and it is easy to understand why replacements are difficult to obtain. Incidentally, the "raw deal" referred to concerns the operation of sets fitted with 1.4-volt valves from 2-volt accumulators; hardly calculated to produce satisfactory results!

In view of all the facts set out above, many owners of "all-dry" sets are faced with the fact that the sets are useless due to the fact that the valves—for one reason or another—have had their day. What can be done to put these sets into commission again? A good answer is not easy to find, although I have been searching for one for quite a long time now. Being called upon to service receivers of the type in question, I have had to give the problem a good deal of thought. And I know that many other service mechanics have done likewise.

General Circuit Arrangement

Let us review the position, and see what opportunities there are for repairing these sets. Most of those which I have in mind are similar in general design, and have a simple four-valve superhet circuit. There is normally a pentagrid frequency-changer, followed by an H.F. pentode used as intermediate-frequency amplifier. Then comes a (single) diode-triode, this being followed by an output pentode. Tuning is by means of a two-gang condenser, of which one section operates on the frame aerial (or aerials, when a separate one is used for long waves) and the other on the oscillator coil.

In some cases the on-off switch is combined with the volume control; in others, it is combined with the wave-change switch. The volume control is normally connected in the grid-feed circuit to the triode section of the diode-triode, and it will often be found that the on-off switch breaks both L.T. and H.T. circuits. When the on-off and wave-change switches are combined, there is a central "off" position, and the supply-circuit contacts are closed when the switch is moved to either side.

Automatic grid bias is invariably employed, this being provided by a fixed resistor having a value in the region of 1,000 ohms in series with the H.T. negative lead.

Valve-base Connections

Some of the receivers have octal-base valves, while side-contact valves are used in others. The connections for both types are shown in the diagram so that the circuit can more readily be traced if necessary.

If we assume that the set is serviceable apart from the valves, it might be possible to effect a makeshift remedy fairly easily. Sometimes it is found that the valve filaments are intact, and that the failure of the set to operate is due to the lost emission of the filaments. If the set is moved into a dark corner, the filaments can be seen to glow if they are intact. Remember to check the L.T. voltage on load, of course, before condemning any valves whose filaments fail to light.

Should it be found that the filaments are intact, it can be fairly well taken for granted that the set has been used for some time with an excessive L.T. voltage. That probably means that the filaments have been heated from a 2-volt accumulator, and that the treated filaments have lost the special oxides with which they are coated, and which serve to enhance emission at low temperatures.

Valve "Reconditioning"

As "The Experimenters" pointed out in PRACTICAL WIRELESS some months ago, it may be possible partially to recondition the filaments by allowing them to glow for a few hours without any H.T. being applied to the anode. This can be done by inserting them in a holder of which only the filament terminals are connected; these should be wired to a 1.5-volt cell, preferably through a small resistor. Sufficient resistance can be introduced into the circuit by making the cell connections with, say, a yard length of twin 26-gauge wire. The resistance should be such that the filament can just be seen to glow faintly in a darkened room.

It may be found that this treatment will make the valve usable, even though by no means 100 per cent. efficient. If the valves still fail to operate after being connected in this manner for five or six hours, the effect of feeding the set from a 2-volt accumulator may be tried. Very often the set will work when operated in this manner—but the valves cannot be expected to last very long when so grossly overloaded. Sometimes, when reproduction is faint and "tinny" it has been found possible to bring about a reasonable improvement by reducing the value of the automatic bias resistor. On one set, output was fairly good after shunting the existing resistor with another of 500 ohms.

A very last resort in attempting to "rejuvenate" the valves is to "flash" the filaments. This is done by connecting one lead from a six-volt section of a H.T. or G.B. battery to one filament terminal, and then quickly "brushing" the end of the other lead over the second filament terminal. This should be done to each valve individually. It will not make the valves like new; it might burn out the filament completely; but I have found one or two instances in which it has given a valve another short lease of life.

Replacement by 2-volt Valves

So far we have dealt only with very crude makeshift methods of overcoming the valve-supply problem. The more workmanlike approach is to change the 1.4-volt valves for others with 2-volt filaments, which are normally easier to obtain, and which many amateurs already have available from other sets. It is not, however, a very simple matter to make the change-over, and I do not recommend any reader who has not had a wide practical experience of receiver making and servicing to attempt it. Any reader in the latter category who does try to make the modification is more likely to ruin the set permanently than to put it into good working order.

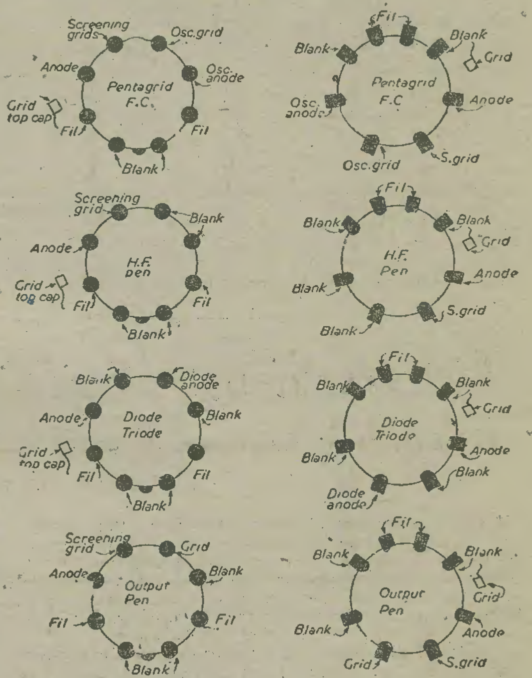
The major practical difficulty is that new valve holders will have to be fitted. The octal or side-contact holders will have to be replaced by seven-pin or five-pin holders. Another possible snag is that the new valves will have different characteristics and may cause the set to be unstable, so that additional decoupling will be needed. First make sure that new valves of suitable types are to hand. Then deal with the valveholders one at a time. Draw the connections carefully on a sheet of paper and mark the leads in some way; they can then be unsoldered.

In drawing the connections it will often be found that leads and components are soldered to valveholder terminals which are shown as blanks in the diagram. The terminals are merely used as convenient supports, and the leads can be left suspended after fitting the new holder, if necessary. To remove the old holders it is generally best to file off the upper faces of the hollow rivets, taking care that wiring is not damaged. They can then be pressed out with a pin punch.

Grid Bias

It will almost certainly be necessary to replace the automatic bias resistor with one of different value, and the required resistance will have to be calculated in the usual manner, by dividing the required bias voltage by the total H.T.— current consumption of the set in amps. For this purpose it is sufficient to take the makers' normal figures for voltage and current at any given H.T. voltage, since the auto-bias system is self-regulating to a large degree. After fitting the new valves it may be found desirable to limit the H.T. voltage to about 90 to avoid instability. It will also be necessary to re-align the set, adopting one of the methods which have previously been described in these pages.

It was stated above that the second-detector valve normally used in these "all-dry" sets is of the diode-



Valve-base (underneath) connections for 1.4-volt octal (left) and side-contact (right) valves.

triode type, as compared with the double-diode-triode which will probably be used as replacement. Connection can be made to only one of the diode anodes when using the new 2-volt valve, or both diode anodes may be strapped together.

In deciding on the type of 2-volt output valve to be used it may be wise to choose one with an optimum load similar to that of the valve which it is to replace—probably between 8,000 and 10,000 ohms. By doing this, better matching with the speaker should be ensured.

Switch Troubles

Quite a lot of trouble has been experienced with the combined on-off and wave-change switch fitted to some of the "all-dry" portables. It is often sufficient to clean the contacts with a spot of carbon tetrachloride applied with a pipe cleaner, but in some cases I have actually shorted out the appropriate contacts after turning the switch to the medium-wave position, and then fitted an ordinary toggle switch in series with the battery leads. Since it is not required to use the receiver for long-wave reception, this is a perfectly satisfactory arrangement, and obviates any further switching trouble.

Attenuators and Filter Sections

Mathematical Considerations and Practical Uses

By S. A. KNIGHT

TO attenuate, broadly speaking, means to reduce, and an ideal attenuator is a device which will enable us to obtain as our output some desired fraction of the input, this fraction being a constant irrespective of the frequency applied.

To filter means to select out of a wide range of frequencies a desired band, known as the pass band, and an ideal filter will give us zero attenuation over this pass band and infinite attenuation outside.

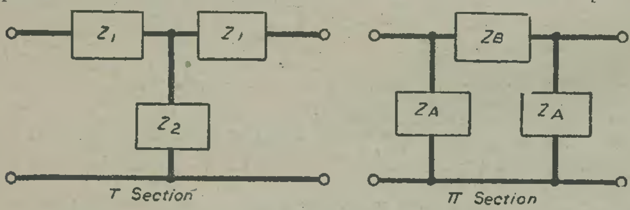


Fig. 1.—"T" and "π" section filters or attenuators. These form the most widely used arrangements.

Both of the above conditions are ideal and are, of course, impossible of practical design.

It follows that ideal attenuators would have to be made of perfect resistors, since reactive elements would give frequency discrimination, and it also follows that ideal filters would have to consist of ideal reactors, since resistive elements would be sure to result in attenuation even in the pass band.

General Systems

Attenuators and filters are usually made up of repetitive sections, the commonest being known as *T* and *pi* (π) sections. (Fig. 1.)

The following mathematical treatment should not prove difficult to follow and is the best way of grasping the fundamentals of attenuator and filter technique.

Consider the *T*-section arrangement. Obviously the input impedance, which we will call z, when the output terminals are open-circuited, is given by:

$$z_{oc} = z_1 + z_2$$

similarly, the input impedance when the output is short-circuited is given by:

$$z_{sc} = z_1 + (z_1\ z_2 \text{ in parallel})$$
$$= z_1 + z_1 z_2 / z_1 + z_2$$

Therefore, if we terminate the section by some impedance zr, which may be anything between a zero and an infinite impedance, the input impedance z is given by:

$$z = z_1 + (z_1 + zr) z_2 / z_1 + zr + z_2$$

Thus it is clear that if zr is altered z must alter also, i.e., the input impedance will vary with the value of the termination. A study of this condition will bring the question: is it possible to adjust the termination zr in such a way that the impedance z of the whole network is also equal to the value to which zr is adjusted?

If this condition is possible, the results will be of great value, since any desired amount of attenuation may then be applied by such a network without an upsetting of the input impedance.

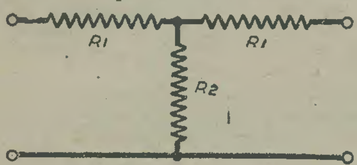


Fig. 2.—A "T" section attenuator in which Rk=√R1²+2R1+2.

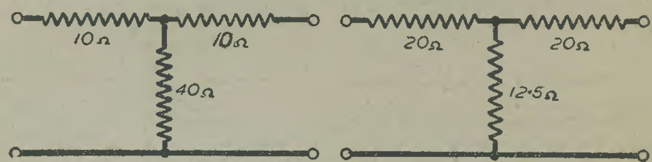


Fig. 3.—Both of these arrangements will match into a 30 ohm load, but the one will give greater attenuation.

Assume that when zr has a certain value zk, z has this value also, then:

$$zk = z1 + (z1 + zk)\ z2/z1 + zk + z2$$
$$z1.zk + zk^2 + z2.zk = z1^2 + z1.zk + z1.z2 + z1.z2 + zk.z2$$
$$\therefore\ zk^2 = z1^2 + 2z1.z2$$
$$zk = \sqrt{z1^2 + 2z1.z2}$$

Now

$$zoc = z1.z2$$
$$zsc = z1 + z1.z2/z1 + z2$$

Practical Uses

Attenuators are employed practically to reduce in a desired way the input or output of electrical and radio apparatus according to the particular conditions of the circuit or circuits. Simple attenuation is employed in practically every radio receiver made, namely the volume control, and consists of a resistive element across part of which a proportion of the input is taken off and fed on to the following stages. Simple arrangements based on potentiometer systems such as this are in common use and merely depend on ratios of resistance and voltage. Other types, such as are employed in test equipment, are so constructed that the amount of attenuation does not affect the circuit impedance, nor external loading the attenuation.

Filters are employed for a number of reasons: simple interference suppressors and power pack smoothing circuits are typical everyday examples. When a desired range of frequencies only is required on a particular piece of equipment, filters are employed; reduction of harmonic interference on ultra-short wave transmitters is brought about by filtering devices; knowledge of filter circuits is an essential to a good understanding of transmission lines and aerial feeder systems.

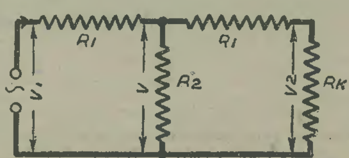


Fig. 4.—An arrangement to show how K —the attenuation ratio — is obtained.

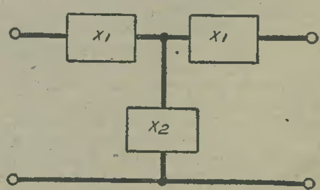


Fig. 5.—A "T" section filter in which X1 and X2 represent reactors of opposite kind.

$$\therefore \quad zoc.zsc=(z_1.z_2)(z_1+z_1.z_2/z_1+z_2)$$
$$=z_1^2+z_1.z_2+z_1.z_2$$
$$=z_1^2+2\,z_1.z_2$$
$$=zk^2$$

So
$$zk=\sqrt{zoc.zsc}$$
and this result, rather reminding one of a swarm of bees, is general for any kind of section.

Carrying on a little farther, consider the T-section with the shunt arm open circuited, and let zm be the total series impedance.
$$\therefore \quad zm=2\,z_1$$
Now let zn be the total shunt impedance with the series members short circuited.
$$\therefore \quad zn=z_2$$
So for the T-section:
$$zk=\sqrt{zm^2/4+2zm.zn/2}$$
i.e., $$zk=\sqrt{zm^2/4+zm.zn}$$
$$=\sqrt{zm.zn\,(1+zm/4zn)}$$
$$=\sqrt{zm\,.\,zn\,(1+p)}$$
where p is equal to $zm/4zn$.

It will be shown later that in the case of a filter the limits of the pass band are given by $p=0$ and $p=1$.

For a *pi*-section
$$zk=\sqrt{zm\ zn/1+p}$$

Attenuation

Consider a T-section, as in Fig. 2. From what has gone before we have seen that
$$Rk=\sqrt{R_1^2+2R_1\ R_2}$$
and that with this termination the input impedance will be Rk, no matter how many such sections are used.

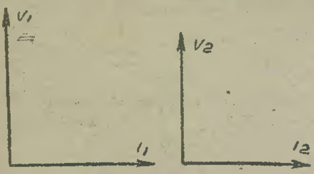


Fig. 7.—Showing the effect of th. filter circuit Fig. 6.

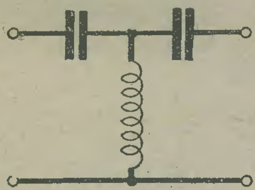


Fig. 9.—A high-pass filter arrangement.

This is fairly obvious when it is remembered that if the input impedance of any one section is Rk, then if this section terminates a similar section this latter will also have an input impedance of Rk.

A desired Rk can be obtained with numerous combinations of R_1 and R_2. The two examples (Fig. 3) will both match into a 30-ohm load, but the second will give greater attenuation than the first. So in practice the problem is that given Rk and the attenuation required, find suitable values for R_1 and R_2.

The attenuation may be given in terms of attenuation ratio K. This is simply the ratio of V_2/V_1 where V_1 is the input voltage and V_2 the output voltage.

Consider the circuit in Fig. 4. Then for the solution of the above:
$$V_1/I_1=Rk$$
$$I_1=V_1/Rk$$
$$V=V_1-R_1.I_1$$
$$=V_1-R_1.V_1/Rk$$
$$=V_1\ (1-R_1/Rk)$$
$$V_2=V.Rk/R_1+Rk=$$
$$V_1\ (1-R_1/Rk)\ (Rk/R_1+Rk)$$
$$V_2/V_1=K=Rk-R_1/Rk$$
$$\times Rk/R_1+Rk$$
$$K=Rk-R_1/Rk+R_1$$
Cross multiplying:
$$K\ Rk+K\ R_1=Rk+R_1$$
$$K\ R_1+R_1=Rk-K\ Rk$$
$$R_1\ (1+K)=Rk\ (1-K-)$$

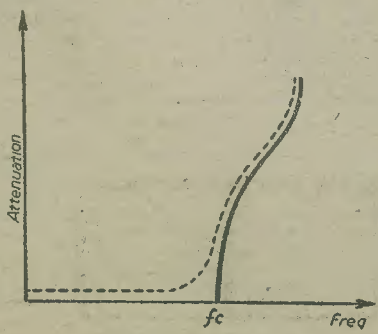


Fig. 8.—The behaviour of the low-pass filter shown in graphical form.

$$\therefore \quad R_1=Rk.1-K/1+K$$
Now:
$$Rk^2=R_1^2+2\ R_1.R_2$$
$$\therefore \quad Rk^2-R_1^2/2R_1=R_2$$
$$\frac{Rk^2-Rk^2\ (1-K/1+K)^2}{2Rk\ (1-K/1+K)}=R_2$$

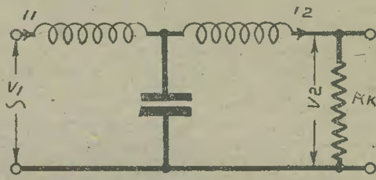


Fig. 6.—A low-pass "T" section filter.

i.e., $$R_2=\frac{Rk1-(1-K/1+K)^2}{2\ 1-K/1+K}$$
$$=Rk.\ 4K/2\ (1-K)^2$$
$$\therefore \quad R_2=Rk.\ 2K/1-k^2$$

Knowing the amount of attenuation required and the input impedance Rk when correctly terminated by Rk. the values of R_1 and R_2 are given by the above results,
$$R_1=Rk.\ 1-K/1+K$$
$$R_2=Rk.\ 2\ k/1-K^2$$

Filters

In the consideration of filters, only the case of sections composed of ideal reactors will be dealt with, since to attempt to analyse cases in which filter members have both resistance and reactance would not only be beyond the scope of the article, but would involve some rather heavy mathematical treatment.

Consider the T-section in Fig. 5, and assume that X_1 and X_2 are reactors of opposite kind. Then zoc and zsc can be either inductive or capacitative depending entirely on the frequency applied.

If we let the magnitude of the reactance on open circuit be Xa, and the magnitude of the reactance on short circuit be Xb, then, using the j notation to indicate quadrature phase, there are four possible combinations of the above:

(i) $zoc=jXa\,;\ zsc=jXb$
(ii) $zoc=jXa\,;\ zsc=-jXb$
(iii) $zoc=-jXa\,;\ zsc=-jXb$
(iv) $zoc=-jXa\,;\ zsc=jXb$

Now we have seen that
$$zk=\sqrt{zoc.zsc}$$
Consider cases (ii) and (iv).
Then:
$$Zk\ =\ \sqrt{-j^2Xa.Xb}=\sqrt{+Xa.\times b}$$
$$=\sqrt{a\ positive\ number}$$
Hence Zk will be a pure resistance since there is no term.

Now in cases (i) and (iii).
$$Zk=\sqrt{j^2Xa\ Xb}=$$
$$\pm\sqrt{a\ positive\ number}.$$
In these cases Zk will be a pure reactance. Therefore, since both the magnitude and the nature of zoc and zsc depend upon frequency,

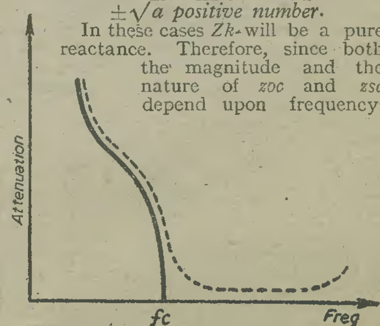


Fig. 10.—The curve produced by a well designed high-pass filter.

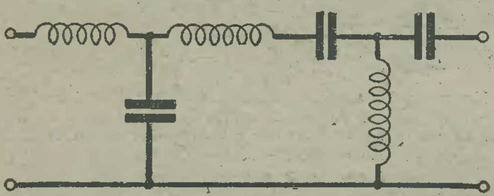
so also will the magnitude and the nature of Zk depend upon the frequency.

A filter terminated in Zk which is called the characteristic or surge impedance of the filter, is said to be properly terminated.

The Low-pass Filter

Consider now what is called a prototype low-pass T-section filter (Fig. 6). The circuit is terminated by a resistor Rk and is fed from an A.C. source whose *p.d.* is constant but whose frequency is variable. Now, as the reactance of an inductance increases with frequency, whilst that of a condenser decreases with frequency, it is to be expected that the impedance of the circuit will vary with the frequency, which is what it does, though in a rather curious way.

It can be shown mathematically that, when the



termination is correctly adjusted, the impedance of the circuit at all frequencies below a certain critical frequency is more or less constant, above the critical frequency the impedance goes up very rapidly. This circuit is a "Low-pass" filter, since it passes without attenuation (ideally) all frequencies below a critical—cut-off—frequency.

Mathematical Treatment

Consider Fig. 6 working at such a frequency that the termination is a pure resistor. Then:

$$V_1/I_1 = Rk = V_2/I_2$$

Consequently power $I_2\ V_2$ will be dissipated in the load, the input power being $I_1.V_1$. Then since no power can be dissipated in the filter members, these assumed to be ideal reactors:

$$I_1.\ V_1 = I_2.\ V_2$$

$$\therefore\quad I_1 = I_2.\quad V_1 = V_2$$

Hence, if the filter is properly terminated and working at such a frequency that the termination is resistive there is zero attenuation.

Now if the frequency is such that Zk is a pure reactance, then:

$$V_1/I_1 = \dot{X}k = v_2/I_2$$

but this time the current and voltage are everywhere in quadrature. Therefore the circuit can neither accept nor deliver any power. So the second condition of the previous case does not obtain in this one, and since V and I are in quadrature, attenuation can occur while the $V_1/I_1 = V_2/I_2$ relation still holds. V_2 is is less than V_1, consequently there is attenuation, but $V_1/I_1 = V_2/I_2$ (Fig. 7).

It can be shown that at frequencies such that $Zk = Xk$, attenuation is inevitable, and that it increases the farther the frequency is removed from that frequency (cut-off) at which Zk changes from Rk to Xk.

Low-pass Section Pass Band

The behaviour of the L.P. filter can be visualised from an examination of the curve in Fig. 8 where attenuation is plotted against frequency and shows the effect before and after the critical frequency fc. In practice the resistive elements in the filter cause the curve to round off near the cut-off frequency, as is shown by dotted lines.

We know that

$$Zk = \sqrt{Z_1^2 + 2\,Z_1.\ Z_2}$$

In this case

$$Z_1 = jwL/2\ ;\ Z_2 = 1/jwc$$

$$\therefore\quad Zk = \sqrt{L/C - w^2\,L^2/4}$$

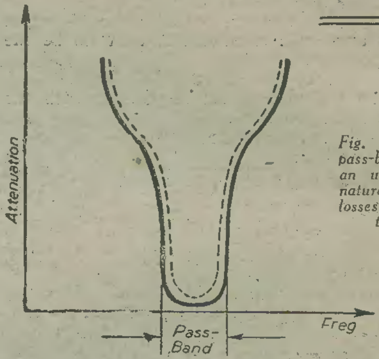


Fig. 11.—A limited pass-band filter of an uneconomical nature, owing to losses introduced by the sections.

Hence Zk will be $\sqrt{}$ a positive number, provided L/C is greater than $w^2\ L^2 / 4$; so in this case Zk is a pure resistor Rk.

Similarly, Zk will be a negative number, which equals j a positive number, if $w^2\ L^2 / 4$ is greater than L/C, in which case $Zk = Xk$; a pure reactance.

Attenuation will therefore commence when

$$L/C = w^2L^2/4$$

i.e., at such a frequency that

$$w^2 = 4 / LC, w = 2 / \sqrt{LC}.$$

This is therefore the cut-off frequency fc where

$$w = 2\pi fc$$

$$\therefore\quad fc = 1 / \pi\sqrt{LC}$$

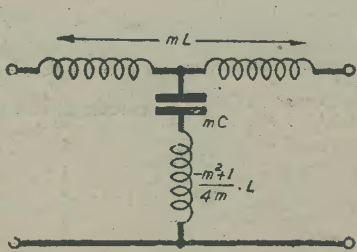
The limits then of the pass band for a L.P. section are:

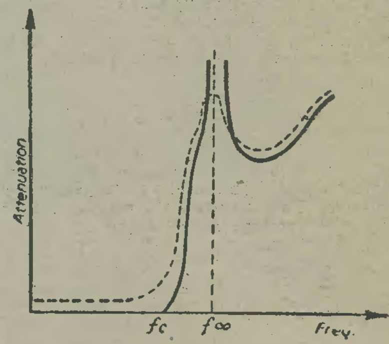
$$f = 0 \text{ and } f = 1 / \pi\sqrt{LC}$$

Now for such a section as we have seen

$$Zm = jwl\ ;\ Zn = 1/jwc$$

Fig. 12.—An m-derived section of a limited pass-band filter.





Therefore:

$$p = Zm/4Zn = jwL.\ jwC/4$$
$$= -w^2LC/4$$

When $w = 0$; $p = 0$

and when $fc = 1 / \pi\sqrt{LC}$ then:

$$w = 2\pi fc = 2/\sqrt{LC}$$

So $p = -4/LC.\quad LC/4 = -1$

The conditions p=0 and p=−1 will always give the limits of the pass band.

The High-pass Filter

Fig. 9 shows a filter circuit made up of reactors, but differently arranged. This circuit might be expected to prefer high frequencies to low, and theoretically its impedance is constant at all frequencies above a critical value, below which it increases very rapidly. This is a high-pass filter and when correctly designed gives a curve similar to that shown in Fig. 10.

As in the low-pass type, the practical curve is rounded off by resistive elements and is again shown dotted.

High-pass Section Pass Band

The limits of the pass band are given thus:

Put $p=0$ and -1

$Zm=1/jwC$; $Zn=jwL$

So that $p=Zm/4\ Zn$

$\therefore \quad =1/jwC.\ 4\ jwL$

$=-1/4w^2\ LC$

When $p=-1$

$-1=-1/4w^2\ LC$

$\therefore \quad 4\ w^2LC=1$; $w^2=1/4\ LC$

$w=1/2\sqrt{LC}$

$\therefore fc=1/4\pi\sqrt{LC}$

When $p=0$

$0=1/4\ w^2\ LC$, hence $w=\infty$

i.e., the upper limit of the pass band is at infinite frequency.

Limited Pass-band Type

In practice it may be necessary for a filter to pass a frequency fa near to fc and also attenuate heavily a frequency fb also near to fc. It might be very difficult to design a prototype section having such sharply marked frequency discrimination; in this case two methods of getting the desired result are possible.

(i) By using a great number of sections, but since in practice each section would introduce some loss, this would probably be uneconomical. (Fig. 11).

(ii) By using what is known as an m-derived section. (Fig. 12.)

This latter is a section in which an additional impedance has been placed in either the series or the shunt arm so that at some frequency near to fc (above for a L.P. and below for a H.P. filter) resonance occurs causing (ideally) infinite attenuation. In order that the same Rk shall exist as in the prototype, it will be necessary to modify L and C.

It can be shown that if a low-pass prototype is taken, and L and C reduced to mL and mC respectively (m being a fraction), then the same Rk is achieved if an additional inductance is placed in the shunt arm of

$$1-m^2/4m.L$$

$f\infty$, the frequency of infinite attenuation is equal to

$$1/\pi\sqrt{(1-m^2)\ LC}$$
$$=fc/\sqrt{1-m^2}$$

So the smaller m, the nearer will $f\infty$ be to fc and hence the steeper the characteristic. But practical limitations make very small values of m extremely difficult to achieve, and anything below 0.3 is very unusual. 0.6 is a general value.

It is not intended to proceed farther into the question of filter sections, nor the phase relations therein. Neither the application of the principles to a study of transmission lines, which is a subject on its own and will be dealt with separately.

The design and theory of filter sections is a subject involving complicated mathematics and the foregoing is intended only to give a general idea of the working properties of attenuators and filters.

Parts of the mathematical treatment may have proved heavy going to some readers; if certain sections are a little beyond the grasp of some, take the results as the correct ones and leave it at that.

Notes from an Amateur's Log-book

2CHW Explains How Essential is a Valve Voltmeter to the Experimenter, and How Easy it is to Construct and Operate

ONE of the problems with which most of us have to contend, even in normal times, is the acquisition of the instruments we desire to complete our testing equipment. Good instruments cost a fair amount of money, and many of us had our range of selection limited owing to that reason; to-day, the Services take priority, therefore, even if one has accumulated the necessary wealth, meters of the type most of us require are as scarce as extra copies of *P.W.* If you are fortunate enough to own, or be able to secure, a good low-reading milliammeter, preferably one having a full-scale reading in the region of 1mA., it is not a difficult matter to construct around it a most useful "universal" multi-range test meter. Several past issues of *P.W.* contain all the essential details for such work, but if I may be allowed to make any recommendation, I would suggest following the extensive constructional data which is given in the "Practical Wireless Service Manual," as the instrument described therein is really "universal."

During the many visits I have made to shacks and dens belonging to my S.W. friends, I have been struck by the absence of one type of meter in particular. Some of the installations I have seen have been a sight for sore eyes as regards equipment in general, but, more often than not, has the one meter, which I think is so essential to any keen experimenter, been missing. If you have not already guessed to what I have in mind, I am referring to the simple valve voltmeter, a piece of apparatus which can be assembled—assuming the parts are to hand—in less time than the average single-valver, and which will enable certain voltages to be measured, which before you were unable to check and, therefore, could not secure valuable data concerning the efficiency or effect of components or individual sections of a circuit. With the usual range of volt and milliammeters which we amateurs manage to secure, voltage and current readings can be taken across or in D.C. and A.C. circuits, but it becomes a very different matter when voltages, possibly minute, of an A.C. nature having frequencies within the radio (H.F.) and audible (L.F.) ranges have to be checked.

Valve Voltmeter

It is in such instances as these when the valve voltmeter proves itself invaluable; if such an instrument is to hand it is surprising how frequently it can be used to provide essential information, and how varied are its applications. One thing which has to be avoided when taking measurements across circuits concerned with radio or audio-frequencies is the consumption or drawing off of any power from the circuit under test. The valve voltmeter offers a high impedance to the test circuit; therefore one of its features is the absence of any power consumption, thus making it suitable for use on high or low-frequency circuits in which the actual power might be very small. The circuit shown in Fig. 1 depicts a simple peak-type of valve voltmeter, which, as the prefix denotes, measures the maximum or peak voltages developed across the circuit under test. Although a triode valve is shown, use can be made of an S.G. valve if so desired; personally, I favour the triode as it allows a more compact unit to be made and simplifies wiring.

It will be seen by reference to Fig. 1 that the wiring forms a normal valve circuit; the anode receives its positive voltage from a low value H.T. battery, which has, in series with its negative return to the negative side of the filament, a milliammeter having a low maximum scale reading, preferably 1mA.

On the input side, two terminals or sockets are provided, one being connected to the grid of the valve, and the other to a variable supply of negative grid-bias. Two potentiometers are used across the two G.B. batteries, the reason for this and the voltmeter Vm, is explained below. One point which must be noted when using the circuit under consideration is, it is essential that the circuit under test must be capable of providing a D.C. path between the two input terminals, i.e., between the grid of the valve and the bias supply, so that the grid does receive the bias necessary for the operation of the complete circuit.

Operation

With the input terminals connected to the circuit to be measured, or short circuited, turn R2 to the full on position, so that its moving arm is at the positive end of its resistance element, thus putting its maximum negative bias in circuit. The other potentiometer, R1, should then be turned until the voltmeter shows a zero reading; the anode circuit can then be completed by plugging-in the positive H.T., the voltage required being in the region of 15 to 20 volts, depending on the characteristics of the valve.

The potentiometer R2 should now be adjusted until the milliammeter M shows a low reading somewhere near its zero: the exact reading is not critical, but it must *be noted* as it forms an arbitrary zero which is made use of during the actual measurements. After allowing a few seconds for the circuit to settle down, so to speak, or to allow the valve to reach its proper operating temperature and to ensure that all batteries are constant, the H.F. or L.F. voltage to be measured can then be applied across the input terminals. The potential thus applied across the grid circuit of the valve will cause the anode current to rise, this being indicated by the meter M. The control R1 is then slowly rotated until the anode current returns to its original arbitrary zero as previously noted on M. The voltmeter Vm will indicate the value of the bias which has been applied to bring about the reduction in anode current, and this value will be *equal* to the peak voltage of the circuit being measured. It is owing to this method of operation, that this particular form of valve voltmeter is known as the "slide back" method.

Components

The two potentiometers should be of the wire-wound type of good quality: R1 has a value of 2,000 or 2,500 ohms, and R2 1,000 ohms. The fixed condensers are of the mica dielectric type, the two values shown on the diagram for C being advisable for use on H.F. and L.F. voltages respectively. It is best to use a 9-volt battery for the G.B. supply, and plug the connection formed by the junction of the two potentiometers into the 4½-volt socket. Should the 4½ volts across which R1 is thus connected *not be sufficient* to return the pointer of M to its arbitrary zero, it will indicate that the voltage under measurement is greater than 4½ volts, therefore, additional bias must be brought into circuit by adding an external battery. This should be introduced at the point marked X, but as its value will not be indicated by Vm, its voltage must be measured and added to Vm's reading. If one is likely to want to measure voltages higher than 4½ volts, it would be best to use a higher voltage battery for that section across which R1 is connected, in the first place.

The voltmeter Vm should be of good quality having a resistance of, at least, 500 ohms per volt, a maximum scale reading of 10 or 12 volts is adequate.

If measurements have to be made across circuits carrying H.T., "blocking" condensers should be connected in series with the input terminals. These should have values of .0005 mfd. and .05 mfd. according to whether H.F. or L.F. voltages are being measured. It must be understood that in the event of using these condensers, the required D.C. path between grid of valve and bias supply will be interrupted, therefore a high resistance must be connected across these two points, i.e., between the grid and the moving-arm of R1, or the bottom input terminal; the resistor should have a value of 3 to 5 megohms.

The valve should be of medium to low impedance; one of the L.F. or small power types is usually satisfactory for general work. If possible, once the most satisfactory valve has been selected, it should be retained for use in the valve voltmeter, and it will be found best to make up the unit—complete with batteries and meters—in a neat case so that it becomes a self-contained piece of apparatus ready for instant use. Fortunately, with the "slide back" circuit described, no complicated calibration of the meters is necessary, thus one does not have to be super-critical about ensuring constant operating conditions as with other types of circuit.

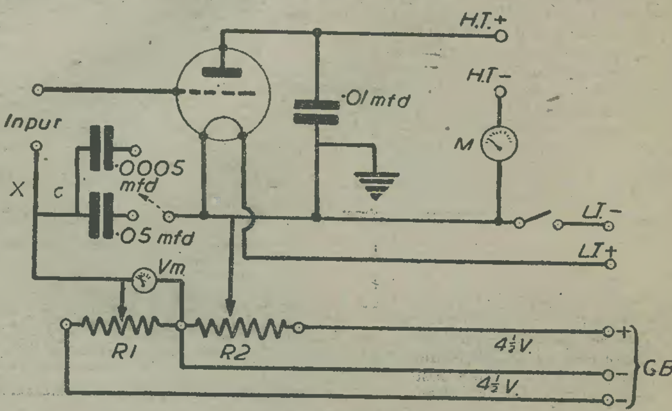


Fig. 1.—The simplicity of the valve voltmeter is shown by this theoretical diagram.

PRIZE PROBLEMS

Problem No. 439

WHITWORTH was very satisfied with the 4-valve A.C. mains receiver he had constructed, and which had given him good service without any attention. One day, however, he switched on, and after the usual slight delay the programme started to come through. Before it reached its full volume there was a "plop" and the signals disappeared, but an audible hum was heard through the speaker. For a while Whitworth fiddled with the tuning, etc., but eventually decided to have the chassis out. On examination of the wiring he found that the detector decoupling resistor was smoking-hot, and on measuring the output from the rectifier found that its voltage was low. What do you think had happened?

Three books will be awarded for the first three correct solutions opened. Entries should be addressed to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 439 in the top left-hand corner, and must be posted to reach this office not later than the first post on Monday, December 14th.

Solution to Problem No. 438

The test James applied was really useless so far as testing the condenser was concerned, as he overlooked the fact that the tuning coil was connected in parallel with the condenser

The three following readers successfully solved Problem No. 437, and books have accordingly been forwarded to them: L. Edwards, 7, Coed Afon, Llangollen; W. Pierce, Hayes, Kent; I. P. Sexstone, c/o G.P.O.

Introducing Degeneration

A Simple Explanation of the Advantages of This System

By S. C. MURISON

MOST readers will be familiar with the idea of positive feed-back (regeneration) in H.F. tuning circuits, but they may not be aware of the use of negative feedback (degeneration). This system is at present confined mainly to L.F. amplifiers although it has been used in the H.F. and diode detector circuits. We shall confine our examination of the idea to its use in L.F. amplifiers, where it is most useful.

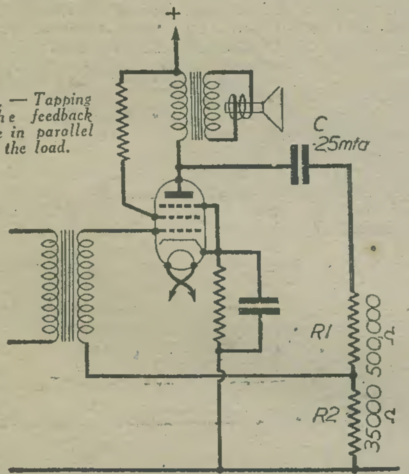


Fig. 1.—Tapping off the feedback voltage in parallel with the load.

Readers know how positive reaction, which is obtained by feeding part of a stage's output back into the input so that it adds to the existing input, thus raising the output, decreases the apparent resistance of a tuned circuit, and allows a very sharp resonance to be obtained. Degeneration can be expected to produce the very opposite results, and this it certainly does. Let us see if these results are of any help in the search for pure amplification of sound.

One does not want resonances in an L.F. amplifier, so if degeneration only gets rid of any tendency to resonate it will serve a useful purpose. Even a resultant small loss in amplification can be tolerated if a gain in quality results. The amount of "ironing out" of resonances depends on the amount of feedback; so also does the loss of amplification.

Impedance

Regarding the other consideration, the effect on the circuit's apparent impedance, degeneration can perform a very helpful task, for it reduces the apparent impedance of the output valve of any amplifier to which it is applied correctly. This may seem of no great importance, but when the output valve is a pentode (as is now usual, owing to the great shortage of high-power triodes) it is important. A pentode places little or no load on the speaker which it feeds, and so does not in any way stop the speaker resonating at frequencies determined by its design. With degeneration applied, it does place a load on the speaker and so improves its characteristics. It should clearly be understood that although there is a loss in amplification as a result of degeneration, the pentode still gives a greater output than a triode would in the same circumstances. In much the same way, all other tendencies to resonances in the whole amplifier are eliminated or at least reduced.

The use in the last paragraph of the phrase, "applied correctly" may give rise to misgivings. There is really no cause for this, as there are only two ways of applying degeneration. The first, the one used least, is to tap off the voltage to be fed back in series with the load on the output (normally the speaker). This method does not reduce the apparent resistance of the output valve so we shall not consider it further.

Feedback Voltage

The second method is to tap off the feedback voltage *in parallel* with the load. Fig. 1 shows a common way of doing this. In this case the feedback voltage is tapped off the fixed potentiometer formed by R_1 and R_2 in series at the junction point. The amount of feedback can be worked out from the formula $\frac{R_2}{R_1 + R_2}$. When the result is required as a percentage, as it usually will be, the answer to the above formula should be multiplied by 100.

At this stage it is well to consider just what we are to lose in amplification to gain all the advantages. It is usual to apply somewhere about 10 per cent. feedback to gain the full advantages of the system. If the feedback is below 5 per cent. the advantages are not so obvious. A loss of 10 per cent. in a modern amplifier using a pentode capable of supplying, say, 4 watts is tolerable. The actual loss can be determined from the formula $O = \frac{g}{1 + gB}$ where O is the actual amplification obtained, g the amplification prior to the use of degeneration and B the percentage of the output fed back. If you work out a few examples, you will see that the loss can very well pass unnoticed if the percentage feedback is kept below 10. In Fig. 1 the values shown will, approximately, give 7 per cent. degeneration.

With battery valves the loss of even 7 per cent. may not be tolerable. Q.P.P. output stages are almost the only battery output stages with which such a loss can be allowed. However, degeneration tends to be complicated in such cases. In any case, battery output triodes which do not require degeneration to ensure good quality output are easily obtainable. As degeneration is not therefore needed to such a great extent in battery designs

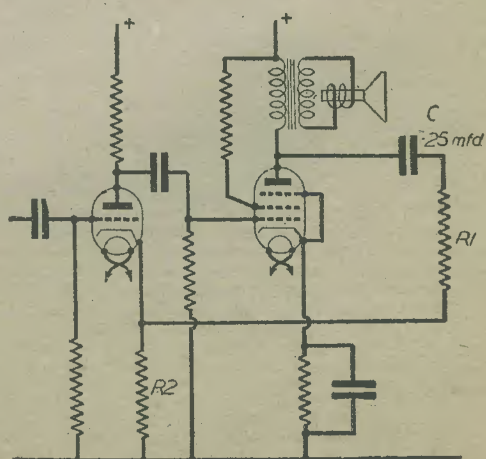


Fig. 2.—A suitable method when R.C. coupling is in use.

it will not be considered here, although *it is practical when the loss can be tolerated.*

The circuit of Fig. 1 applies only to transformer coupled stages, so Fig. 2 is given for those using capacity

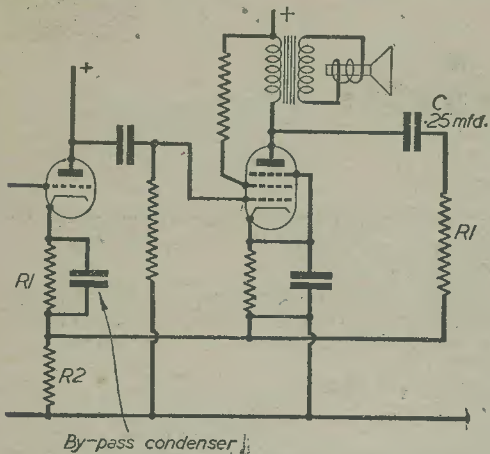


Fig. 3.—An improved version of Fig. 2. Both sides of the potentiometer can now be varied.

coupling. For all purposes it can be regarded, so far as degeneration is concerned, as the same as Fig. 1. As R_2 is the bias resistor (the value of which depends on the valve and cannot be varied to suit the feedback considerations) the designer must choose the value of R_2 to suit the amount of feedback needed. The circuit of Fig. 3 shows a way out of this difficulty. The bias resistor R_b is by-passed in the usual way and so it does not play any part in the feedback. The designer can again vary both sides of the potentiometer. In all the figures a condenser marked C will be seen. This is only to prevent the flow of H.T. to earth through the feedback potentiometer. As long as the value of this condenser is above .1 mfd. it will play no part in the feedback, but if a small capacity is used it would mean that the amount of feedback varied with the frequency, thus ruining the attempt to get a level response.

The feedback can be taken from the speech winding of the speaker, but as few speakers give ready access to this winding no circuit is added. It should be said of this method, however, that it also helps to even out peaks in the output transformer's response.

Transformer Characteristics

The characteristics of the transformer depend greatly on whether it is being used with the correct valve. The same applies also to the valve, in that it must be used with the correct load, this being most noticeable when a pentode is in the output stage. The use of degeneration, with its accompanying apparent reduction in the valve impedance, means that although one should still use the load specified by the valve makers, there is a certain amount of deviation possible without any effect on either the valve or its output.

In conclusion, it may be noted that the loss in amplification is well repaid by the quality obtained, and in the reduction of the trouble due to having to match the speaker to the valve accurately.

Broadcasting House Hears from the World

SEVERAL times a day in all B.B.C. overseas transmissions announcers ask listeners to write and say what they think of the programmes, and to report on reception conditions. The response to these requests is remarkable in volume and variety, and affords a most valuable guide to the planners of the vast networks which have grown out of recognition since the beginning of the war.

Over 30 000 letters have been received from Empire and North American listeners since January, 1940; the largest number from Africa, with North America a close second. The number of letters received from any one area cannot, of course, be taken as a reliable indication of the proportion of listeners. In these days of uncertain mails, the thought that a letter may never reach its destination must be discouraging to many would-be correspondents. However, hardly a day passes but Broadcasting House gets its loaded mailbag, which is not only a satisfying proof of the interest taken in the programmes, but a heartening indication of the number of convoys which come safely home.

Ninety-five per cent. of the letters received are replied to personally. An experienced staff deal with the many complicated programme queries which pour in.

The world situation is reflected in correspondence in an immediate and often revealing manner. When the war is going badly, criticism increases and news bulletins naturally receive more unfavourable comment; but entertainment programmes which are appreciated when things are going well are also criticised in depressing periods.

Letters come from people in every walk of life—rich man, poor man, beggarman, thief—all write to the B.B.C. In recent weeks letters have been received from a shortwave enthusiast of 11, a listener of over 90, a West African native prince, and a writer who gave his occupation as ex-burglar.

Link With Home

A link with home provided by the B.B.C. is emphasised in many letters, and the chimes of "Big Ben" are a constant reminder that, as one writer puts it, "England lives on and fights on." Here are other typical comments:

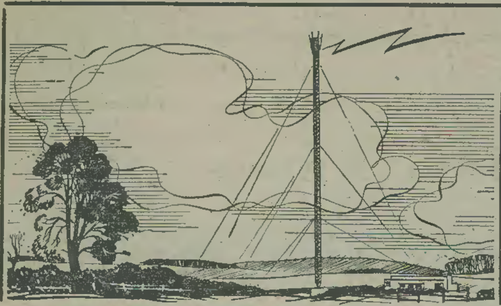
From Honolulu: "Can you imagine what it means to me to hear the voice of 'Big Ben' chiming his way across thousands of miles of sea and land? As a small boy of 10, when I was a chorister at Westminster Abbey, 'Big Ben' was necessarily a part of my life. The only time I did not hear him sounding the passing of each quarter of an hour was when I was asleep."

From Alabama, U.S.A.: "What it means to me personally to hear your 'This is the B.B.C. . . .' you can imagine. To hear only the voice of your announcer brings to me a deep reminder of the soil that is so dear to me; and please accept my heartiest thanks and gratitude for your transmissions, which serve as a world-wide bond of friendship between the nations."

From Victoria, Australia: "Gone are the sighs from our hearts and the cry from our lips of 'If only I could hear them speak,' for the voice of our dear ones speaks to us through your announcers, telling us of the good, serious and gay side of life in the dear home far across the sea."

A listener in Northern Rhodesia is 102 miles from his nearest white neighbour, 260 miles from the railway and 300 miles from a shopping centre. This listener has not seen a train or a soldier for seven months, and he last caught sight of an aeroplane in 1935.

Many letters ask the B.B.C. to help listeners in a diversity of ways. In every case an effort is made to get the required information, or to put the writers in touch with an organisation which can help them.



Things to come

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Engineering. All branches, subjects and examinations
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Insurance
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Matriculation
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Mining. All subjects
Mining. Electrical Engineering
Motor Engineering
Motor Trade
Municipal and County Engineers
Naval Architecture
Novel Writing
Pattern Making
Play Writing
Police, Special Course
Preceptors, College of
Press Tool Work
Production Engineering
Pumps and Pumping Machinery
Radio Communication
Radio Service Engineering
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ON YOUR WAVELENGTH

By THERMION

Programmes in Welsh

I SEE the Welsh people are kicking up a fuss because they feel there is risk of their language dying. They want more B.B.C. programmes in Welsh. In this respect they are like the Irish. Now most people who learn languages learn one which is going to be useful to them. Erse and Welsh are not useful languages, even if we admit that they are a language, and not a useless dialect like Yorkshire or Scotch brogue. However, perhaps someone will suggest that more time be given to English programmes, or rather programmes in English. The Scots have had their fair turn!! Isn't it just stupid for parts of nations to wish to remain parts of the corporate whole, and yet want to retain a pretence at being an individual nation? I do not see that the B.B.C. need listen to the Welsh, the Scots, or the Irish for that matter; they had nothing to do with the foundation of broadcasting, which, in any case, was not intended to be used for Scottish, Irish or Welsh nationalist purposes. The programmes are there for entertainment and not to advance national causes, and if, as the B.B.C. motto suggests, "Nations shall speak peace unto nations," heaven help us if we speak in the Welsh lingo or patois. Such lingo is more likely to promote wars than peace! I am merely being facetious, of course, but you get my meaning!

Negative or Positive?

I AM glad that Mr. Andrews, in delivering the Cantor Lecture this year before the Royal Society of Arts, drew attention to the silly belief that there are two kinds of electricity, positive and negative. As he points out, these terms have been applied to electricity as a pure convention. The Greek sage, Thales, discovered that by rubbing amber it would attract small particles. Others have discovered that by rubbing certain substances they repel small particles. Because of this it was presumed, and still is presumed by large numbers of people, that there are two forms of electricity. The terms negative and positive really apply to the substances and not to electricity, and they can also apply to the direction of a current. Sorry to destroy another illusion.

Composers and Lyric Writers

THE indefatigable "Torch" is reminded by my recent paragraph on the subject that it is practically impossible for English composers and lyric writers to get their work accepted and published. He agrees with me that merit has nothing to do with it. A year or so back the editor of a leading national Sunday newspaper commented, as I have done, on the fact that this war has not produced any good songs as did the last war. It is noteworthy that broadcasting did not commence until after the last war. This editor invited his readers to submit efforts to him, and he promised to see that those having merit should have every assistance from his paper towards making them widely known and popular. Naturally, the response was enormous, and submissions poured in by the thousand. Some of these it is reasonable to suppose were of merit. The offer was repeated for several weeks, and the hopes of would-be lyric writers, dreaming of fame and fortune, were built up. Finally, the editor announced that he had made his own selection, and had submitted them to one of the well-known music publishers. "Torch" took it upon himself to tell the editor in advance what the decision of the Barons of Bolony would be. He was right, for the barons informed the editor that not one of them had the least merit or chance of any success, the reason apparently being that there would not be a rake off. We are, therefore, still relying upon "Tin Pan Alley" to give such soul-stirring and meritorious tunes as:

"Guggly wuggly little piggly wiggly,
Ro de oody do,
With you in my arms,
I love your charms,
And I've just got to tell you so."

As "Torch" says, with plenty of money behind such tripe to subsidise band leaders, crooners and cryners, it is converted into the latest song hit, and you will hear it five or six times a day. The first time it will be announced as "that parpular sarng," the second time "by special request," and from that point it becomes "the latest song hit." I could sometimes wish that some of these tripe factories could have another hit—a direct hit by some new form of incendiary bomb with an affinity for slush music. The recent B.B.C. edict that there was to be no more debilitated music has not had effect, for more of it is being poured out than ever.

"Noises in their Brains."

PRESS ITEM—B.B.C. Brains Trust has been beaten by question, "Why Does a Whistle Whistle." Professor Needham refused to tackle it, Commander Campbell suggests that sometimes a sound comes that the human ear cannot hear, and Professor Joad said, "Surely the sound does not come from the whistle. It does not sound in the air but in the brain."

The antics of the Brains Trust
Have often caused us pains.
But now we know the reason—
They've got noises in their brains.
Some obstacle to common sense,
They felt, seemed very sure.
But now that they have cleared things up.
The reason's not obscure.

A question asked, the whistle shrieks
And bells begin to toll,
And in their brainpans' vast expanse
Strange noises start to roll.
The bats within the belfry wake
And flutter to and fro.
Professors giggle with delight
And answer "We don't know."

Which only leaves things as they were—
Of that there is no doubt.
But this we know, that twenty quid
To each one is paid out.
No bit the wiser for their aid,
We feel exceeding sore,
To think they're coming back next week
To whistle down some more.

—"TORCH."

Our Roll of Merit

Readers on Active Service—Twenty-seventh List.

E. Hanson (L/Cpl., R.E.)
A. C. Tanner (Cpl., R.A.F.).
R. G. Hussey (Sgt., R.A.).
T. Worrall (Gnr., R.A.).
H. Parker (S.H.Q. Signals, R.A.F.).
W. C. McCrossan (L.A.C., R.A.F.).

P.W. Blueprint Service

The £5 . 5 . 0 Battery Four (W.M. 381) and the W.M. A.C. Short-wave Converter (W.M. 408) are Described this Month

THE £5 5s. Battery Four is a screen-grid high-frequency stage, leaky-grid detector, transformer-coupled low-frequency stage and a resistance-coupled pentode (or triode) output valve. This is a combination that gives a reasonable degree of selectivity because of its two tuned circuits. It also gives adequate range and power. (See Fig. 14.)

The aerial is taken to the first coil through a .0001 microfarad fixed condenser; this is to increase the selectivity. Built into the tuning coil itself, and thus forming an integral part of it is a further .00003 microfarad condenser; this is in circuit only when the set is used for long-wave reception.

In the anode circuit of the screen-grid valve there is a high-frequency choke, which should be of an efficient type, so that the maximum signal strength is passed on to the detector valve, which is coupled to the first by the tuned-grid method.

Without any alteration of the circuit or the set in any way it is possible to substitute a triode power valve for the pentode if desired. This course may appeal to those who already have one or two spare valves provided the speaker is fitted with a suitable matching transformer.

Although, for the sake of simplicity, the aerial coil has been shown in the blueprint in a vertical position it is *actually mounted horizontally*; this is to avoid interaction between the aerial coil and the tuned-grid coil.

Capacity Shield

There is also a vertical partition screen between the aerial-tuning side of the set and the tuned-grid side; this screen acts rather as a capacity shield between the wires than as an electro-magnetic screen between the coils, which is why the latter are mounted with their axes at right angles.

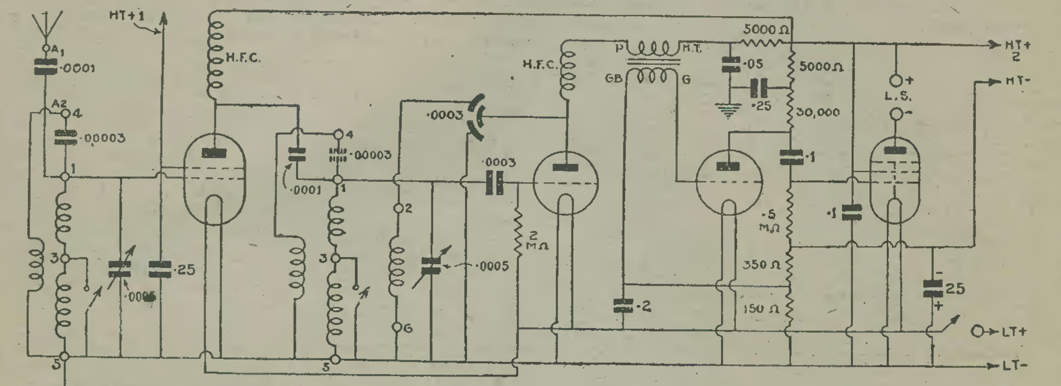


Fig. 14.—The theo. of the £5 5s. Battery Four, blueprint No. W.M. 381. This is a good general purpose dual-range receiver.

Tuning Circuit

Between these two valves there is a coupling condenser of .0001 microfarad, immediately followed by the grid coil, which is tuned (as is the aerial coil) by a .0005-microfarad variable condenser. Separate tuning has been employed for both tuned circuits, so that those who have a couple of spare condensers by them can make use of them without going to the expense of buying new ones.

The detector grid leak and condenser have the usual values of 2 megohms and .0003 microfarad. Reaction, it will be seen, is arranged on the differential principle.

The intermediate low-frequency stage is resistance coupled to the output valve. A 30,000-ohm resistance and a .1-microfarad coupling condenser are used for this purpose. The two 5,000-ohm resistances and the .05 and .25-microfarad fixed condensers are for decoupling the detector and low-frequency stages respectively.

Automatic Bias

Associated with the output valve are further resistances and condensers. The two resistances of 350 and 150 ohms are for providing the output valve and the intermediate low-frequency stage with automatic grid bias.

The 150 ohm resistance is by-passed by a condenser of .2 microfarads, while the two are by-passed by an electrolytic condenser of 25 microfarads. The latter must be connected with due regard to the proper polarity.

COMPONENTS NEEDED FOR THE £5 5s. BATTERY FOUR

Baseboard: One 5-ply, 16in. x 9in.
Chokes, High-Frequency: One Graham Farish, type Snap; One Graham Farish, Ohmic.
Coils: Two B.T.S. type Droitwich.
Condensers, Fixed: Two .0001-microfarad, one .0003-microfarad, one .05-microfarad, two .1-microfarad, one .1+.1-microfarad, two .25-microfarad, one .25-microfarad (electrolytic).
Condensers, Variable: Two .0005-microfarad; one .0003-microfarad differential reaction type.
Dials, Slow-motion: Two Ormond, type R361.
Holders, Valve: Three four-pin, one five-pin.
Plugs, Terminals, etc.: Four Clix wander plugs, marked H.T.+1, H.T.+2, H.T.—; two Clix spade terminals, marked L.T.+L.T.—; five Clix metal sockets.
Resistances, Fixed: One 150-ohm, type ½-watt, one 350-ohm, type ½-watt; two 5,000-ohm, type ½-watt; one 30,000-ohm, type ½-watt; one ½-megohm, type ½-watt; one 2-megohm, type ½-watt.
Sundries: Ebonite strip 5in. x 1in. x 3/16in.; three doz. ½-in. wood screws; connecting wire and sleeving; three yds. thin flex; aluminium for screen 6in. x 9in.; wood for panel 16in. x 6in. x 3/16in.
Switches: One two-point push-pull; one three-point push-pull.
Transformer (Low-Frequency) One ratio 1 : 3.5.
Valves: One Cossor 215 S.G.; one Cossor 210 H.L.; one Cossor 210 Det.; one Cossor 220 H.P.T.

One other point to note is that the .2 microfarad condenser used as a grid-bias by-pass is composed of a .1+.1 microfarad condenser; those who are starting this set from scratch, as it were, can use an ordinary .2 microfarad type.

Five Controls

Apart from these special points there is nothing that the beginner will not be able to understand from the diagram Fig. 14, or the full-size blueprint.

There are five controls in all—three condensers and two switches. The condensers, from left to right, are for aerial tuning, grid tuning and reaction; the switch on the left is for wave-changing, and that on the right for putting the set on and off.

There will be very little difficulty about the operation of the two tuning condensers, as their readings will remain practically the same at all wavelengths.

When the set is first put into operation it is important to adjust the anode voltages properly. The battery should be of 120 volts, as some of this will be lost any way because of the incorporation of automatic grid bias. This is not a great disadvantage, though, when the convenience of the system is taken into consideration.

Quite apart from the saving of connecting leads, the grid bias will automatically fall, as the voltage of the battery decreases so that the grid bias will always be in more or less correct proportion to the applied anode voltages and quality will not suffer as the battery runs down.

Suitable Voltages.

H.T.+1, which supplies the screen of the high-frequency valve, should be plugged in at about 80 volts, while H.T.+2 should be plugged into the 120-volt tapping. There is, of course, no objection to the use of a 150-volt battery, in which H.T.+2 should be plugged into 150 volts.

It is best to start reception on the medium waves as there are more stations working on that band, and it is easier to pick up a selection of programmes. To adjust the set for this waveband, pull out the wavechange switch on the right (push it in for long waves) and, of course, pull out the right-hand knob to switch the set on

Operating Hints.

Adjust the reaction condenser to its minimum point (that is, turn the knob in an anti-clockwise direction as far as possible) and then slowly turn the two main tuning dials. Keep them more or less in step as far as the readings are concerned until a station is picked up. After a few minutes' experience it will be simple enough to see how far the dials are actually out of step.

For distant stations it will be necessary to apply a certain amount of reaction and to do this the knob of the reaction condenser is turned in a clockwise direction. Do not advance the reaction control too far or the set will burst into oscillation and the quality of reproduction will be spoiled.

Using a Pick-up

When it is desired to use a pick-up, this should be connected across the grid circuit of the detector valve provided that a volume control is used. Most modern pick-ups give an output of the order of .75 volt, and the 210 H.L. valve will be well loaded.

On the other hand, if an older type of pick-up giving an output of the order of 1.5 volts is employed, then the valve is liable to be overloaded and it will be better to connect the P.U. to the intermediate low-frequency stage.

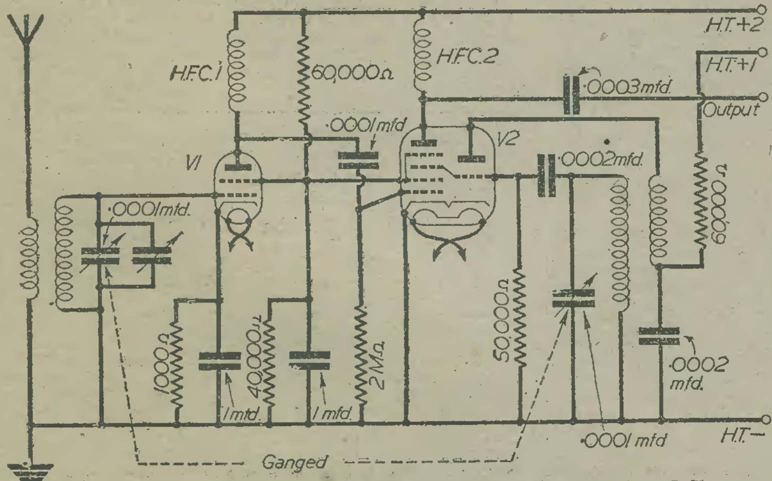


Fig. 15.—An efficient S.W. Converter for A.C. mains. It is known as the W.M. A.C. Short-wave Converter, blueprint No. W.M. 408.

The "W.M." A.C. Short-Wave Converter (W.M. 408)

The tuning is by means of the two variable condensers which are ganged, but a trimmer (50 mmfd.) is provided across the first grid circuit. (See Fig. 15).

For the high-frequency stage an ordinary screen-grid valve has been used, and the screen voltage is fixed by means of a potentiometer comprising two resistances, one of 60,000 ohms and the other of 40,000 ohms. The screen is by-passed to earth by a condenser of 1 microfarad capacity.

The high-tension is fed through a choke to the anode of the first valve, and aperiodic coupling is used between this anode and the grid of the hexode. A condenser of .0001 microfarad and a leak of 2 megohms look after this coupling.

Grid-bias for the screened-grid valve is provided by a 1,000-ohm resistance between the cathode and earth, by-passed by a 1-microfarad condenser. The screen voltage for the hexode is derived from the same point as that for the first valve. There is no sign of instability whatever, and that may be regarded as sufficient justification for this small break-away from standard practice.

Oscillator Circuit Details

The triode inside the second valve forms the oscillator, and, as is well known, the grid of this triode is connected inside the valve itself to the third grid of the hexode. In the latter section of the valve the first grid handles the signal from the first valve, and the second and fourth strapped together form the screen element.

The triode section is provided with a standard oscillatory circuit using a four-pin coil and a fixed "reaction condenser" of .0002 microfarad. High tension is fed to the anode of this triode through the reaction coil in series with a resistance of 60,000 ohms. A separate tapping has been provided for this, but the two high-tension terminals may be connected together and a single supply used for them if this makes arrangements more convenient.

The output from the triode-hexode consists of an all-wave choke in the anode circuit and a fixed condenser of .0003-microfarad capacity, which couples over to the aerial terminal of the broadcast receiver with which the converter is to be used.

Plain flex is used for the connections at the top of the two valves instead of the flexible hooded connectors sometimes employed. No trace of instability has resulted from this change, and as these two points, one of which is the anode of the first valve and one the "input grid" of the hexode, are virtually connected together, it might be desirable to do away with the slight extra capacity to earth that is introduced by the use of shielded wiring.

Small Current Needed

Since the high-tension requirements of this converter are extremely modest (6 milliamperes at 120 volts representing the absolute maximum), it is not worth while to build a separate power-pack for the purpose of obtaining it. Many readers will find that their best plan is to use a 4-volt transformer for supplying the heater current, and an ordinary 120-volt dry battery for the high tension.

In other cases it will be possible to derive the high-tension from the supply to the broadcast receiver. This can obviously be done without the slightest risk of putting too high a load on the power-pack of the latter; the extra 6 milliamperes should pass unnoticed!

Power Supply

Normally, however, it will not be possible to derive the heater current from the broadcast receiver since most sets are equipped with a 4-volt transformer designed to supply just the amount of current required by the valves in the broadcast receiver, and an extra load of 2 amperes would probably result in some overheating.

Your 4-volt transformer, which should preferably be centre-tapped, must be connected across the terminals marked "L.T. A.C.," and the centre-tap connected to the H.T. negative terminal. If there is no centre-tap on the transformer one of the centre-tapped resistances supplied for this purpose should be used.

If the set with which the converter is to be used is a home-constructed affair it is just possible that both low-tension and high-tension may be derived from it. If it is a commercial product it would be best to leave its internals alone, and to save time and trouble by using a 4-volt transformer and a 120-volt high-tension battery, which will last for a very long time.

During the initial tests of the converter, the full 120 volts was applied to the "H.T.+2" terminal. To the "H.T.+1" terminal anything between the full 120 volts and the 24-volt tapping could be connected. Even with the 60,000-ohm resistance in series with the latter terminal, the triode would oscillate freely on all bands with only 24 volts. This should give some idea of the ease with which the triode-hexode can be taken down to the very short wavelengths.

Actually with some experimental coils having very small turn-numbers the converter was used on 7 metres and on the amateur 10-metre band, and results were just as good down there as on the lower frequencies.

The choice of .0002 microfarad and 50,000 ohms for the grid condenser and leak of the triode was not a matter of chance. These figures are recommended by the makers and definitely give more even oscillation over all bands than any other combination.

They also help to ensure that the output of the triode is right for efficient "mixing" within the hexode.

First Tests

When testing out the converter with a broadcast receiver it is suggested that you start with the two coils marked "22-47 metres." Actually this range is only obtainable with a tuning condenser of .00015-microfarad capacity. The .0001-microfarad condensers used, however, give ample "overlap" between the various ranges; the range covered by those particular coils is about 22-42 metres, the next pair starting at 41 metres.

With these coils you should find the 31-metre broadcast band at about 80 degrees on the condenser scale. At practically any time of day you are certain of discovering a strong transmission from at least one station in this band and that will enable you to get things lined up and to be quite sure that the converter is working as it should.

Once the trimming has been set to your satisfaction it is possible to make a real job of calibrating the converter. The coils are sufficiently well matched to ensure that it won't matter which one you insert in the oscillator holder, and which in the first grid circuit.

LIST OF COMPONENTS FOR THE "W.M." A.C. SHORT-WAVE CONVERTER

Chassis: One 12in. x 8in. metal.
Chokes, High-frequency: One Eddystone, type 1010; one B.T.S., type 112.
Coils: Two sets of short-wave.
Condensers, Fixed: Two T.M.C.-Hydra 1-microfarad, 250-volt working; two Dubilier .0002-microfarad, type 670; one Dubilier .0001-microfarad, type 620; one Dubilier .0003-microfarad, type 620.
Condensers, Variable: Two Eddystone 100 micro-micro-farad Microdensers, type 900/100 with gauging extension; one air-dielectric trimmer, baseboard mounting, 50 mmfds.
Resistances, Fixed: One Erie 2-megohm grid-leak; One Erie 1,000-ohm resistance; one Erie 40,000-ohm resistance; one Erie 50,000-ohm resistance; two Erie 60,000-ohm resistances. All 1-watt type.
Sundries: One Eddystone wide-vision vernier dial, type 973; one Eddystone adjustable insulated bracket, type 1007; one Eddystone flexible coupler, type 1009; two Belling-Lee plug-top valve connectors, type 1167; Belling-Lee terminals marked Aerial, Earth, L.T.A.C. (2), H.T.—, H.T.+1, H.T.+2, and Output; tinned copper wire, oiled cotton sleeving, etc.
Valve-holders: Two 4-pin, one 5-pin, one 7-pin.
Valves: One Cossor MSG/HA; one Osram X41.

HOW THE EMPIRE LISTENS TO BRITAIN

ALTHOUGH short waves are necessarily the medium for the B.B.C. broadcasts in the Empire Service, the audience is not restricted to listeners with short-wave sets. All over the Empire, as well as in the United States, Empire news and other programmes from London are picked up and re-broadcast by local stations on medium waves.

The Australian Broadcasting Commission, for example, re-broadcast B.B.C. programmes for an average of over two and a half hours every day. Nearly all of the 1,300,000 radio sets in Australia can therefore pick up these programmes as easily as listeners in Britain get the Home and Forces programmes. New Zealand gives over two hours a day to the relaying of the B.B.C.'s Pacific transmission, South Africa over one and three-quarter hours to the African transmission, while Canada takes the same amount of time from the North American transmission.

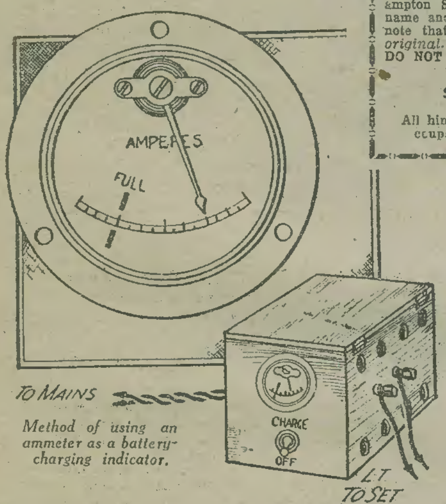
Radio for India is a special problem, since All-India Radio has to broadcast for listeners in many languages, inevitably constricting the time available for the relaying of London programmes in the Eastern Service. Nevertheless, on an average over half an hour a day is given by the Indian medium-wave stations to radio from London, some of it including broadcasts in Bengali and Tamil.

In the Crown Colonies the amount of re-broadcasting varies according to the operational hours of the local station, the availability of local talent, and the amount of time which must be devoted to vernacular broadcasts. A number of West Indian and West African colonies have re-diffusion systems, by which subscribers are linked by wire to a central distributing point. These systems make very extensive use of B.B.C. programmes. That in Nigeria, for instance, re-diffuses the B.B.C. for over 14 hours a day, while those in the Gold Coast and Sierra Leone do so for six hours. The re-diffusion system in Malta relays London almost continually throughout the day and evening, including, of course, the special programmes devised for the George Cross Island.

Practical Hints

A Battery-charging Indicator

WITH modern, low-filament-consumption battery valves, the strain on the accumulator is quite small, and even a trickle charger can overcharge the battery after a short period. If you have an old ammeter handy, you can easily make an indicator to tell when the battery is fully charged, thus preventing excessive over-charging.



Method of using an ammeter as a battery-charging indicator.

The ammeter is simply wired in series with the charging leads, and the unit switched on. When the accumulator is fully charged (test with a voltmeter, and by observing the gassing in this instance) it will be found that the amperage has dropped below the starting figure owing to the reduction in the difference between the accumulator and the charger voltage. The ammeter reading should then be recorded, either on the dial or on the glass, by any easily-read mark. The meter can be mounted in any easily-observed position, and will serve as a definite indicator of when the accumulator is fully charged.

A voltmeter could be used across the accumulator, but as it is utilised for many other measurements, it could not be wired permanently into position, whereas an ammeter (as distinct from a milliammeter) has no great utility in the average battery set. Trickle-charged accumulators are usually placed out of sight in the cabinet or a cupboard, so that it is usually difficult to observe visually whether they are charged. For neatness, the accumulator, trickle charger, meter, and switch could all be mounted in one box, as shown.—E. PARKER (London, S.E.).

THAT DODGE OF YOURS!

Every Reader of "PRACTICAL WIRELESS" must have originated some little dodge which would interest other readers. Why not pass it on to us? We pay £1-10-0 for the best hint submitted, and for every other item published on this page we will pay half-a-guinea. Turn that idea of yours to account by sending it in to us addressed to the Editor, "PRACTICAL WIRELESS," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Put your name and address on every item. Please note that every notion sent in must be *original*. Mark envelopes "Practical Hints." DO NOT enclose Queries with your hints.

SPECIAL NOTICE

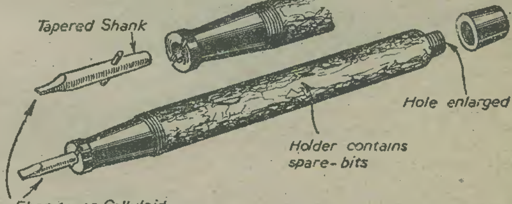
All hints must be accompanied by the coupon cut from page ii of cover.

Pocket Tool Set

A FOUNTAIN pen with a damaged or broken nib or ink sac can be put to excellent use by using the case to form the handle and container for a pocket set of trimming tools.

The particular pen that forms a good basis is one of the stud-filler variety.

A piece of ebonite rod, or toothbrush handle, is filed to form a set of screw-driver bits of varying sizes, with tapered shanks. The nib, etc., is removed from the pen case, together with the rubber tube. The bits are made to be a tight fit, in the usual position of the nib. If trouble is encountered due to the bits slipping in the holder, they could be drilled and provided with a short pin, and the holder filed as indicated in the sketch. The bits may be accommodated in the holder body by removing the stud filler and slightly enlarging the hole.

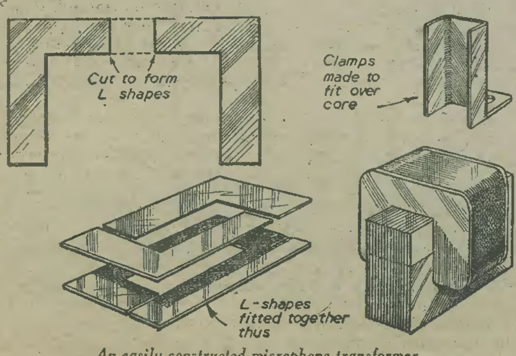


A vest pocket tool-holder, made from an old fountain-pen case.

This will be found to be a useful tool and in use will not cause any mistuning due to magnetic effects of metal bits.—C. INES (Yatesbury).

Microphone Transformer

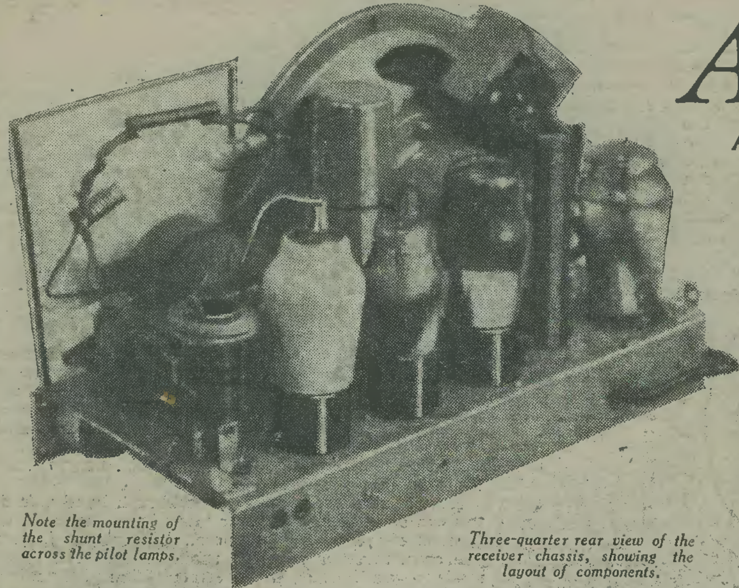
WHEN constructing a ribbon microphone recently, I required a very small transformer to fit into the microphone case for stepping up the output. After examining every possibility, I hit on the idea of using an old L.F. transformer modified in the following manner. I dismantled it completely and cut the U-shaped stampings as illustrated. It may not be necessary to cut all the stampings, but this will be determined by the size of the core required. I then made a bobbin in the usual way to fit the core, and wound it with the desired ratio, taking care that the windings did not exceed the core winding space. The accompanying sketch explains how the transformer is built up.—JOSEPH MACSWAN (Paisley).



An easily constructed microphone transformer.

A Midg

A Handy Mains-operated R
Present Component Diff



Note the mounting of the shunt resistor across the pilot lamps.

Three-quarter rear view of the receiver chassis, showing the layout of components.

THE limitations imposed upon receiver design under present conditions demands sets of a simple nature, both from the point of view of initial construction and subsequent servicing.

This receiver has, therefore, been designed to incorporate as few components as possible, having regard to its ultimate efficiency. Furthermore, although the set is of the so-called midget class, the majority of parts are standard, except the coils, but since they are of an extremely simple type and for medium wave only, they may easily be made at home if unobtainable commercially.

Unfortunately, we cannot do without valves, but here again standard types are employed and considerable latitude is permissible when choosing them.

The performance of most midget sets is marred by the very small speaker usually employed, this being amply demonstrated by connecting a normal speaker externally: the results simply do not bear comparison.

Naturally, the cabinet is the deciding factor where the speaker size is concerned, and in this design provision has been made for a unit of 6½in. diameter, which enables an output of good quality to be obtained.

Reference to the circuit diagram of Fig. 1 will show that a straight tuned radio frequency system is employed. The aerial is coupled by the primary of coil L.1 to the grid circuit of V.1, which is a variable Mu H.F. pentode. This valve is transformer coupled to another H.F. pentode (non-variable Mu) connected on the anode-bend principle, detection by this method being very suitable where an H.F. pentode is used.

Resistance capacity coupling feeding the output pentode completes the radio circuit, high tension being supplied by the usual half-wave rectifier with the loudspeaker field providing the necessary smoothing inductance.

It will be observed that no reaction proper is included in the circuit, because the set was designed primarily for local station reception. It will, however, receive many distant stations as well, but this will be described later in the operating notes.

Construction

The original receiver was assembled on an aluminium chassis measuring 11in. × 5¼in. × 1½in. deep. The problem of obtaining suitable metal for chassis these days is quite acute, but very often an old one may be adapted to suitable measurements. Failing the use of metal, however, ¼in. plywood may be usefully employed, covering this with metal-foil or even metallised paper.

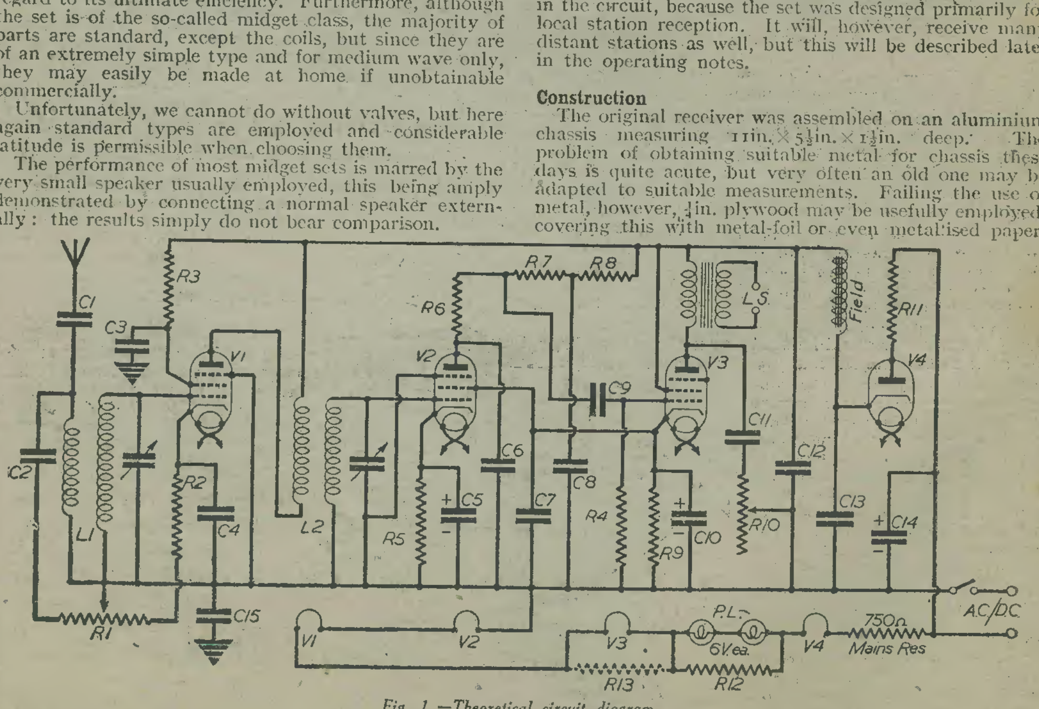


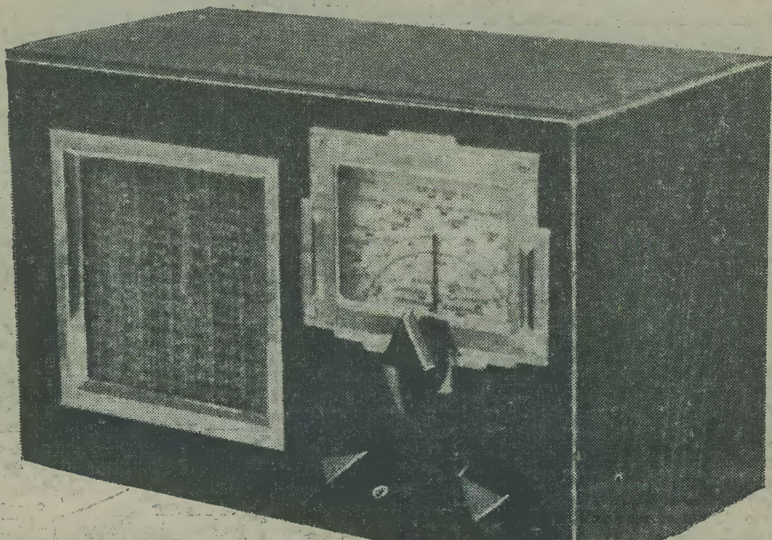
Fig. 1.—Theoretical circuit diagram.

et Universal Receiver

eceiver, Designed to Meet
ulties. By S. BRASIER

In this case make certain that the *inside* depth measures at least 1½in., or you may have difficulty in locating some of the sub-chassis components.

Only approximate positions for the various holes, etc., are shown in Fig. 2, since these will vary according to the parts used. However, the illustration and diagrams give a good idea of the location of the various parts. It will be necessary to cut away a portion of the chassis in order to permit of the mounting of the loudspeaker. Here again no actual measurements can be given, but a general idea may be gained from Fig. 2. Some support may be advisable at the back of the speaker, depending on the rigidity or otherwise of the chassis.



This front view of the complete receiver gives a good idea of its smart appearance.

The H.F. transformer, volume control and tone control are mounted below deck, all resistances, condensers, etc., being suspended by their own wiring.

In order to impart a professional-looking finish the chassis and all suitable parts might at this stage be painted grey.

Having fixed all components, it is wise to remove temporarily the loudspeaker from the chassis, thus guarding against possible damage during the wiring-up operation.

Wiring

There is not a lot of this to be done, as will be seen from the wiring diagram, but it should, nevertheless, be done systematically. Commence by running a thick copper wire (16 or 18 SWG) down the centre of the underside of the chassis, anchoring it firmly at each end and in the centre, all earth returns being connected to it. The valve heater circuits may then be wired, noting particularly that the earthed end of the chain starts at the detector. This is most important. The bypass and coupling condensers, etc., may next be wired in position, the remainder of the wiring being completed by starting from the aerial and working through, stage by stage, to the rectifier, and finally attaching the mains lead.

Operation

The operation of the receiver is simplicity itself, the only controls concerned being the tuning condenser and the volume control. No slow-motion arrangement was fitted to the tuning dial owing to the amount of space usually required, but perhaps readers may have ideas of their own which could be incorporated.

The set will give quite a good account of itself with a throw-out aerial of a few feet, but in order to justify the results of which it is capable a fairly efficient, though not long, aerial should be used. As is usual with this type of receiver, an earth connection is not necessary, but if one is used it must make contact *only with the earth socket* and *not to the chassis*, otherwise a few sparks might fly.

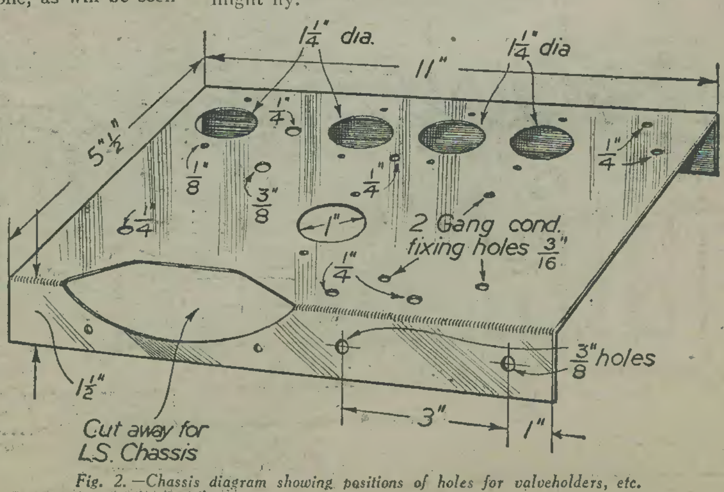


Fig. 2.—Chassis diagram showing positions of holes for valveholders, etc.

Having decided the above points, switch on the set by the knob on the left, and, with the volume control set about half-way round, tune in the local station, when a fairly comfortable signal should be received. The two trimmers on the gang condenser may then be adjusted for maximum output, turning the volume down to a low value in order to perceive small changes in volume. Repeat the operation at a few points on the dial, after which the circuits may be considered to be aligned.

Reaction

Having got the set working satisfactorily on the local station, turn the condenser dial to about 250 metres and slowly increase volume. Just as full volume is reached the circuit should slide gently into oscillation, and this condition should prevail over the whole of the waveband, although naturally the effect will be slightly more pronounced at the bottom end, as in ordinary reaction circuits. It will be seen, therefore, that in this state the receiver will be sensitive to distant stations, the volume control also serving—in effect—as a reaction control. The quality of the local programmes is not affected by this, shall we say, induced instability—for that is what it is—because the volume control under these conditions would be well below maximum, thus ensuring complete stability. It is partly for this reason that a fairly good aerial is recommended.

The manner in which this instability at full sensitivity is achieved is mainly by leaving the grid leads (to the valve caps) unscreened. In this way coupling is introduced between the H.F. and detector circuits and the effect may be increased to some extent by bringing the leads closer together, and vice versa.

It is important also that the full sensitivity of the H.F. stage is made use of, the critical point being the fixed bias resistor R2, since, if it is of too high a value, full sensitivity will never be reached, and the receiver will probably not oscillate. Also, if a long aerial is used, it would be advantageous to include a series condenser of .0001 or .00005 mfd.

With the on-off switch just on, the tonal balance is normal, but further rotation of this control will cause a gradual attenuation of the high notes. It was thought necessary to include a high note cut-off owing to the occasional interference—with consequent heterodyne note—caused by foreign jamming.

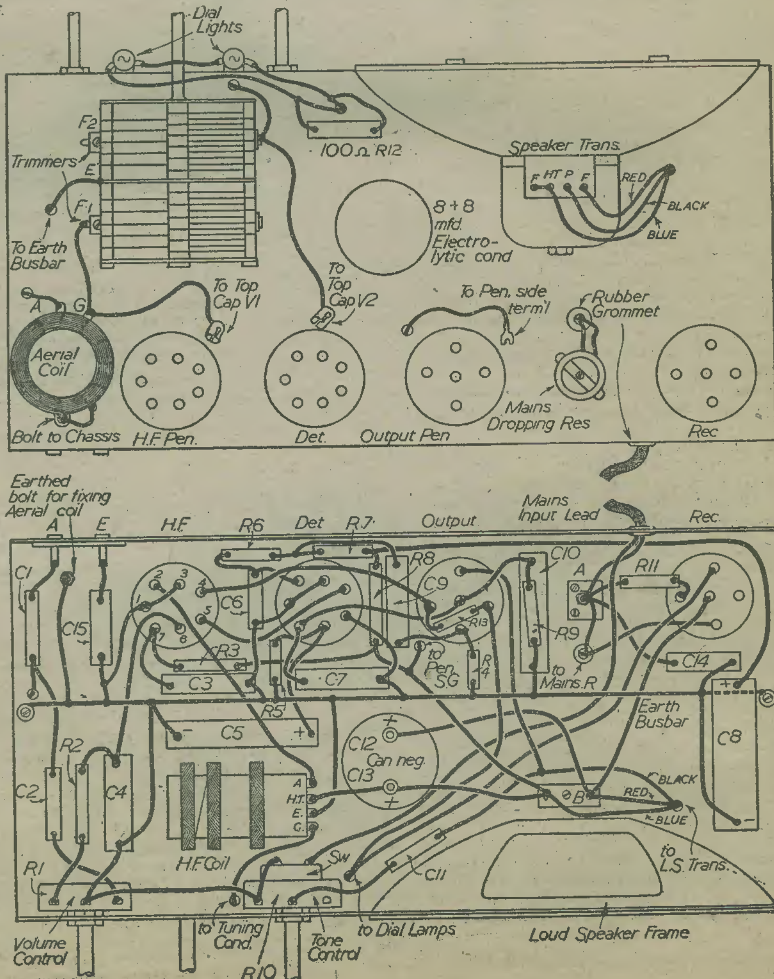
Components

Turning now to the question of alternative components, readers will understand that it is impossible, during these times, to lay down a specified receiver design, because it is highly improbable that the original parts are available in large quantities. Referring to valves, the supply question is a little easier than it was, and it should not be too difficult to obtain a set, though possibly not of the exact type.

V1—if not a 13 VPA—must be an H.F. pentode of the variable Mu type and the values of R2 and R1 (the fixed and variable bias resistances respectively) may require to be altered to suit, particular attention being given to R2 as mentioned earlier. The value of the screen-dropping resistor R3 is such that it gives a little over 100 volts and will probably be suitable for most valves of this type. V2 is an H.F pentode of the "straight" variety. The load resistance indicated by R7 in the circuit diagram may be anything from $\frac{1}{4}$ to 1 megohm for valves of other types, but the bias resistor R5 is a good all-round value and should be suitable.

It will be noticed that V2 in the diagram receives its screen volts from the cathode of the output pentode. This is merely for the sake of convenience as the voltage needs to be on the low side (15 to 20 volts) for the correct operation of a pentode detector. This is important, and if the usual dropping resistor from the high

WIRING DIAGRAM OF THE MIDGET A.C./D.C. RECEIVER



tension line is used instead, its value will need to be round about 3 megohms.

Regarding the output valve, in the original model a PP2018 was used because it was a new valve on hand. It has a .18 amp. heater and is the reason for the 1,000 ohm shunt resistor R13, shown in dotted lines in the circuit diagram of Fig. 1. It would probably be more convenient, however, to use a valve of the same current —such as the Pen 36C, or similar. In this case a 7-pin valveholder would be required and the bias resistor, R9, may have to be changed.

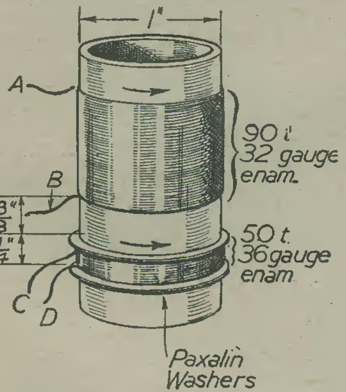


Fig. 3.—Diagram of windings for the coils.

Aerial Coil.	*H.F. Transformer.*
A—To Grid.	*A—To Grid.*
B—To Earth.	*B—To Earth.*
C—To Aerial.	*C—To Plate.*
D—To Earth.	*D—To H.T.+*

Any .2 amp. half-wave rectifier may be used for V_4, but watch the heater volts, which may be 20 or 30. This will affect the value of the mains dropping resistance as will, indeed, any alteration to heater voltages of preceding valves. However, all details for calculating mains-dropping resistances, shunts, etc., were given in issue No. 436, in an article entitled "Mixing Valves in A.C./D.C. Sets."

Speaking of dropping resistances, it is quite permissible to use a line cord for this receiver, and, incidentally, keep the heat out of the cabinet.

L.S. and Coils

The loudspeaker is of the mains energised type with a field resistance of 1,000 ohms. Similar results could be obtained with a smoothing choke of this value (connected in place of the speaker field) and a permanent magnet speaker. There is room on the chassis for an L.F. choke on the right of the speaker (rear view).

A pair of commercial coils were used in the original receiver, but if these are unobtainable they may be easily wound on a 1in. diameter paxalin tube as shown in Fig. 3, care being taken that the grid windings on each coil are as even as possible. If they are found to be very unbalanced when the set is trimmed, final adjustment may be effected by gradually shortening that winding across which is connected the trimmer that is most open. In other words, as the winding is shortened the capacity of the trimmer (previously low) will have to be increased, thus matching it approximately to the other trimmer.

Regarding the primary winding—that wound in the slot—it would perhaps be just as well when testing out to change around the leads C and D, Fig. 3, in order to make quite certain that they are in phase with their respective grid coils. Obviously, the connections which give the best results should be retained. Also, the selectivity may be increased by reducing the number of turns on this winding and likewise the coupling.

In conclusion, it will be seen from the illustration that the cabinet is quite simple, the appearance being enhanced by the addition of chromium frames for dial and speaker fret. These are obtainable from most surplus radio stores, but their addition is, of course, a matter of taste.

LIST OF CONPONENTS

One 2-gang condenser .0005 mfd. each section (of small type).
One dial to suit above.
One aerial coil (see text).
One H.F. transformer (see text).
Four valveholders.
Fixed condensers: One 8 x 8 mfd., can-type electrolytic condenser, 450 v.w. (C12 and C13); one 2 mfd. 350 V.W. electrolytic (C8); one 50 mfd. 50 V.W. electrolytic (C10); one 25 mfd. 25 V.W. electrolytic (C5); three .01 mfd. 600 V.W. (C11, C14, C15); four .1 mfd. 600 V.W. (C3, C4, C7, C9); one .002 mfd. 450 V.W. (C1); one .0001 mfd. 450 V.W. (C6); one .00025 mfd. 450 V.W. (C2).
Resistances: One mains dropping resistance (see text); three 100 ohm (R2, R11, R12); one 500 ohm (R9); one 5,000 ohm variable resistance (R1); one 100,000 ohm variable resistance with switch (R10); one 1,000 ohm (R13) (see text); two 10,000 ohm (R6, R8); one 25,000 ohm (R5); one 30,000 ohm (R3); two 1 megohm (R4 and R7). One chassis, 11in. x 5 in. x 1 in.; one socket strip A and E; one loudspeaker, 6½in. diameter, with O.P. transformer (see text).
Valves: One Cossor 13VPA (metallised); one Brimar 8D2; one .2 amp. output pentode (see text); one rectifier Tungsram V20;
Two 6-volt .3 amp. pilot lamps with holders; one cabinet; wire, screws, etc.

BRITAIN'S AUDIENCE IN AMERICA

THE "Britain to America" series, produced by Laurence Gilliam, which has lately been broadcast in the B.B.C.'s North American service and rebroadcast by the National Broadcasting Company of America, has been so successful that the B.B.C. has been invited by America's blue network to continue this weekly story of Britain at war for listeners throughout the United States. The new series started on October 11th, and will run through the winter.

Each programme will be written and directed by one or other of the B.B.C.'s feature producers, such as Louis MacNeice, D. G. Bridson, John Glyn-Jones, Robert Barr, Cecil McGivern and Francis Dillon.

Among the subjects that have already been chosen for the series are the Commandos, the Merchant Navy, the Royal Air Force, the British private soldier in his fighting against heavy odds in all parts of the world, the British workers, and even the B.B.C. itself at war. After his success in the first series, Leslie Howard is again the narrator.

The popularity of this series is an outstanding example of the very considerable increase during the past few months in the rebroadcasting of B.B.C. programmes by the U.S. networks and independent stations.

At the same time there has also been a very decided increase in direct listening in North America to the British short-wave broadcasts, partly due, of course, to the presence of American forces in Britain.

Another of the big broadcasting companies of the U.S.A., the Mutual Broadcasting System, has for long been rebroadcasting items from the B.B.C.'s North American service, and is now taking even more. At peak listening times Mutual rebroadcasts the two programmes that present the United States Forces in Britain: "Stars and Stripes in Britain" on Sunday evening and "American Eagle Club," a Saturday evening programme. Both are taken by the New York key station, WOR, and by about 100 other stations in 35 different States. Through this chain, Radio News Reel, one of the great successes of the B.B.C., is rebroadcast.

Unusual Circuits

Simple Crystal-valve Receivers Using Reflex and Unorthodox Arrangements

MOST constructors have a number of spare parts lying unused in the "junk-box." These can be put to many uses, not the least interesting being the construction of circuits of a different type from those which are in general use to-day. Modern circuits have become so stereotyped that the majority of one- and two-valvers are exactly the same, at least in their basic design. The circuits here described have been tested and found satisfactory; they require very few parts, and when built provide results definitely superior in one way or another to those obtained from normal one- and two-valve sets.

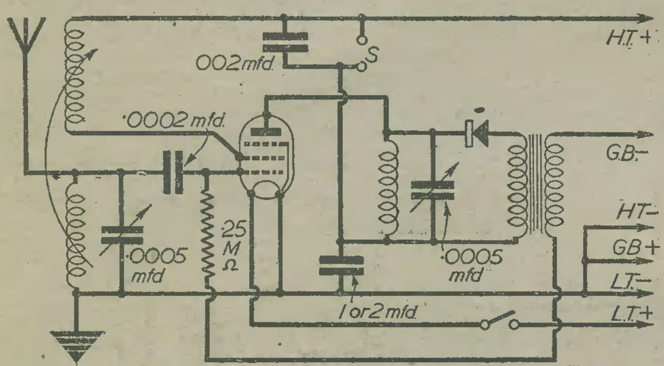


Fig. 1.—The circuit of a pentode-crystal combination in which the valve acts as an H.F. and L.F. amplifier.

A Pentode Circuit

A reflex circuit which uses the screen-grid of the valve for reaction purposes is shown in Fig. 1. The detector is tuned-anode coupled to the H.F. stage, the L.F. output from it being returned to the grid of the valve by means of the .25 MΩ resistance. This is definitely a better method than feeding the signal through the aerial tuning coil, as is sometimes done. The circuit will provide good loudspeaker results when used in a locality where reception is good. An L.F. type pentode should be used, the Cossor 220 HPT or Mullard PM22A will be found satisfactory. If a coil unit with a movable reaction coil is made up it can also be used for the other circuits. If some old two-pin plug-in coils and a holder are to hand, they can be used. Alternatively 60 turns of 24 S.W.G. D.C.C. wire wound on a former 2in. in diameter will be suitable for the medium-wave band; a coil, consisting of 50 turns of some finer wire, arranged so that it can be swung in relation to the grid winding, will be suitable for reaction purposes; if reaction cannot be obtained the leads to this coil should be reversed. When using the circuit shown in Fig. 3 the number of turns on the grid winding should be increased to approximately 100.

Crystal-valve

A crystal detector followed by an L.F. stage (Fig. 2), plus reaction. The .0002 mfd. condenser connected from aerial to the grid of the valve is necessary to obtain reaction. A pentode valve could be used instead of the triode to secure greater volume. If it is desired to use a modern coil with fixed reaction winding, this could easily be done by using the coil in conjunction with a variable condenser in the normal manner.

Series Tuned

The notable feature of the circuit shown in Fig. 3 is the use of a series-tuned acceptor instead of the usual parallel-tuned rejector. This circuit was popular round about 1929, and will be found to be quite sensitive. The rheostat for controlling the filament temperature is an advantage and should be included if the component is available. The high-tension voltage applied to the valve should *not be high*, as the 'phones are connected to earth and H.T.+.

"Flewellyn" Circuit

The circuit Fig. 4 was originally called the "Flewellyn"—it has been said of it that it can produce a good whistle if nothing else! This is an unfair criticism, as *careful*

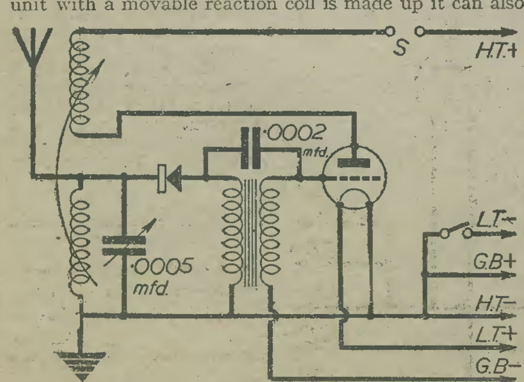


Fig. 2.—A suggested circuit using valve and crystal; the former acting as L.F. amplifier

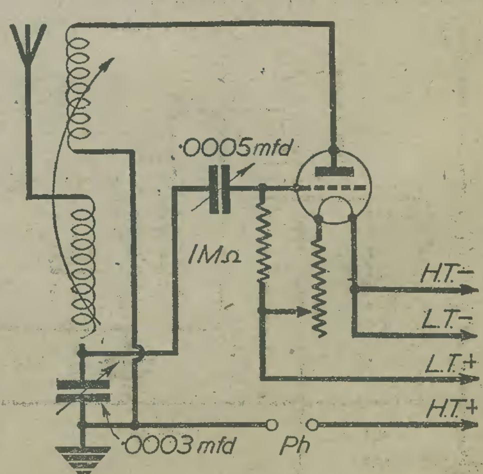


Fig. 3.—A circuit which used to be popular, and is still interesting to the experimenter.

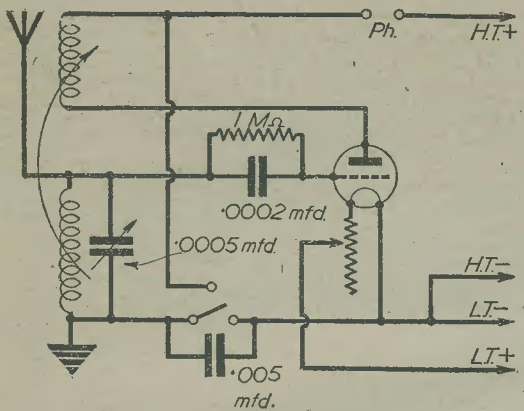


Fig. 4.—This arrangement is based on the "Flewellyn" circuit, and calls for special care in use.

adjustment of the rheostat and the *coupling of the coils* will reduce the whistle to a minimum. When the single-pole double-throw switch is positioned to short-circuit the .005 mfd. condenser, the receiver operates as a normal single-valver. On throwing over the switch the "super" part of the circuit comes into action. It is an unfortunate fact that the receiver must whistle (if it is working correctly), but this is not such a disadvantage as it might at first sight appear.

The two circuits shown in Figs. 5 and 6 will be found to provide better quality of reproduction than is usual with ordinary two- or three-valvers. This is especially so with the circuit shown in Fig. 6, where the detector is directly coupled to the output valve. The 1 MΩ. resistor in this circuit is used to prevent the possibility of slight currents flowing through the rectifier; if a cat's whisker and crystal are used, it prevents the grid of the valve being open-circuited if the detector whisker is lifted. Theoretically there should be a small-capacity shunted across this resistor, but it will not be found necessary in practice. The quality of reproduction obtained from the circuit depicted in Fig. 5 depends largely on the L.F. transformer used. It will be seen that tuned-anode coupling is used between the H.F. and detector and that the rectifier is connected to a tapping on the detector tuning coil. This is done to lessen the damping on the tuned circuit so that a gang condenser can be used for tuning. If the coil used does not have a suitable tapping, two separate condensers must be used—or, alternatively, a trimmer of .0001 mfd. capacity can be connected across the aerial tuned circuit.

V.M. Volume Control.

A valve of the 210 VPT type will be found suitable for the H.F. stage. Although V.M. volume control is not shown, it can, of course, be added, wiring it in one of the standard ways. The circuit shown in Fig. 5 possesses quite good range and volume. A pentode can be used with advantage instead of the power valve shown in the last two circuits—the idea that a pentode L.F. stage must provide bad or poor quality is definitely not true, provided its circuit is properly designed.

When trying out circuits of the types discussed, it is well to remember that the characteristics of the valve employed in any reflex arrangement play a very important part, therefore, it is always advisable to try one or two types before condemning a circuit. To those readers who are not familiar with unorthodox circuits, those described in this article will provide good material for interesting experimental work, and, possibly, the formation of some more unusual circuits.

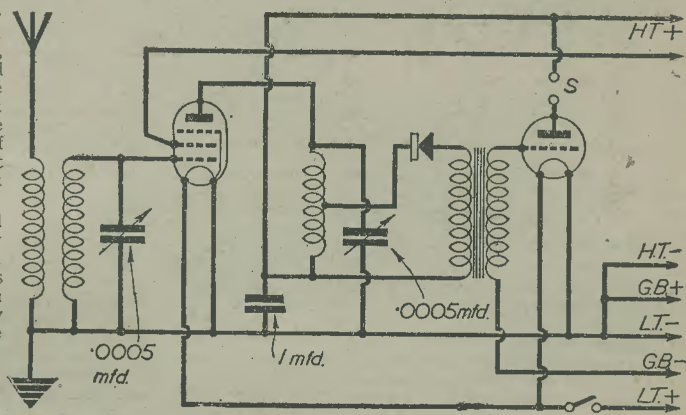


Fig. 5.—An H.F. plus detector plus L.F. stage circuit which should give good volume and quality.

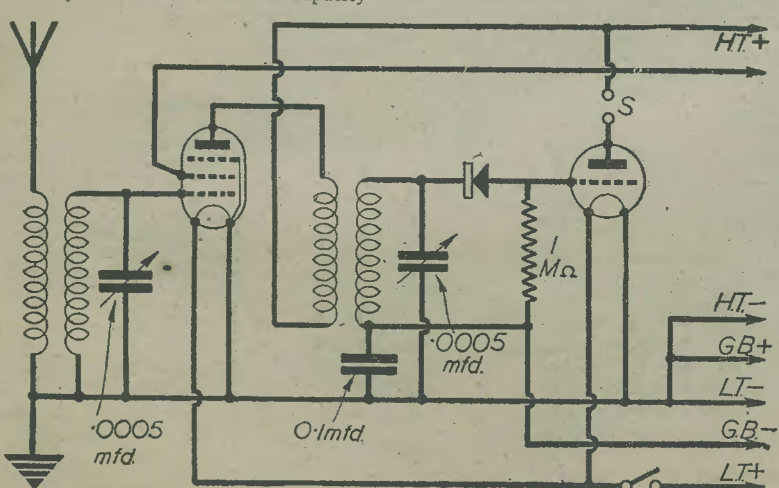


Fig. 6.—Similar to Fig. 5, but in this circuit the detector is directly coupled to the output valve.

Radio Examination Papers—14

Another Set of Random Questions, with Replies by THE EXPERIMENTERS

BEFORE we answer the questions printed on this page, let us apologise for a stupid slip made in No. 12 of this series. We have been taken to task for saying that *odd* harmonics cancel out in a push-pull amplifier. Of course, we should have stated that it is the *even* harmonics which cancel out; this is because they affect the grids of the two push-pull valves similarly on each half-cycle of the fundamental.

Sorry, readers. Even "The Experimenters" run off the rails occasionally.

QUESTIONS

1. *If it were found that a mains transformer became excessively hot in use, what faults would you suspect, and how would you carry out initial tests?*
2. *Why is selectivity normally improved by inserting a small fixed condenser in series with the lead-in from a long aerial?*
3. *Describe the essentials of one method of determining the capacity of a fixed condenser.*
4. *What is a loading coil, and for what purpose is it employed?*
5. *Explain the significance of the terms: "Radio Telephony," "Wireless Telegraphy" and "Interrupted Continuous Wave" or "Modulated Continuous Wave," as applied to types of transmissions.*

1. Overheating of Mains Transformer

If a power transformer were running hot, it would mean that an excessive current was being drawn from the mains supply. This could be due to the fact that the primary was connected to an A.C. supply voltage appreciably higher than that for which the component had been designed. Although this is possible, the cause is unlikely, since most transformers are made for use on supplies between about 200 and 250; even if the wrong tapping was used, the overheating would not normally be very marked.

A more probable cause would be that the secondary winding was being overloaded—possibly due to a faulty smoothing condenser "after" the rectifier. Another possibility would be a short-circuit of a portion of one of the windings; this might be due to the insulation having broken down between turns in adjacent layers of the winding, or to two turns in different parts of the winding shorting to the iron core.

In some transformers there is a copper screening disc between an L.T. secondary and the primary winding. This is to prevent mains hum, and consists of a ring or washer having a gap. If the gap was bridged, due to the two sides making contact with the metal chassis of the power unit, for example, the result would be the same as short-circuiting a very low-resistance winding, and therefore excessive heating would occur.

Tests would be made by checking the load on the various secondary windings against the rating of the transformer, and also by disconnecting these windings in turn while the primary was still in the A.C. supply circuit. If heating continued when the latter test was applied, it would be reasonable to expect an internal short-circuit. Measurements could be made with a megger or ohm-meter to see if there were any shorts from the windings to the core, and/or between different windings. If the nominal D.C. resistance of the windings was known, a check for a short-circuit of a portion of a winding could be made by measuring the actual resistance of the various sections.

2. Increasing Selectivity

The reason for the increased selectivity when using a series aerial condenser can be explained in at least two different ways. The simplest of these—although it is not a complete answer—is that the condenser increases the impedance of the aerial circuit, which is in parallel with the tuned input circuit. Thus, the "damping" due to the external circuit is reduced.

This can better be explained by reference to Fig. 1, where the aerial-earth capacity is represented by a broken-line condenser; aerial inductance is represented by a broken-line coil, and aerial resistance or impedance by a broken-line resistor in series with the aerial lead in. It will be seen that if the value of the resistance was increased the total impedance of the aerial-earth circuit in parallel with the tuning circuit would be increased. In practice it would be more efficient to increase the impedance by inserting a condenser than by fitting a fixed resistor.

Another method of considering the question is to assume that the aerial-earth capacity is a source of alternating e.m.f. The object of the tuning circuit is to provide the greatest possible signal voltage to the first valve. Obviously the highest voltage will be developed across the tuning circuit when it is tuned to the frequency of the signal; in such conditions the impedance of a parallel-tuned circuit is infinity.

If, however, the "internal resistance" of our source of alternating e.m.f. was zero, the same voltage would be applied to the tuning circuit irrespective of its impedance. Thus, the voltage across it would remain sensibly the same whether the tuning was accurate or not.

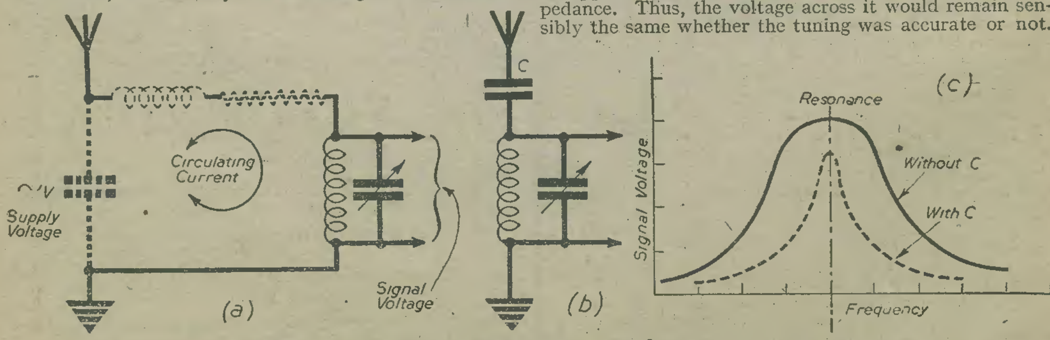


Fig. 1.—Diagrams used to explain the effect of a series aerial condenser on selectivity. (a) Shows the capacity, inductance and resistance of the aerial-earth circuit in parallel with the tuning coil; (b) shows the series aerial condenser, and (c) shows corresponding tuning curves without a series condenser (full line) and with it (broken line).

This is theoretical only, since it would be impossible to design an aerial circuit of zero impedance. Nevertheless, the lower the impedance, the broader would be the tuning. In other words, the tuning curve would be relatively flat, as indicated by the full-line curve in Fig. 1. Increasing the aerial-circuit impedance would sharpen the tuning, as indicated by the broken-line curve in the same diagram. It will be noticed that the maximum signal voltage developed across the tuning circuit is lower when using the series condenser; this is not surprising when the increased selectivity is obtained by introducing losses in the form of extra impedance.

3. Measuring Capacity

The most usual method of measuring capacity is by means of a bridge, as illustrated in Fig. 2. It will be noticed that this is similar in principle to the Wheatstone resistance bridge described in this feature last month.

Two fixed resistors of known value form two arms of the bridge, while a calibrated variable condenser, marked C, and the condenser of unknown value, C_x, form the other two arms. Instead of the D.C. supply used with the resistance bridge, we use A.C. This is shown as being obtained from a high-note buzzer, which is a very convenient source. In place of a centre-zero galvanometer we have a pair of ordinary head telephones.

The ratio of R_1 to R_2 can be equated with the ratio of C_x to C, and since we know the values of all except C_x, this may be calculated by re-writing our equation as $C_x = \frac{R_1 \times C}{R_2}$. Thus, if R_1 were 20,000 ohms, R_2 were 10,000 ohms, and C were .0003 mfd., R_x would be .0006 mfd.

It will be understood that balancing is carried out in the bridge shown by adjusting C until the note of the buzzer cannot be heard in the 'phones. If the calibrated variable condenser C were replaced by a fixed condenser of known value it would be possible to replace R_1 and R_2 by a potentiometer with a calibrated scale. The scale need only be marked in equal divisions, provided that the potentiometer resistance unit had linear characteristics, since the ohmic value of the two resistance arms is not required—only the ratio between them.

4. Loading Coils

So-called loading coils are not used in present-day receivers, but are occasionally used with transmitters. In the early days of broadcasting, however, it was customary to use a loading coil when changing from medium-wave to long-wave tuning. The coil was of the plug-in type, and was connected in series with the normal, fixed, aerial-tuning coil. When not in use the loading coil holder was shorted out by means of a shorting plug.

This method of increasing the wavelength range is not very efficient, because the loading coil may not be closely coupled to the medium-wave coil, but it was found convenient when long waves were not widely used.

In the case of a transmitter designed to work with a comparatively long aerial the matching of the transmitter to the aerial would be upset if a short aerial were employed. This would mean that the effective output would be appreciably reduced. Correct matching may therefore be obtained by connecting a loading coil in series between the short aerial and the aerial terminal of the transmitter. The purpose of the coil would be to increase the inductance of the aerial, whereas in the case of a receiver its purpose is to increase the inductance of the tuning circuit.

5. R.T., W.T. and I.C.W.

Radio telephony is the name applied to the transmission of ordinary speech and music. This type of transmission is received with a non-oscillating receiver, since it is the audio-frequency modulation which is required—not the carrier wave.

Wireless telegraphy is the name applied to morse transmission and reception when only a carrier wave is used, this being interrupted so that it is radiated in the form of dots and dashes. For reception to be possible the receiver must be in a state of oscillation, so that an audible beat note can be obtained by "mixing together" the oscillation from the transmitter and that produced in the receiver. The frequency of the receiver oscillation must be 1,000 cycles (1 kilocycle/sec.) different from that of the transmitter if a 1,000-cycle note is to be heard in the 'phones or speaker.

Interrupted-continuous-wave transmission is also used for morse, and in this case the carrier wave is not only "chopped up" by means of the morse key, but is also interrupted at a frequency of about 1,000 cycles/second by including an interrupter in the H.T. circuit. This usually consists of an electric motor with a commutator, the segments of which are connected together. They are then connected to one side of the H.T. supply, while the corresponding H.T. lead to the transmitter is taken from a carbon brush which bears against the commutator. This method of supply has the effect of modulating the transmitter with a note of a certain frequency. The frequency is, of course, governed by the number of segments and the speed at which the motor is run.

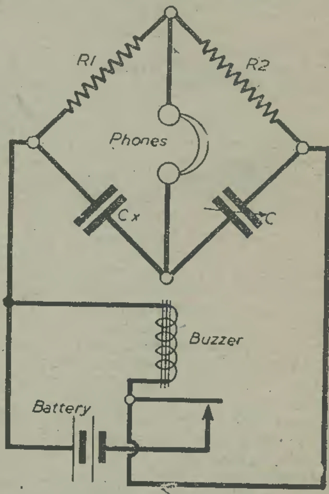


Fig. 2.—The essentials of a capacity bridge for measuring the capacity of the condenser marked Cx. Condenser C is a variable one with an accurately calibrated scale.

In modulated-continuous-wave transmission the transmitter is normally modulated by means of a valve which oscillates at audio frequency.

Both I.C.W. and M.C.W. are received on a non-oscillating receiver in the same manner as is radio telephony. The advantage of these two forms of transmission appears only when "emergency" transmissions are to be made. It is that the tuning is somewhat flatter, and the transmission may therefore be picked up on a receiver which is not tuned to the precise frequency of the transmitter. One of the two systems is often provided as a standby, but morse is nearly always sent out as ordinary C.W.

BRITISH LONG DISTANCE LISTENERS' CLUB

An Interesting Letter

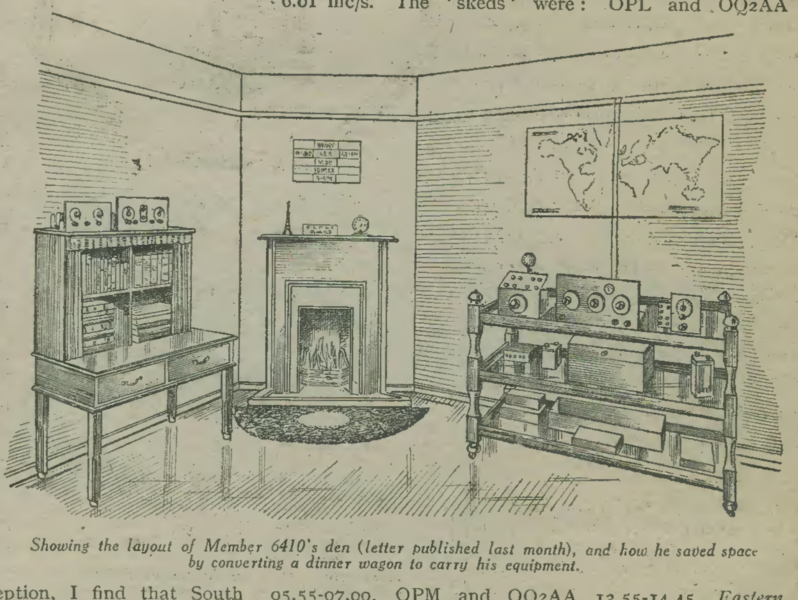
LANGOLD, Worksop, Member 7,065—R. W. Iball. We thank this member very much for an interesting letter and report, and we hope that we shall receive further communications from him in the near future.

"I believe this is my first letter to you, since being admitted to the B.L.D.L.C. However, not being an experimenter-constructor I haven't had very much to write about. My object in writing is to let you know that it was not from lack of interest that I haven't written before.

"I have been a SWL since December, 1936, and have verified all continents on S.W.Bc. and wanted South Africa (British) to complete my V.B.E.; but South Africa refused to answer my reports. Also a few 'Ham' cards ('phone and C.W.) which my brother—now H.M.F.—received. Well, that covers my activities quite briefly. At present, the receiver is an 8v.-all-wave (mains) with the antenna S.S.W.-N.N.E., 24ft. high, 25ft. long (25ft. lead-in).

"Here is a sore point I'd like to air: I've noticed many B.L.D.L.C. members asking for information on S.W.Bc. transmissions, and giving the barest details only. I don't know how they expect fellow members to help, when they say 'it was in the 19 m., 29 m., 30 m. bands,' etc. If they really want assistance, surely it's no trouble to give full details.

"In the September issue (1942), Member 7,224 uses, what I call, a funny way of giving the signal strength of S.W.Bc. stations, in using the R.S.T. code. This code is, I believe, used solely in reporting C.W. transmissions, and *not* Bc. He lists XGOY 16 m., *R.S.T.* 446, WRCA 14 m. 557, etc., etc. *R.S.T.* represents *R*eadability *S*ignal *T*one, in case Mr. Posner doesn't know. Anyway, I'd like to hear of other members' views.



Showing the layout of Member 6410's den (letter published last month), and how he saved space by converting a dinner wagon to carry his equipment.

"Turning to general reception, I find that South and Central Americas have been poorly represented during this past month, especially at 04.00 B.S.T. On the other hand, some good North American signals have been logged during early afternoons, but very poor signals at 04.00 B.S.T.

"This 'mystery' business is enough to make a cat laugh. Some months ago (around April) I heard a 'Radio De Bunk debunking the news' operating around 42.56 m. at 01.15 B.S.T. This also was supposed to be broadcasting from America to Americans, telling the 'truth' about the Roosevelt Government. Some of the speakers—'all true Americans'—were suspiciously un-American in tone. Need I say more?

"Before giving my logs, would members assist in tracing a station giving weather reports (mentioned Buffalo, Ontario, etc.) on approximately 46.2 m., giving a call W17K? This was logged on November 29th, 1941, at 23.15 B.S.T. Also to a station 'New Delhi' broadcasting once on 31.18 m. (app.) at 04.30 B.S.T., giving its call as title and English news at 04.25. I don't think it is the Delhi station of 31.28 m. HET2 (56.25 m. app.), R 5/6, 17.30 G.M.T., 3/9/42; S4V (?) (29.84), R7, 22.50, 3/9/42; Moscow (19.09), R 6/2, 13.10, 6/9/42; 'Free' India (20.34), R5, 14.40, 13/9/42; Moscow (25.36), R5, 17.15, 15/9/42; OAX4Z (49.30), R4, 03.20, 23/9/42; OVW (40.20 app.), R3, 17.50, 23/9/42; XGOY (31.14), R5/3, 15.00, 12/10/42; OP—(?) (25.60 app.), R4, 18.28, 15/10/42.

"The two Belgian Congo calls are definite, although the actual call letters are not known. I don't think there's much use in giving a list of the 'local' Yanks or European signals, so I'll end the log.

"It seems that quite a few members are interested in Belgian Congo broadcasts. Here is a short list of such stations which appeared in 'Radio and Television' (U.S.A.), June, 1941:

"OPL 20.04 mc/s, OPM 10.14 mc/s, OQ2AA 15.175 mc/s, also transmissions on 11.73 mc/s, 9.55 mc/s, 6.01 mc/s. The 'skeds' were: OPL and OQ2AA 05.55-07.00, OPM and OQ2AA 13.55-14.45, *Eastern Standard Time*.

"Well, I think that's all for now. I'll be writing later."

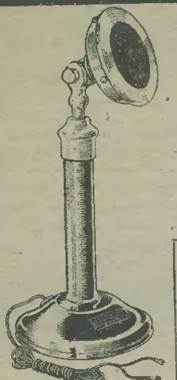
A Handy L.F. Oscillator

WOLVERHAMPTON Member 7,223—J. Woodward—sends us the following interesting letter, which contains details of a useful L.F. oscillator he has made, the circuit of which appears on next page.

Regarding the multi-range test meter, we would mention that complete constructional details will be found in "PRACTICAL WIRELESS Service Manual."

"I am enclosing a circuit diagram of a simple, but efficient, one-valve audio-frequency generator, which I use for the testing of A.F. amplifiers, in radio sets which require servicing, where the proper service oscillator is not available. It will operate with a very low H.T. voltage, and may, of course, be operated from batteries. The .0001 μF condenser may be replaced by a .0005

(*Continued on page 77.*)



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In factories, canteens, at public meetings, dances, etc., this Piezo-Crystal Microphone is unsurpassed for quality of speech and music. Fitted with the well-known Rothermel D104 microphone insert, the frequency response is remarkably uniform throughout the musical scale and the characteristic is practically level from 25 to 10,000 c.p.s. No energising current or transformer is required, therefore installation and operation are exceptionally easy. Equally convenient for hand or table use. All metal lacquer and chromium finish with adjustable mouthpiece. .. .. .. Price **82/6**

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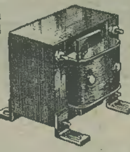
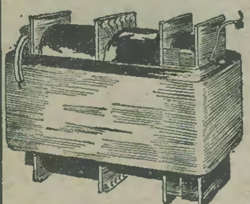
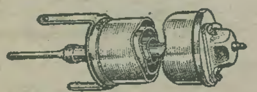


Brand new, well built chokes 60 ohms D.C. resistance 100/120 m.a. Size: 2½in. by 2½in. by 1¾in., 5/6 each. Also 400 ohms D.C. resistance 60 m.a. Size: 1½in. by 1½in. by ⅝in. Each **3/6**



PHILIPS HIGH VOLTAGE TRANSFORMERS

These transformers are robust in construction and weigh approximately 13 lbs. Dimensions: 5¾in. by 5¼in. by 4¼in. Specification: 350-0-350 v., 70 m.a. Four tappings giving 4 v. 3 amps., 6.3 v. 4 amps., 4 v. .65 amp. and 4,000 v. at 3 m.a. Input 100/250. Carriage forward. Free wiring diagram... .. Price **32/6**



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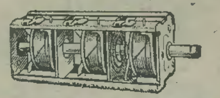
Non-drift air di-electric, 60 m.mfds., suitable for S.W. work. Each **1/3**



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700,000 ohms, with 2-pole M and B Switch **4/6**
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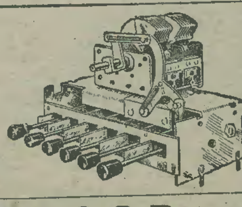

A chance for Experimenters! 0.0005 mfd. 2-gang, 6 push-button Superhet Condensers. Mechanical cam lever type (not trimmer type), easily adjustable, to receive any six stations desired. Excellent workmanship. A product of General Instrument Corporation, U.S.A. A real bargain. .. .. .. Price **10/6**

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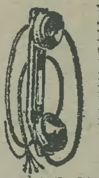

HANDCOMBS—Govt. All-metal Field Handcombs, Micro-telephones or Transceivers for portable or fixed telephones. These are the famous No. 16 Handcomb, used in so many field sets. Sturdily built with mike finger switch. Brand new with 4-way cord, **15/-.** Limited number available. Similar handcombs less centre switch and no cord, **7/6.** 4-way Cords, **2/6.** A Home Guard can make a complete pocket telephone with these, a mike transformer and buzzer with a torch battery.

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PHONE SOUND AMPLIFIERS and horn for loud use with buzzers, **7/6.**

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DIMMERS or RHEOSTATS with "off" 0 to 1 ohm and will carry up to 4 amps., for regulation on 6 to 12 volts, dimming or bank circuit battery charge model control, etc. One hole fixing for panels with bracket for other fixing. Hollow knob has socket for min. bulb, glowing when circuit alive. New U.S.A. Atena make, in carton, **2/6.** Worth 5/-. Large 40 amp. ironclad grid Rheos with heavy 10 stud switch to drop 220 volts to 45 volts. Size 33-in. x 16-in. x 14-in., **£5 10s. 0d.** 110 volt ditto, 16-in. x 14-in. x 16-in., **£2 10s. 0d.**

CIRCUIT Breakers, 25/-. MOTOR STARTERS, 220 volts D.C., ½ h.p. to ¾ h.p., with no-volt and overload release. Ironclad, 13-in. x 12-in. x 7-in., **45/-.**

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MAGNETS. Massive horse shoe permanent steel magnets. Various sizes, **3/6** and **4/6** each. Wonder midget 2 ozs. Disc Magnets as last advert., **2/6** each.

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DYNAMO BARGAINS. Rotax, 6-12 volts, 8½ amps., D.C., 3rd brush size. 8-in. x 4½-in., 11lb., cost £10, unused, **17/6** (carr. paid Eng. and Wales).

Callers can see many other excellent bargains. All post enquiries should be accompanied by stamped addressed envelope. Rly. Station: **Queen's Road,** Battersea, or come by No. 137 Bus.

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mfd. variable, which gives a small variation of note, with fair attenuation, at the higher frequency; the potentiometer gives quite a big variation of note, with little attenuation. The 25,000-ohm resistor should be included, to prevent a large current flowing, when the potentiometer is shorted out by the slider being at the top. If required, a morse key can be connected across the switch; another use for the oscillator is the energising of a resistance-capacity bridge.

"Congratulations on your articles Radio Exams; Maths. Refresher Course; Servicing Mains Receivers, and B.L.D.L.C. page, which are extremely interesting.

"*Re* the colour code controversy, I fail to see how any enthusiastic constructor does not know the code for resistors and condensers; he should get 'The Radio Engineer's Vest Pocket Book.'

"A suggestion for future articles is: radio servicing equipment, such as a good R. and C. bridge, an output meter, valve voltmeter, and a re-issue of your multi-range test meter of 1935-6, which is the best I have ever seen in any journal.

"Lastly, I must say how much I was interested in and enjoyed the C.R.O. articles. I think the amateur ought to know more about this most useful piece of apparatus (which, of course, he now should), as its possibilities are limitless.

"I am interested in meeting all other B.L.D.L.C. fans in this town, so hope you can give a hint, as I shall be pleased to write to or hear from them."

Microphone Transformer

WOLVERHAMPTON Member 6,950—G. Baugh—tells how he was able to convert a broken-down L.F. transformer into a "mike" model, thus allowing the microphone to be kept in service, and, incidentally, saving the purchase price of a new component.

"Recently, when wanting to use my microphone transformer, I found that one of the secondary leads had broken off, and as it was the inner end of the winding I could not easily repair it.

"Being unable to get a replacement in town, and wanting one urgently, I had to look for an alternative.

"I tried an ordinary L.F. transformer, but found the volume very poor. It then struck me, why not remove the primary winding and re-wind another of fewer turns and of thicker wire? This would lower the impedance to suit the mike, and also increase the step-up ratio.

"I found an old L.F. transformer with a burnt-out primary, dismantled it, removing the core, and cut away the damaged primary. In place of it I wound about 150 turns of 32 s.w.g. enamelled wire. Then, after replacing the core, and soldering the wires on to the terminals, I replaced it back in its case.

"On trying it out, I found the quality of speech was easily as good as my old one, while the volume was very much greater."

Will be Welcomed

PORTSTEWART Member 7,214—Alan McGugan—offers to send in some detailed reports covering reception, and we wish to assure him that they will be welcome as we feel sure they would be appreciated by all.

"I hope what I have to say will be of some interest. Portstewart, as a matter of fact, is very rural, and there is practically nobody who goes in for amateur radio work.

"Reception of short waves is fairly good usually, but medium-wave reception is not nearly so clear or loud not only for the Home and Forces programmes, but very obviously in the case of continentals.

"Until about 18 months ago I confined myself to medium-wave Rx. construction, and the subsequent thorough testing of the circuits. The most successful of these was 'The Students Three,' which I found particularly efficient. About 30 stations were easily received with 'phones, 10 or 12 were L.S. strength. Conditions were ideal.

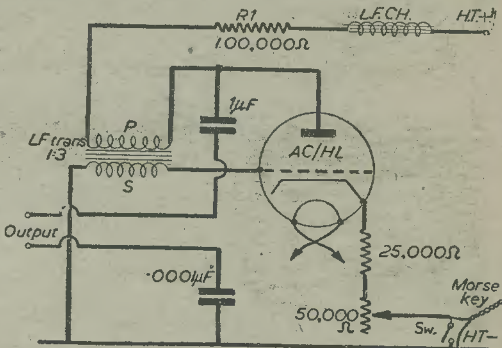
"During the winter, on short wave I used two Rx.s, a Premier one-valve adaptor (sometimes in conjunction with an amplifier) and the short-wave section of a Murphy B 69.

"Although I did very little serious listening, most of the stronger American and continental stations were received well.

"The Murphy aerial was 7/22 and strung up between the chimneys.

"The aerial for the kit is 7/22, inverted L, about 25ft. high and 45ft. long, and pointing E.N.E. I keep a log of all reception and usually include weather—the effect of which on certain varying frequencies I would like to send a report later, when I have the time and opportunity to make a complete collection of data in detail and not merely generalisations.

"I am also interested in the reproduction of gramophone records, and as I have a rather critical ear I have not, so far, discovered anything nearing perfect reproduction, possibly since financial restriction has limited the quality of materials.



Theo. of the L.F. oscillator built and described by Member 7,223 of Wolverhampton.

"I like the new size PRACTICAL WIRELESS, and I like the new theoretical articles. I will write again as soon as I've got something interesting.

"About a month or six weeks ago, on the 17-metre band, I got some very weak signals at about 22.30 G.M.T. and a call which sounded like BNBI. What was this?"

Co-operation Needed

KINGTON, Hereford, Member 7,231—E. T. Smith—is interested in some experimental work connected with L.F. circuits, and seeks co-operation. All replies via headquarters.

"I would like to get in touch with any member who is interested in collaborating with me in some simple experiments on audio-frequency coupling circuits, and audio-frequency work in general.

From Trowbridge

MEMBER 8,037—A. P. Rushforth—has a few words to say about short-wave converters.

"I have recently been experimenting with short-wave converters and find that results are pretty good. At present I have a one-valve converter coupled to my Osram H.F. Det. Pen. and am now thinking of building a two-valve circuit.

"My Rx. and two-valve amplifier are working off a home-made eliminator which can be converted to a power pack for a small mains set if required. I also have a trickle charger which keeps the L.T. battery in good condition.

"My log for the last month, all received on loudspeaker, includes: 'RW96 Moscow, FZI Brazzaville, ZNR Rabat, XGOY Chungking, and the more usual American stations WCW, WOWO, WCBX, WGEA, WRUL and WRCA.'

"In conclusion I should like to say that I think the way PRACTICAL WIRELESS has carried on during the war is wonderful and that I hope the handier form which it now takes will continue after the war."

A Refresher Course in Mathematics

By F. J. CAMM

(*Continued from page 31, December issue.*)

MENSURATION

Terms

MENSURATION is the branch of mathematics which deals with the rules for finding the lengths of lines, the areas of surfaces, and the volumes of solids. There are various sub-divisions of this subject.

Geometry is the science of the properties and relations of magnitudes in space of lines, surfaces, and solids.

Longimetry is the measurement of distances.

Planimetry is the measurement of plane surfaces, in other words plane geometry as distinct from solid geometry.

Stereometry is the science of measuring solids—solid geometry.

Trigonometry is the branch of mathematics which deals with the measurement of the sides and angles of triangles, and particularly with functions of angles—the sine, cosine, tangent, secant, cosecant, and cotangent.

In order to refresh his memory as to the names of the various geometrical figures, the reader should study the diagrams accompanying this article.

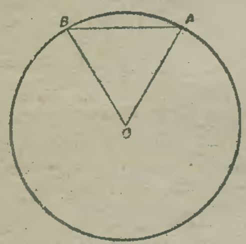


Fig. 1.—Diagram explaining radian.

Sexagesimals

We will take trigonometry first. When dealing with angles we make use of the *sexagesimal* system of measurement in which each *degree* is divided into 60 equal parts termed *minutes*, and each minute is further divided into 60 parts termed *seconds*. A *circle* contains 360 degrees or four right-angles of 90 degrees. The three angles of any triangle always total 180 degrees.

Degrees are denoted thus: $19°$

Minutes are denoted thus: $27'$

Seconds are denoted thus: $35''$

Although the sexagesimal system is generally employed throughout the world, it has the objection that there are two multipliers, 60 and 90, and for this reason the *centesimal* system was proposed. This is a French system in which the right-angle is divided into a hundred parts or *grades*. Each grade consists of a hundred minutes, and each minute one hundred seconds. However, it has not been adopted.

The Radian

Another system of measurement of angles is used in the higher branches of mathematics, and it makes use of the unit called the *radian* and it is the unit of circular measurement. It is sometimes denoted by 1^c. It will be as well to understand how this unit is derived. Draw a circle of any radius and step off on the circumference a distance equal to the radius. Join these two points to the centre O. The angle AOB (Fig. 1) is the angle (a radian) which is taken as the unit of circular measurement, and in terms of which we measure all others. It is well known that the circumference of a circle has a constant ratio to its diameter. We can prove this by examining Fig. 2. It will be seen that Oe and Ob are equal, and that OE and OD are equal, and that the lines ed and ED are parallel.

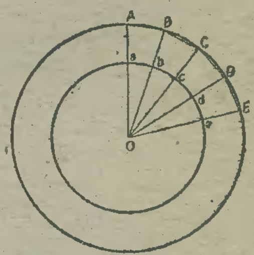


Fig. 2.—Diagram showing relation between radius and circumference.

$$\text{Therefore } \frac{ED}{ed} = \frac{OE}{oe}$$

As the figure shown by Fig. 2, if completed, would form a regular polygon, the length of the perimeter, presuming the polygon to have n sides, will be $n\ ED$; in other words the number of sides multiplied by the length of one side.

Therefore we have:

$$\frac{\text{Perimeter of Larger polygon}}{\text{Perimeter of Smaller polygon}} = \frac{nED}{ned} = \frac{ED}{ed} = \frac{OE}{oe}$$

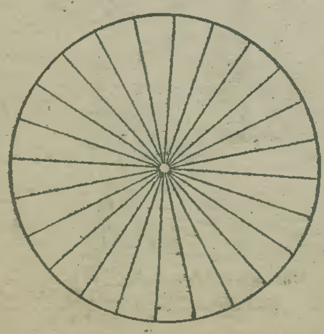


Fig. 3.—Regular Polygon.

In the right-angled triangle on the right, the square of the base, plus the square of the height, equals the square of the hypotenuse.

Fig. 4.—The Polygon rearranged as a rectangle.

Fig. 5.—Right-angled Triangle.

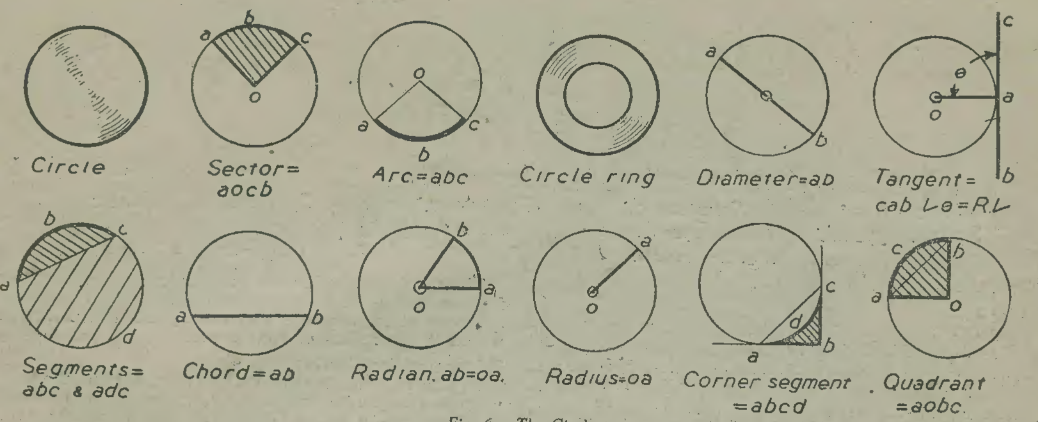


Fig. 6.—The Circle.

This must be true irrespective of the number of sides the polygon contains.

Now, presume a polygon having an infinitely large number of sides. Then the perimeter would equal the circumference of the circle.

Then,

$$\frac{\text{Circum. of larger circle}}{\text{Circum. of smaller circle}} = \frac{OE}{oe}$$

or $$\frac{\text{Radius of larger circle}}{\text{Radius of smaller circle}} = \frac{OE}{oe}$$

Therefore,

$$\frac{\text{Circum. of larger circle}}{\text{Radius of larger circle}} = \frac{\text{Circum. of smaller circle}}{\text{Radius of smaller circle}}$$

It is clear from this that the circumference of any circle divided by its radius is the same for circles of all diameters. In other words, the ratio is constant.

Pi

The value of this constant is always denoted by the Greek letter *pi*, written π. We can prove that *pi*=3.1459 approximately. Actually, no one has ever worked out its exact value, although some mathematicians have pursued it to more than 100 decimal places. Let us take a circle 4in. in diameter, and divide the circumference in 24 equal parts, constructing the polygon shown in Fig. 3. We know that $\pi \times$ diameter equals the circumference, and taking the very approximate value, of π to be $3^1/_7$, the circumference of the circle will be $12^4/_7$ or 12.571. Now let us consider the polygon as a series of triangles, rearranging them as shown in Fig. 4. If we calculate the length of each piece of the circumference and multiply by 24 the result should be the same as multiplying the diameter by *pi*. The angle contained by each triangular piece will be $\frac{360}{24}$ degrees, or 15 degrees, and, as we shall see later, the length of the arc will therefore be *sin* 15 degrees multiplied by the radius. We consult a table of sines, and find that the sine of 15 degrees is .261. Multiplying this by the radius (4) we obtain .844. Multiplying this again by 24 we obtain 12.528. This compares with 12.571 obtained above. By taking a greater number of triangles, however, so that the curved arc is almost a straight line we shall obtain a result practically accurate. The difference shown above is accounted for by the fact that the base of the triangle is curved. As I have said, *pi* cannot be worked out exactly, and it is considered as of *incommensurable magnitude*, that is to say, it cannot be exactly calculated. For ordinary calculations $3^1/_7$ is sufficiently accurate. Other values of *pi* adopted according to the degree of accuracy required in calculations are:

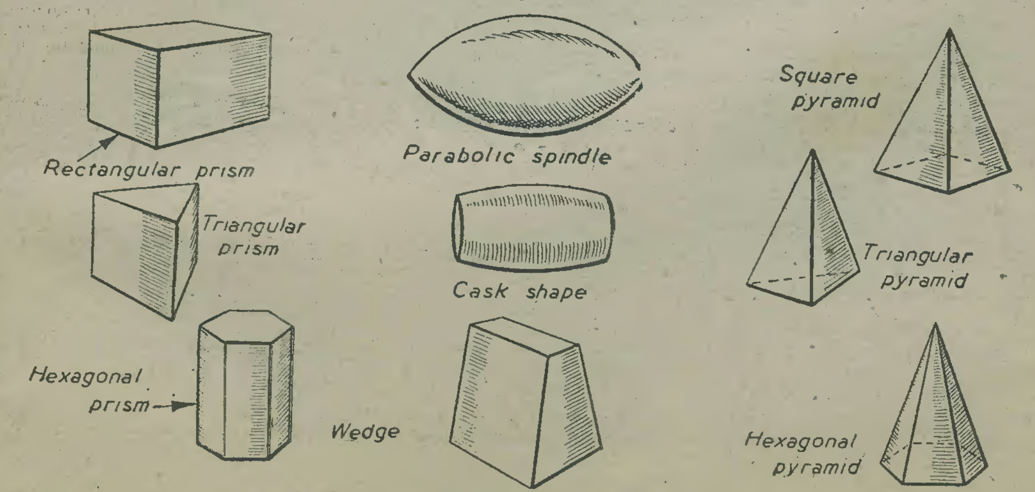


Fig. 7.—Prisms, Pyramids, etc.

Fig. 8.—Frustums.

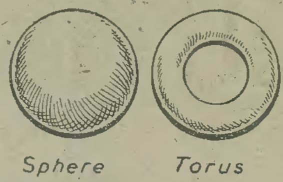


Fig. 9.—Sphere and Torus.

3.3412
3.1416
3.14159
3.14159265358979323846

Correct to 6 decimal places, pi equals $\frac{355}{113}$ which equals 3.14159203. It will be seen that $3^1/_7$, or $\frac{22}{7}$, equals 3.142857. Thus, this value is only correct to the first two decimal places. Usually the value, 3.14159, is taken for accurate calculation.

The number of radians in any angle is equivalent to a fraction having as a numerator the arc which the angle subtends at the centre of any circle, and a denominator which is the radius of that circle.

Trigonometrical Ratios

In any right-angle triangle, as stated earlier, the sides vary in relation to one another according to the angle of the opposite side. Thus, the *sine* is obtained by dividing the perpendicular by the hypotenuse. For any given angle this value will hold true no matter what the size of the triangle happens to be. For example, if the

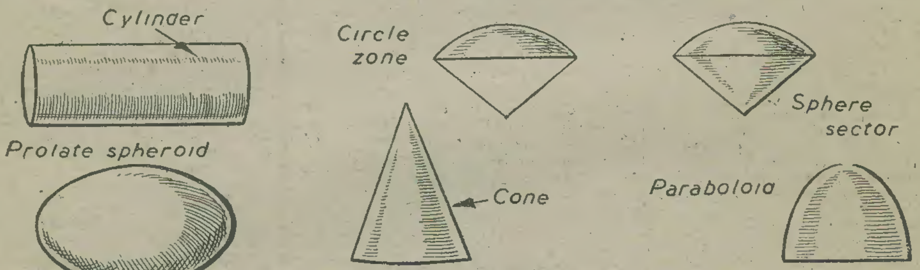


Fig. 10.—Various loter solids.

The radian is a constant angle. It is equal to $\frac{2}{\pi}$ of a right angle.

$$=\frac{180^\circ}{\pi}$$
$$=180^\circ \times .3183098862\ \ldots\ldots$$
$$=57.2957795^\circ$$
$$=57^\circ\ 17'\ 44.8''\ \text{approximately.}$$

It is obvious, therefore, that a right angle is $\frac{\pi}{2}$ radians. $360^\circ = 4$ right angles $= 2\pi$ radians.

Hence, $180^\circ = 2$ right angles $= \pi$ radians.

perpendicular were 2, and the hypotenuse 3, the sine would equal $\frac{2}{3}$, or .6666. . . . If we double the size of the triangle, the perpendicular would be 4, and the hypotenuse 6, which still equals .6666. . . . Obviously, the value of the sine will vary according to the angle, which will control the length of the sides.

Similarly, the cosine of an angle is found by dividing the base by the hypotenuse; the tangent is found by dividing the perpendicular by the base; the cotangent by dividing the base by the perpendicular; the cosecant by dividing the hypotenuse by the perpendicular, and the secant by dividing the hypotenuse by the base.

(Continued on p. 82.)

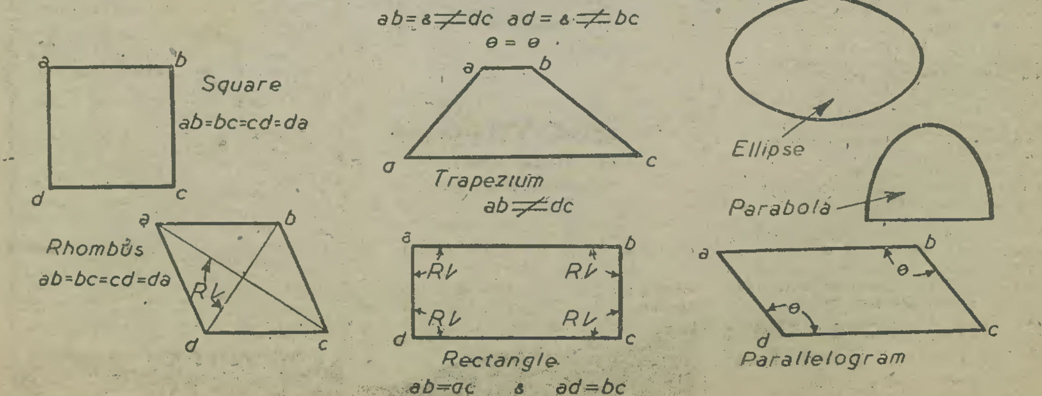


Fig. 11.—Plane figures.

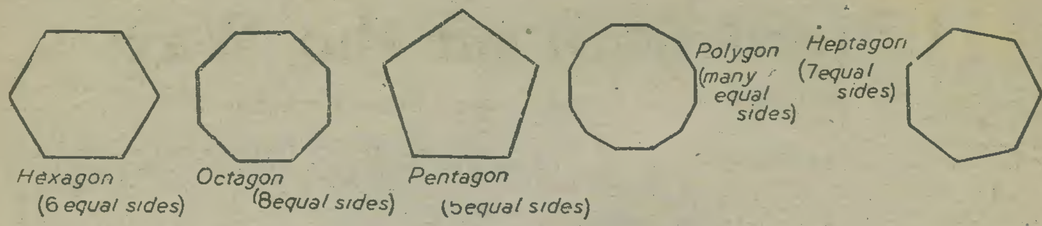


Fig. 12.—Polygons.

The amount by which the cosine falls short of unity, that is to say, 1 minus *cos A* is known as the versed sine, written *versin*, and the amount by which the sine falls short of unity, that is to say, 1 minus *sin. A* is called the covered sine, written *coversin.*

The abbreviations for all of these terms are as **follow:**

Sine=sin.
Cosine=cos.
Tangent=tan.
Cotangent=cot.
Cosecant=cosec.
Secant=sec.
Versine=vers. or versin.
Covered sine=coversin.

It is not often that the two latter ratios are used.

There is another function, written *cosh*, which will be dealt with later.

It will be seen from the foregoing that some of the ratios are reciprocals of the others.

Thus:

$$\begin{cases} \text{Sine} = \dfrac{\text{Perp.}}{\text{Hyp.}} \\ \text{Cosecant} = \dfrac{\text{Hyp.}}{\text{Perp.}} \end{cases}$$

$$\begin{cases} \text{Cosine} = \dfrac{\text{Base}}{\text{Hyp.}} \\ \text{Secant} = \dfrac{\text{Hyp.}}{\text{Base.}} \end{cases}$$

$$\begin{cases} \text{Tangent} = \dfrac{\text{Perp.}}{\text{Base.}} \\ \text{Cotangent} = \dfrac{\text{Base}}{\text{Perp.}} \end{cases}$$

Hence we may write:—

$$\text{Cotangent} = \frac{1}{\text{tangent.}}$$

$$\text{Secant} = \frac{1}{\text{cosine.}}$$

$$\text{Cosecant} = \frac{1}{\text{sine.}}$$

There are many other ratios which may be deduced and which are given later.

Evaluating the above, by cross multiplication:

$$\text{Cotan.} \times \text{tan.} = 1.$$
$$\text{Sec.} \times \text{cos.} = 1.$$
$$\text{Cosec.} \times \text{sine.} = 1.$$

Therefore, if one of the trigonometrical ratios of an angle be known, we can calculate the other ratios.

Pythagora's Rule

The rule relating to right-angled triangles is: The square of the base, plus the square on the height, is equal to the square of the hypotenuse.

(*To be continued.*)

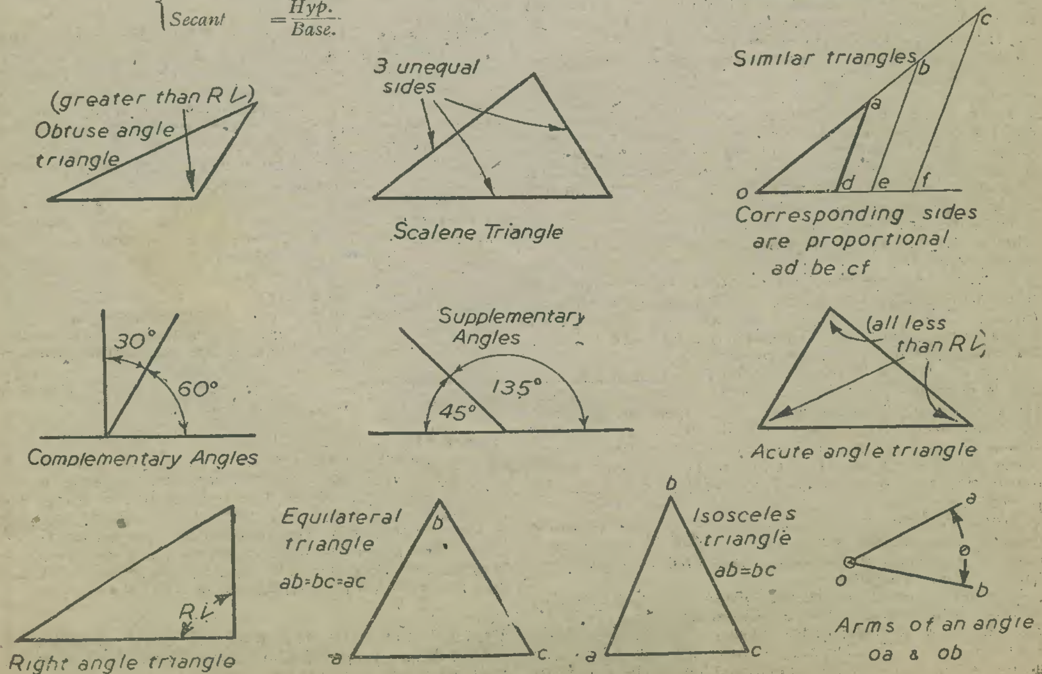


Fig. 13.—Angles and Triangles.

Impressions on the Wax

Review of the Latest Gramophone Records

Columbia

CONSTANT LAMBERT has a very thorough understanding of Tchaikovsky and his works, having made a life study of the great composer, and this is very evident in the deeply emotional rendering of Tchaikovsky's Symphony No. 4 in F minor (op. 36) by the Hallé Orchestra under the baton of Constant Lambert.

There are five records—*Columbia DX1096* to *DX1100*. A fine 10in. record in the *DB* series is *Columbia DB2098*, on which the Albert Sandler Trio has recorded "Belle of New York"—Selection. This introduces some of those famous old tunes which will never die: "She is the Belle of New York," "From Far Cohoes," "La Belle Parisienne," "They Always Follow Me" "When We Are Married," "Oh, Teach Me How to Kiss, Dear," and Finale, Act 1.

"Carroll Calls the Tunes (No. 21)" is simply another way of saying that Carroll Gibbons offers a very nice selection of the latest tunes, played, of course, on the piano. They are rendered in true Carroll style, and include "Hey Mabel," "Married An Angel," "White Christmas," and, on the other side of the disc, "Always in My Heart," "Where in the World," and "One Dozen Roses." The record is *Columbia FB2866*.

As usual, I am including one of Victor Silvester's records in my list, this time—he is with his Strings for Dancing—playing "Remordimiento" and "Illusion," both tangos. Needless to say, they are played in strict dance tempo and well up to Victor's standard—*Columbia FB2862*. Monte Rey—with orchestra—sings "Only You" and "Love is a Song," the latter from the film "Bambi," on *Columbia FB2869*.

H.M.V.

TWO of Chopin's compositions have been selected by Solomon for his latest record. They are "Nocturne in D Flat" and "Berceuse" (op. 57), two works noted for their delicacy and poetic feeling. Each has a lovely melody, and Solomon's performance is of the highest order. These two superb recordings are on *H.M.V. C3308*.

It has been the ambition of many a famous tenor to make a good recording of the "Prize Song" from "The Mastersingers," and one, Webster Booth, has achieved this on *H.M.V.* C3309. With fine co-operation from Warwick Braithwaite and the Hallé Orchestra, he has made a splendid recording of this difficult piece. He links with it "All Hail, Thou Dwelling"—Faust's address to Marguerite's home—in which he takes a magnificent top C.

I have a varied selection of 10in. records, which I think will satisfy most tastes. For example, on *H.M.V. B9300*. The B.B.C. Singers—introduced by Dr. J. W. Welch and conducted by Leslie Woodgate—have recorded "Psalms We Sing" (Psalms 19 and 90).

H.M.V. B9299 is recommended, as it contains two fine recordings by the Band of H.M. Coldstream Guards, the first being "Lilliburlero"—arranged for Military Band by Kenneth Alford—and, on the other side (a) Royal Tank Corps Regimental March; (b) Royal Scots Regimental March; and (c) The Queen's Regimental March. A fine record particularly suited to the present time.

From the film "We'll Smile Again," Gwen Catley (with orchestra) has selected "To-night You're Mine" and "The Waltz of Delight," two nice numbers well sung. *H.M.V. B9293*.

"Hutch"—with orchestra—gives us this month, "Only You." and "White Christmas" on *H.M.V. BD1024*. "Max Miller in the Theatre" is the title given to record *H.M.V. BD1022*, which, by the way, was actually recorded during a performance at the Finsbury Park Empire, London. On Part 1, Max gets ideas about courting and introduces the song "Sitting in the Park with Sarah," and follows this up on Part 2, with some more views. Max was in good form.

The Mood for Dancing, Nos. 13 and 14, *H.M.V. BD5777*, consist of "Fur Trappers' Ball" and "Sioux Sue," played by Joe Loss and his Orchestra, recorded at the Hippodrome, Dudley. Two good numbers.

Decca

CHARLIE KUNZ fans will welcome *Decca F8223*, on which Charlie has recorded—with rhythm accompaniment—another of his "Charlie Kunz Piano Medley" series, this time *No. D57*. He introduces "Always in My Heart," "This is Worth Fighting For," "Three Little Sisters," "White Christmas," "Be Careful It's My Heart," and "One Dozen Roses." A very nice selection. Flanagan and Allen—with orchestral accompaniment—give us, in their own inimitable style, "We'll Smile Again" and "Don't Ever Walk in the Shadows." Make a note of the number—*Decca F8222*.

In the Music While You Work series, Nos. 5 and 6, are entitled "The Belle of New York" and "A Popular Ballad Medley." The recording is by the Victory Band, and I recommend the record to all who like light music.

Anne Shelton tells us that "Love is a Song" and that "You Walk By" on *Decca F8221*. She is accompanied by an orchestra, and makes a good recording.

Lew Stone and his Band, on *Decca F8216*, play two slow fox-trots; "Idaho" and "Make Your Mind Up Now." A good record for a spot of dancing. For two quick-steps, we can put on *Decca F8213*, and hear Ambrose and his Orchestra, with vocal, playing "Please Order Your Last Drinks" and "The Cookhouse Serenade."

Parlophone

THE Organ, The Dance Band and Me, always form a pleasing combination, and this month they have made two fine recordings of "There's a Job I Gotta do for Uncle Sam"—fox-trot—and "I've Seen You Before"—slow fox-trot. (*Parlophone F1950*). Another record I recommend to dance enthusiasts is, "Anywhere On Earth is Heaven"—fox-trot—and "Breathless"—fox-trot—both played by Geraldo and his Orchestra. The number—*Parlophone F1948*.

While on the dance tunes, *Parlophone F1952* must be mentioned; it is another "Tin Pan Alley Medley" this time "No. 50," and on it, Ivor Moreton and Dave Kaye—on two pianos with string bass and drums—introduce "This is Worth Fighting For"; "You Walk By"; "The Love Nest"; "White Christmas"; "Jingle Jangle Jingle," and "Everything I Love."

To conclude my Parlophone selection, I have chosen *RO20516*, on which that delightful tenor, Richard Tauber, sings in English "Your Love Could be Everything to Me"—from "Old Chelsea"—and "Music in My Heart." Two splendid recordings.

Brunswick

THE one and only record from the Brunswick programme I have to mention this month is the first of the Sepia Series selected by Bill Elliott. The number is 03401—make a note of it—and on one side is No. 1 "Preachin' Trumpet Blues," played by Wingy Carpenter and his Wingies, in which a trumpet speciality is given by Wingy himself. On the other side—No. 2—Jay McShann and his Orchestra play "Dexter Blues."

Rex

BILLY COTTON has made a good recording of "Jingle Jangle Jingle" and "White Christmas"—both with vocal chorus, on *Rex 10157*.

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).

One-valve Short-wave Set

SIR,—Enclosed is the circuit diagram of a one-valve set which I have made from junk-box components, and which gives good results on a dipole aerial. The "roofs" are about 15ft. in length and leads-in about 20ft. The valve is a Philco 32E; tuning condenser is a Gecophone .0005 mfd., 12-1 s.m. with a 1½in. diameter knob; reaction condenser is a selectivity condenser removed from an old Telsen 2-wave-band coil; H.F.C. is an old Telsen 18-2,000 metres, but is effective down to 13 metres.

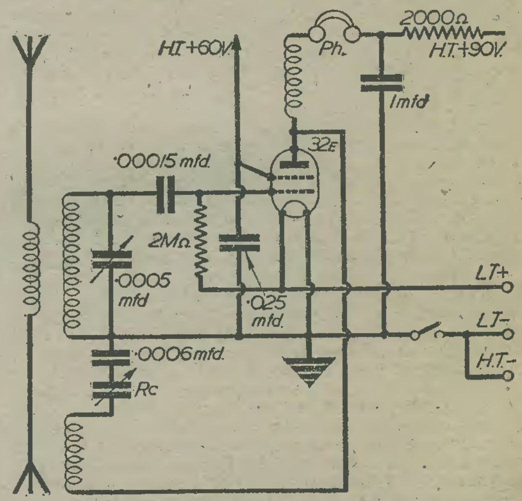
The coil is wound on a cardboard former 1⅝in. diameter fixed to a valve base, the aerial coil consisting of two turns of 22 s.w.g. bare wire spaced about 1/16in.; the grid coil consists of three turns 22 s.w.g. bare wire, also spaced, and at a distance of about ⅜in. from the aerial coil. The reaction coil consists of three turns 28 s.w.g. d.c.c. wire, close wound, and about 1/16in. distance from the grid coil. This coil has a tuning range covering wavelengths from below 16 metres to about 44 metres.

Good reception has been obtained from continental and American stations on 16 metres.

On Sunday, October 18th, Batavia was tuned in on 16.6 metres, and on Saturday morning, October 24th, Tokio was heard giving news in German, Italian and English, also on 16 metres.

I have been interested in short-wave reception for 14 years, and have had various kinds of home-built receivers.

I am also using an 0-v-1 short-waver built on a metal chassis using a Mazda HL2 and a Mullard PM2A, also a two-wave band RX which works on the medium wave band, and on short waves 18 to 50 metres, the switch and coil being home-made.—D. MELVILLE (Kirkcaldy).



Circuit diagram of D. Melville's one-valve short-wave set.

Push-pull Output and Harmonics

SIR,—When reading the November issue of PRACTICAL WIRELESS, I noticed an error in the Radio Examination Papers, No. 12, part 2, entitled "Harmonics," in which the writer states that with push-pull output the *odd* harmonics tend to be cancelled out! Surely if that was the case we would be unable to hear the fundamental taking this as the first harmonic, unless the writer meant that third harmonic distortion can be reduced by using a slightly lower impedance in the anodes of the P.P. valves, thereby offering less impedance at the harmonics. However, I trust the writer meant that *even* harmonics (second and fourth) are cancelled out.—P. BODDAERT (Southsea).

[*The writer was, of course, referring to* even *harmonics. See "Radio Exam. Papers" in this issue.*—ED.]

Converting Battery Set to A.C.

SIR,—The article in the September issue of PRACTICAL WIRELESS on the conversion of battery sets to A.C. operation interested me very much, because it was written and explained in such a lucid manner, that even the amateur with the bare foundations of wireless could understand it. A friend of mine recently sold me a small 2-valve battery set of a well-known make and I at once set about converting it on the lines suggested in the article. The base and sides are made of 4-ply, 9in. x 9in. for compactness, and I made use of a mains transformer from an old commercial set which I had on hand. My rectifying valve was a Marconi U12, and I have two 8mfd. wet electrolytics (one T.C.C., one Philco), across the smoothing field of my M.E. speaker. I really enjoyed building this unit—it was done in about two hours, with soldered connections, and as soon as I switched on it gave a fair volume, even considering the large size of my speaker. At first the reaction was very sensitive and the detector went into oscillation just above the lowest point of the reaction condenser, but I put a 20,000 ohm. resistor in the detector plate and this improved matters. I originally built a unit using a voltage doubler circuit with two 4 mfd. condensers, but unfortunately I didn't take enough notice of that word "unimpeachable," which you used with regard to condensers, and I found that the ones I had were punctured, so I abandoned it for the time and built the other one. The valves I am using are Cossor 41MHL and Cossor 41MP, but I am so pleased with the results that I am going to try a Mullard SP4 (pentode) and a Cossor 41MXP (when I'm next on leave), to see if I can improve the whole outfit.

I must say that I have learnt more about the working of wireless in the last six months with PRACTICAL WIRELESS and your books, than I have in the last 10 years, and now there are all sorts of things coming forward that I want to understand.—EDWARD HANSON (Salisbury).

B.S.R.A. Activities

SIR,—May I beg a little space to deny a rumour circulating in some quarters to the effect that the British Sound Recording Association is now entirely defunct?

Since 1940 it has not been possible to hold any meetings or arrange visits, etc., but the association still acts as a clearing-house for information on aspects of sound recording by all known systems, and its members maintain contact through correspondence. Reports of any activities and publications have appeared in the technical press. Present research in the field of plastics holds some promising developments for sound recording media, when it is permissible for the details to be released.

All communications should be addressed to me at "Strathdee," Studley Road, Torquay, and if from a non-member requiring a reply, please enclose postage. If this letter should catch the attention of Member C. L. Appleby (believed R.A.F. number 1258460), please do not fail to get in touch.—DONALD W. ALDOUS, Technical Secretary, B.S.R.A.

A Reader Since No. 1

SIR,—Many thanks for the copy of "Wire and Wire Gauges" awarded to me in your No. 436 Prize Competition. It is a very handy book indeed, full of useful information, and a valuable addition to my collection of your text-books.

May I take this opportunity of saying how I appreciate the way in which PRACTICAL WIRELESS is carrying on during these difficult times, also the convenient size the last volume has assumed.

I was interested to note that we have completed the first 18 volumes, or 10 years, of our association, as I have been a reader since the first copy appeared, and I still have most of the copies in my possession (unless they have been given up by my family for salvage since I left home for war work). Wishing you every success the future.—ROBERT BARLOW (Ulverston).

Midget Two-valve Portable

SIR,—Having been a reader of your well-known and useful radio journal for some years, I am writing to let you know how I got on with Sgt. Andrews' (R.A.F.) two-valve portable as published in the October number of PRACTICAL WIRELESS. While on 48 hours' leave I sorted out my junk-box and built the set. I was pleasantly surprised at the results obtained. The British stations came in at very good strength, and I managed to pull in one or two continental stations, also at quite readable strength. After this I altered one or two components. First, I rewound the coil (frame aerial) on a smaller former made of cardboard 3 ins. square; instead of the 23 turns as on the old former, I wound 35 turns on each winding. The reaction condenser is now a .0002 mfd. The fixed grid condenser also a .0002 mfd. I have also found that a .002 mfd. fixed condenser across the 'phones makes a great difference to the tone. I advise anyone, as Sgt. Andrews says, to try out this circuit, especially those in the civil services or Forces.—SIGNALMAN J. STITT (Putney).

Finding Resistance of Voltmeter

SIR,—It is sometimes very useful in radio engineering to know the resistance of a voltmeter. This is particularly important if one uses a low-resistance instrument. If this is not indicated on the meter I suggest the following method of finding out:

Using a known current source of which the voltage can be measured with the meter, and giving a nearly full-scale deflection on the meter, the meter should be connected in series with a known resistance, the value of which should be so chosen that the needle shows about half-scale deflection if both are connected across the current source. The P.D. across the meter resistance will then be indicated by the needle, and the P.D. across the known resistance is Er=Er—Em. Knowing this voltage, the current flowing in the circuit can be calculated by using Ohm's law $I=\frac{Er}{Rr}$.

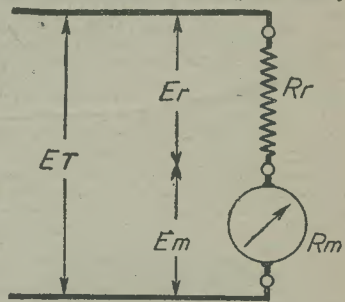
As the current flowing through the meter and the voltage across it is known, the resistance of the meter Rm can be found easily. $Rm=\frac{Em}{I}$.—H. WIENER (Willesden).

S.W. Listening

SIR,—A. W. Mann has asked for the experience of readers regarding the minimum tunable wavelength of certain coils. As I think a considerable body of opinion will support his view, I would like to call attention to the following: In February 26th, 1938, issue of PRACTICAL WIRELESS K. W. Holyland records that he tunes the 10m. band with the coil of advertised minimum of 12m. In a later number Ex. 2FWA records tuning the 16m. band with the coil designed for a 22m. minimum; thus giving one reasonable grounds for supposing that he can tune the 10m. band with a coil intended for a minimum of 9m. A. W. Mann asks if I have removed interwound aperiodic windings, and what kind of former was used. I have used commercial coils exactly as manufactured, also home-wound ones upon various bases (B.T.S., etc.), I have also wound separate aperiodic coils on formers having interwound ones. With standard coils I use a pre-set in series with the aerial. The answer to his question obviously depends upon the actual layout and components used. I hope Mr. Mann realises that I do not question him; I have for many years followed his S.W. articles. He says the question of dead-spots does not arise—this is so, as I did not mention them in conjunction with this matter.—F. G. RAYER (Longdon).

Jazz, Folk Music and Classics

SIR,—I have just been reading the latest issue of PRACTICAL WIRELESS, and it prompted me to drop you a line. It's about this dance music. I agree heartily with *every word* that Mr. K. T. Hardman wrote, and I would put it more strongly, if possible. But why, *please why*, head it *jazz*? Honestly, jazz is a folk music: like English folk tunes it was a part of the life of the people, in New Orleans, who made it. It took on a likeness to that life; it was filled with the chief characteristic of the Negro rhythm. It was rough and crude like the existence of these people. Also, it was sincere. I could write several pages about this but I expect you know what I mean.



Simple method of calculating the resistance of a voltmeter, as described in H. Wiener's letter.

It is the profitable and foul racket of dance music and modern polished raving swing music arrangements, with their stupid, slothful music and vocals, that have to some extent blinded the average person to jazz music. They don't know what it is. To those who have condemned jazz I say give it a fair trial; find out what it is. I like classics as much as, perhaps more than, jazz, and I have a large number of records of both Classical music needs just as much study for appreciation as jazz, which simply wants a square deal.—A. McGUGAN (Belfast).

Condenser Calculations : Attenuators

SIR,—I am a radio amateur of many years' standing, and I am writing to ask you if it is possible to publish some articles on subjects I have looked for in vain in your journal.

For instance, Condenser Calculations is one of the subjects I would like explained, anent power factor. The term itself conveys to the mind something desirable, and is, I believe, the indication of phase angle, or its variation from the ideal 90 per cent. which is the case in the perfect condenser. Other articles convey the idea that the term should really be "loss factor," and it is difficult for amateurs to decide which is good—high- or low-power factor.

Next on my list, Simple Attenuators, with explanations of calculating the arms, for such purposes as home-built signal generators. I have your Service Manual, Hartley, and feel the limitations of the potentiometer output.

Finally, a consideration of service signal generators, their circuits and modulation methods, would be particularly interesting.—P. BURGESS (Paisley).

[*We would refer you to the article on Attenuators and Filter Circuits in the present issue.*—ED.]

Replies to Queries

RULES

We wish to draw the reader's attention to the fact that the Queries Service is intended only for the solution of problems or difficulties arising from the construction of receivers described in our pages, from articles appearing in our pages, or on general wireless matters. We regret that we can not, for obvious reasons :—

(1) Supply circuit diagrams of complete multi-valve receivers.
(2) Suggest alterations or modifications of receivers described in our contemporaries.
(3) Suggest alterations or modifications to commercial receivers.
(4) Answer queries over the telephone.
(5) Grant interviews to querists.

A stamped, addressed envelope must be enclosed for the reply. All sketches and drawings which are sent to us should bear the name and address of the sender.

Requests for Blueprints must not be enclosed with queries as they are dealt with by a separate department.

Send your queries to the Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

The Coupon on page iii of cover must be enclosed with every query.

A.C./D.C. Shocks

"I have connected a pair of headphones to my set by taking two leads direct from the speech coil to an insulated batten holder screwed to the side of the cabinet, together with an adaptor on end of 'phones. I connected these up, but found as soon as I held the metal part of the 'phones I got a shock when I stood on the bare floor (which is composed of a substance which, I think, is concrete), but when standing on carpet everything was normal. Why is this?"—J. H. B. (Fulham).

WITH any A.C./D.C. circuits the metal parts of the receiver are "alive," with one side of the mains; therefore, if such parts are touched when standing on a conducting surface a shock will be experienced. You did not feel the same effect when you were standing on a carpet, as that acts as an insulator and prevents the circuit to earth being completed. One side of the secondary of the L.S. transformer is apparently connected to the chassis or common negative line.

Poor Results

"I have constructed the Midget two-valve portable given in your February issue of 'Practical Wireless.' The components and wiring are the same as shown, but I have not been able to pick up any signals, the set seems dead. I have tested valves, batteries and wiring; these seem O.K., therefore I suspect the frame aerial coil as being inefficient. I reside in a valley where damping is experienced and I submit this is a possible cause of lack of signals. Any alterations to aerial or any other information will be greatly appreciated."—P. C. C. (E. Grinstead).

THE absence of signals is no doubt due to local conditions; therefore we would suggest that you try the effect of using an external aerial, which could be connected to the grid end of the frame aerial.

H.T. Supply

"I wish to build a battery eliminator for my four-valve superhet. The current available here is 120 volt D.C., which simplifies the eliminator, doesn't it? I imagine that all that is necessary is a condenser across the leads and another to earth (2 or 4 mfd.?).

"Will a smoothing choke be necessary? The valves are all coupled to one H.T. lead in the set. Should they be decoupled and the eliminator fitted with suitable resistances?"—L. J. de S. (Lynton).

IT would be advisable to incorporate a good make of L.F. smoothing choke in series with the positive lead and connect another smoothing condenser (4 mfd.) across the positive and negative on the receiver side of the choke. The condenser between the negative line and earth connection should have a smaller value, say, .1 mfd. It would be advisable to incorporate anode decoupling to prevent interaction between the various anode circuits.

Excess Current

"I wish to feed three 4 volt 1 amp. valves in my receiver from a transformer rated at 4 volt 5 amp. Is this injurious to the valves, and should I dissipate the excess current? If so, would you advise me as to the best procedure?"—L. H. (c/o G.P.O.)

WITH any well-designed mains transformer it is usually quite in order to draw off a lower current than that for which the secondary is rated. No appreciable voltage rise should be experienced.

Midget Two-valver

"I am interested in the midget two-valve portable set made by R.A.F. member No. 5,560. Will you please give me instructions how to make the coil (frame aerial), as I cannot find my February issue.

"I would like to thank 'Practical Wireless' for the very interesting articles."—E. J. (Leigh).

THE frame aerial is made from a flat piece of stout cardboard cut to the size of the rear of the case holding the set. Around the edge of the cardboard is cut a series of slots pointing inwards. These have a length of approximately 1in., and it is essential that there should be an odd number of them. The frame aerial winding is formed by threading the wire in and out of the slots in the ordinary basket coil fashion.

Intermediate Frequency

"I have a Marconiphone A.C./D.C. Type 223 superhet. I have stripped set down and building a four-valve superhet (battery set), as I could not get valve renewed for set as it was for A.C./D.C. working (fitting new P.M. speaker).

I am puzzled how to wire up oscillator coil, and at what point to introduce the padding condenser together with switching.

The tuning condenser is one of the tracked kind, therefore I take it that the intermediate frequency transformers will be for about 110 kc/s working. There was a small coil in series with aerial lead and shunted with a trimmer. I have looked up all my wireless books and papers, but cannot find anything to enlighten me."—H. M. R. (Manchester).

WE cannot supply any details of the components or circuit of the receiver mentioned, as we are without any technical data concerning its design. If it is an early product it is possible that the intermediate frequency is 110 kc/s but this does not follow, because of the type of condenser employed.

The small coil in series with the aerial is intended to prevent break-through of signals having a frequency the same as the I.F. transformers.

Hot Mains Transformer

"A few months ago I built the A.W. 453 A.C. Short-wave Two. This was built exactly to plan, except the power pack. I used a unit I had on hand, the power pack of the Home-Lovers All-Electric Three.

"This set has given perfect reception until a few days ago, when I smelt burning rubber, which was obviously coming from the set.

"After examining the set closely I could not find anything wrong, but I did find that the smell came from the mains transformer, which was very hot.

"I have examined it but cannot find anything wrong, and the set still works all right, except for the smell and running hot.

"Can you give me any idea as to what is causing this?"—R. R. (Halton).

WE would suggest that you examine all components associated with the positive H.T. line, in particular the smoothing condensers, as it would appear that a heavy load is being imposed on the rectifier, and this might be due to a breakdown in one, or more, of the condensers. The rectifying valve and transformer windings should also be examined.

W.M. 397

"I have just received the blueprint for the Simplified Short-wave Super (W.M. 397), and as I am without the issue containing the description, I am not quite sure which valves to use. I shall be pleased if you would send me a list of valves specified for the original circuit."—S. J. N. (Bristol).

THE valves specified for the receiver are: One Osram X21; One Osram S24; One Osram HL2; and One Osram PT2.

Unknown Outputs

"Can you inform me how I may find out the input and output, volts and amps, of mains transformers having no markings, only the bare wires?"—E. J. H. (Essex)

IF you have no idea of the outputs of the various windings, it is not possible for us to determine what current might be expected. A rough idea, however, could be obtained by the gauge of wire. If you knew the current output, you could connect across each winding an artificial load, which would consume the required current, and then measure the voltage across the circuits. A megger test would enable you to determine the resistance of each winding and thus help to gauge their current carrying capacities.

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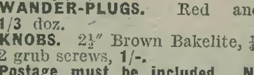

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