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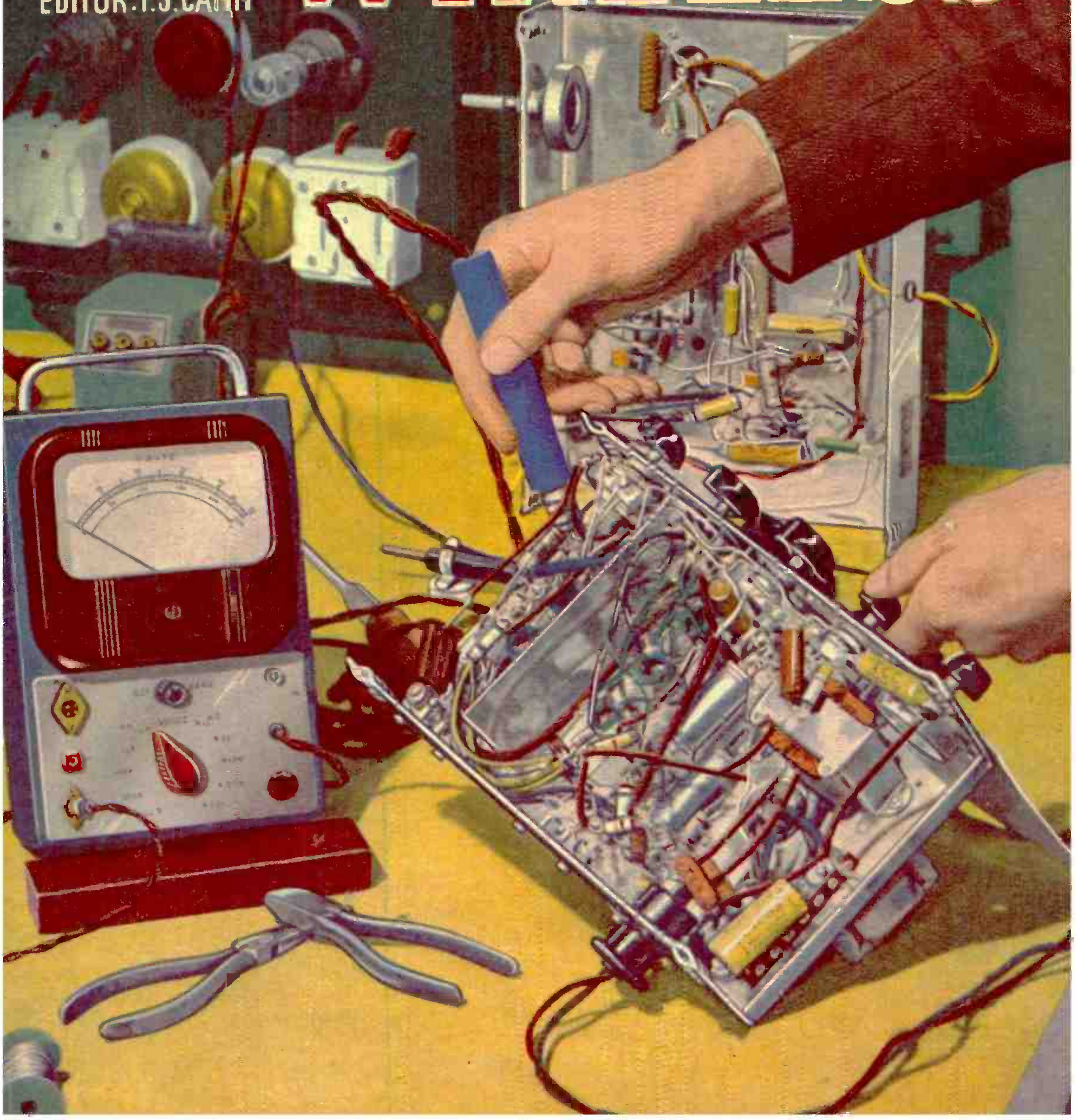
1/-

FEBRUARY 1955

EDITOR: F. J. CAMM



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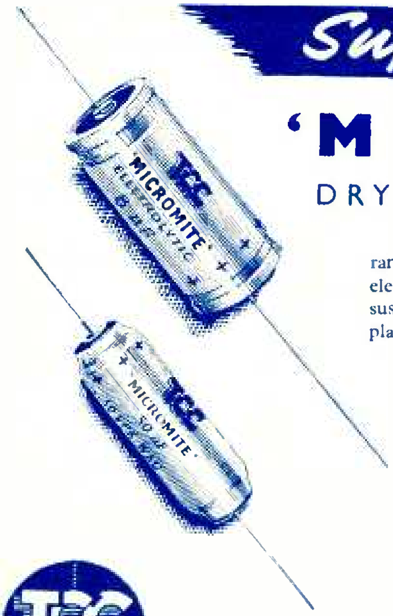

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50	12	15	1 [illegible]	[illegible]	CE87B	2/9
25	50	60	1 11/16	[illegible]	CE88DE	3/-
1	350	400	1 [illegible]	[illegible]	CE86L	2/6
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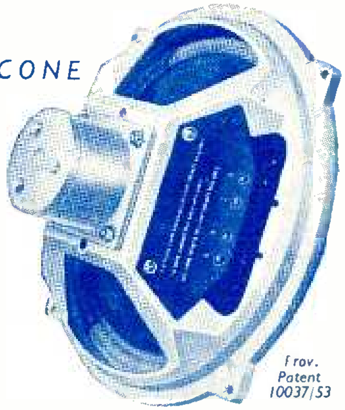

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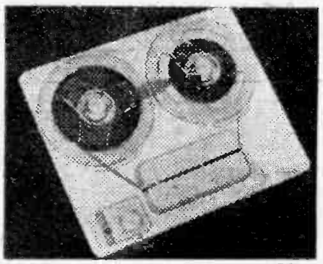

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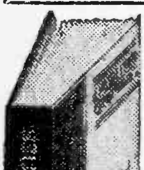

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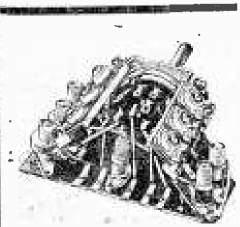

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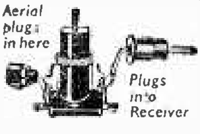

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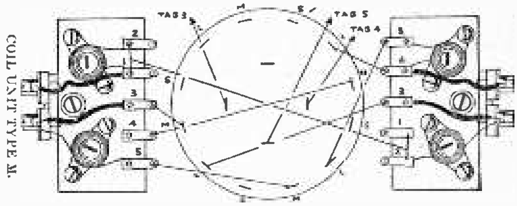

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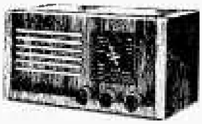

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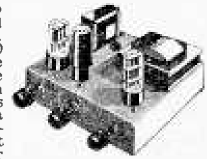

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50 mA. 5-10 H 200 ohms...	2/9
L.T. type 1 amp.	2/9

EX-GOVT. METAL BLOCK (PAPER) CONDENSERS : 2 mfd. 3,000. v., **2/9** ; 4 mfd. 500 v., **2/9** ; 4 mfd. 750 v., **3/9** ; 4 mfd. 1,500 v., **4/9** ; 4 mfd. 2,000 v., **7/9** ; 6-6 mfd. 400 v., **5/11** ; 8-8 mfd. 500 v., **6/11** ; 4 mfd. 400 v., plus 2 mfd. 250 v., **1/11** ; 8 mfd. 500 v., **5/9** ; 15 mfd. 500 v., **6/9.**

EX-GOVT. E.H.T. SMOOTHERS .02 mfd. 8,000 v. cans, **1/11** ; .25 mfd. 4,000 v. Blocks, **4/9** ; .5 mfd. 2,500 v. Blocks, **3/9** ; .5 mfd. 3,500 v. cans, **3/3** ; 1.5 mfd. 4,000 v. Blocks, **5/9** ; .1 mfd., plus .1 mfd. large Blocks 8,000 v., **9/6.**

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MIDGET MAINS TRANSFORMERS. Manufacturer's Surplus. Primary 220/240 v. Secs. 275-0-275 v. mA. 6.3 v. 2 a. Only **11/9.**

TV. PREAMPLIFIER (Plessey) For Fringe Areas. Brand New. Complete with 6F13 valve. Only **22/6.**

R.S.C. MASTER INTERCOMM. UNIT, with provision for up to 4 " Listen—Talk Back " units individually switched. A high gain amplifier allows speech emanating from the rooms containing remote control units to be heard at the master control. The unit is in kit form and point-to-point wiring diagrams are supplied. A walnut veneered wood or brown bakelite cabinet is included. Mains input is 200-250 v. 50 c/cs. H.T. line 300 v. CHASSIS IS NOT " ALIVE." Ideal also for use as " Baby Alarm." Sound amplification 4 watts Price only **£5/19/6.** " Listen—Talk Back units " in walnut veneer cabinets can be supplied at **35/-** each. Full descriptive leaflet 10d. The Master Unit can be supplied assembled and tested for **30/-** extra.

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	Each		Each		Each
IT4	7/9	6Q7G	9/11	AC5PenDD	9/9
IR5	7/9	6SN7GT	9/9	EBC33	7/9
1S5	7/9	6V6G	8/9	EF36	5/9
3V4	7/9	6V6GT	7/9	EB91	8/9
3S4	9/9	6X5GT	8/9	EF91	7/9
5U4G	10/6	8D2	2/11	EL33	9/6
5Z4G	9/6	807	7/11	MU14	8/9
6F6G	7/9	9D2	2/11	MS/Pen	5/9
6J5G	5/9	12A6	7/9	SP4	5/9
6J7G	6/6	12K7GT	10/6	SP41	1/11
6K7G	5/11	15D2	4/9	SP61	2/9
6K8G	8/11	25Z4G	9/6	VU120	2/11
6SK7	7/9	35Z4GT	10/6		

H.T. ELIMINATOR AND TRICKLE CHARGER KIT. Input 200-250 v. A.C. Output 120 v. 40 mA. fully smoothed and rectified supply to charge 2 v. acc. Price with steel case and circuit, **29/6.** Or ready for use, **8/9** extra.

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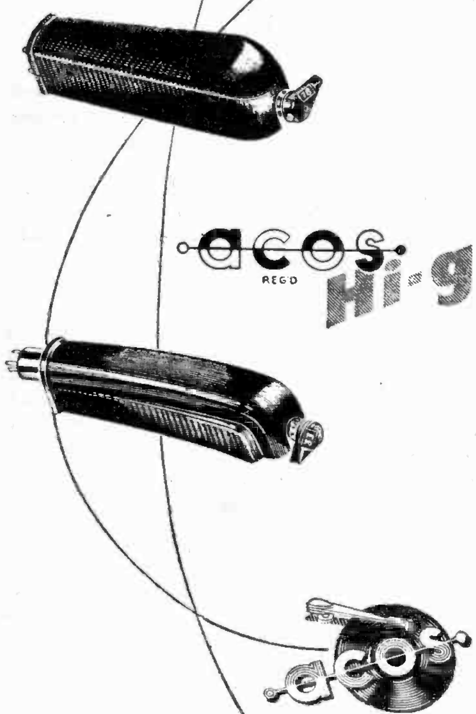

Recording techniques have made such strides over the last two years that if you are to get the really superb reproduction made possible by the latest L.P. records you need one of the Acos "Hi-g" Pick-ups. These have been specially designed to meet the very exacting demands of the new records with their shallow groove and microscopic sound "track". This special design is necessary on two scores—firstly to do justice to the brilliant recording, and secondly to ensure the longest possible life from L.P. records. Such records are expensive; even a single playing with an unsuitable pick-up can cause irreparable harm.

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NUMBER PLEASE!

The new restricted form of London Telephone Directory no longer includes subscribers, like Cosmocord, in "fringe" areas. Please note therefore that our number is **ENFIELD 4022.**

PRACTICAL WIRELESS

EVERY MONTH
VOL. XXXI, No. 580, FEBRUARY, 1955

EDITOR : F. J. CAMM

23rd YEAR OF ISSUE

COMMENTS OF THE MONTH

BY THE EDITOR

Illegal Radio Fees

ACCORDING to the chairman of the Mobile Radio Users' Association, the Postmaster-General has illegally collected about £400 million in radio and television licences since 1904. He was referring to a recent judgment against the Postmaster-General for £143 6s. 8d. which had been paid in licence fees by a Colchester firm of engineers, who claimed repayment of these fees charged for mobile transmitters and receivers on their vehicles, on the grounds that they were illegal.

It was a test case and the Association was responsible for the case being brought to court. Although the case was concerned with licences for mobile radio users, it applied also to domestic licences, because they are only collectable by the Postmaster-General if the regulation empowering him to do so were laid down. In fact, no regulation has been laid down under the relevant Act of 1904. A spokesman for the G.P.O. commenting on the case, in which the P.M.G. submitted to judgment by consent, said that nothing other than land mobile radio licences was in question. The question of the fees which have been extracted for domestic licences was not before the court, and it seems a great pity, as this was a test case, that this matter was not raised also. It is too late now, for the Government proposes by the usual trick of retrospective legislation to legalise what has been illegally done. If an ordinary citizen does something legal to-day, it can be made illegal by retrospective legislation, and the late Cripps was one who made use of this politically dishonest method in the case of Sir Leonard Lord and Sir John Black. When the Government itself does something illegal it makes it legal by the same method. Thousands of people have been fined and their convictions recorded for the non-payment of wireless licence fees which, as it now turns out, were illegally demanded. The proposed retrospective legislation should contain a clause ordering these convictions to be expunged from the records and the fines refunded. Of course, current wireless licences of all kinds are operating under the Wireless Telegraphy Act, 1949, and no question arises as to the charges under that Act. The retrospective legislation proposed will validate licence fees collected between 1904 and 1949, and presumably, therefore, will also validate the convictions.

The case in question was based on the Bill of Rights under which no British citizen can be charged a fee by a Government department without the authority of Parliament. Under the 1904 Act licence fees for mobile radios could be charged only if regulations were made by the Post Office and the consent of the Treasury obtained. This has never been done. The same omissions apply to domestic wireless licences, and it is clear that there has been no power since 1904 to make a charge for a wireless licence.

BONA-FIDE RETAILERS

THE annual report of the Radio and Television Retailers' Association makes it clear that they intend to compile and publish a list of firms who are bona-fide retailers, complying with the definition of a retailer already agreed between R.T.T.A. and other sections of the industry. The other sections, however, are not willing to co-operate in the compilation of this very necessary and much overdue list. We have many times drawn attention to incompetent radio dealers, but unfortunately the publication of such a list, in view of the present state of the law, cannot protect the public against the charletans, since it is a white list and not a black list, and the omission of a dealer's name from it cannot be taken as indicating that he is not a bona-fide dealer. However, such a list will go a long way towards removing some anomalies in radio trading, especially if wholesalers refuse to supply those not on the list.

INDEXES FOR VOLUME 30

THE December issue concluded Volume 30 and the index for it will shortly be available price 1s. 1d., post paid. Arrangements have been made for Messrs. Hazell, Watson and Viney, of 52, Long Acre, London, W.C.2, to undertake the binding of your parts in complete volumes with the appropriate index. If you are desirous of having your parts bound, Messrs. Hazell, Watson and Viney will be pleased to let you have a quotation for the work on receipt of an inquiry. Those readers who prefer to have their copies bound by a local bookbinder can obtain not only the above-mentioned index but also an index for any previous volume from us direct. The order should be addressed to the Publishing Department, George Newnes, Tower House, Southampton Street, Strand, London, W.C.2.—F. J. C.

Round the World of Wireless

By "QUESTOR"

V.H.F. Station

THE opening date of the V.H.F. station to serve East Anglia is not yet known, but it will have a temporary mast at first until a permanent one is erected.

Printed Circuits Agreement

IT is announced that Pye Limited have acquired an interest in Technograph (Printed Circuits), Ltd., who hold patents for printed circuits all over the world.

Both companies intend to work closely together in furthering the development and application of printed circuits, not only in Britain but throughout the world.

September Sales Down

RADIO sales figures for September were slightly down on the previous month. 12.1 sets per shop were sold in September, compared with 12.3 in August.

Radio from Rowridge

THE new Rowridge television station on the Isle of Wight is not intended to be used exclusively for TV. It has been officially announced that the BBC plan to transmit three V.H.F. sound programmes from the station when the 500ft. mast replaces the temporary aerial in about a year's time.

Broadcast Receiving Licences

THE following statement shows the approximate number of broadcast receiving licences issued during the year ended October, 1954. The grand total of sound and television licences was 13,701,205.

Region	*Number*
London Postal ...	1,524,625
Home Counties ...	1,443,030
Midland	1,207,949
North Eastern... ...	1,587,978
North Western ...	1,224,725
South Western ...	992,626
Wales and Border Counties	618,900
Total England and Wales	8,599,833
Scotland	1,040,028
Northern Ireland ...	219,676
Grand Total ...	9,859,537

Scriptwriters Alan Simpson (left) and Ray Galton (right) show a disgusted Tony Hancock their offering for the latest edition of "Hancock's Half-Hour," heard weekly in the BBC Light Programme.

Overseas Appointments

MR. HUGH CARLETON GREENE, O.B.E., has been appointed Controller, Overseas Services and Mr. Oliver J. Whitley, Assistant Controller, Overseas Services.

Commercial Radio Possibility

IT has been reported that should the new commercial television service to be introduced this year prove successful, a proposal for commercial radio may be put forward.

The chief advantage of such a service would be the abolishment of licences.

Radio Telescope

PROF. V. A. AMBARTSUMYAN, a Russian astrophysicist, visited Jodrell Bank experimental station recently as the guest of Prof. A. C. B. Lovell, professor of radio astronomy at Manchester University, who is head of the Jodrell Bank telescope scheme.

He was shown the new £500,000 radio telescope near Chelford which is being constructed to be the largest in the world.

Decline in Canada

FIGURES issued by the Canadian Radio Television Manufacturers' Association reveal that sales of radio receivers in October last totalled 41,411, a decline of 14,031 on the total for October, 1953.

Firm's Communication Station

TARSLAG, LTD., a Teeside building and contracting company, have been negotiating with the Northallerton Water Board for the lease of a site on one of the highest points of the Osmotherley Moors, near Northallerton.

The firm intend building a radio station to keep in constant touch with their employees engaged on jobs in North Yorkshire and South Durham.

Radio Show Dates

THE National Radio Show this year will be held at Earls Court, London, from August 24th to September 3rd, with a preview for overseas and special visitors on August 23rd.

Meanwhile plans are well in hand for a smaller exhibition, the Northern Radio Show, to be held at the City Hall, Manchester, from May 4th to 14th.

Mobile Radio Used

MOBILE radio was used by the Sunderland Transport Department to control bus operations when the Queen and the Duke of Edinburgh visited Wearside. Two vans and a walkie-talkie set were used. The transport committee is now to consider using mobile radio permanently in view of its outstanding success on this occasion.

Civil Defence Exercise

NOTTINGHAM, Derby, Nottinghamshire and Derbyshire civil defence forces made extensive use of mobile radio for their largest exercise since the war. It was assumed that all telephones were out of action and all communication had to be by radio or field telephone.

Obituary

IT is with deep regret that we record the death of Mr. "Jimmy" James, production manager of Whiteley Electrical Radio Co., Ltd., who collapsed and died in his office on Friday, November 12th.

Mr. James was only 49 years of age and had completed nearly 28 years of service with the company. He was an outstanding personality and will be greatly missed by all who knew him.

British Institution of Radio Engineers

THE following meetings of the above institution will be held during January:

London Section.—Wednesday, January 26th, 6.30 p.m., at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1. "A Survey of Tuner Designs for Multi-channel Television Reception." D. J. Fewings, B.Sc., and S. L. Fife, A.M.Brit.I.R.E.

North-eastern Section.—Wednesday, January 12th, 6 p.m., at Neville Hall, Westgate Road, Newcastle. Address by the president, Rear-Admiral (L) Sir Philip Clarke, K.B.E., C.B., D.S.O.

South Wales Section.—Wednesday, January 12th, 6.30 p.m., at the Glamorgan Technical College, Treforest. "Electronic Counting Devices." F. H. Gage, D.Sc.

Scottish Section.—Thursday, January 20th, 7 p.m., at the Department of Natural Philosophy, the University, Edinburgh. "Modern Ship-to-Shore Communication." G. Macdonald.

Marconi Staff Appointments

MR. E. GREEN, M.Sc., having reached the normal retiring age, has relinquished his position as head of the Transmitter Advanced Development Group of Marconi's Wireless Telegraph Co., Ltd. He is, however, continuing his work for the company on a full-time basis as a consultant engineer.

Mr. V. J. Cooper, B.Sc., has been appointed chief engineer, Advanced Development.

Radiogram Gift

A COSSOR radiogram was recently presented to the Islington Branch of the Infantile Paralysis Fellowship. This presentation was made on behalf of A. C. Cossor, Ltd. by its medical officer, Dr. L. B. Bourne, in the presence of the Mayor, Councillor Mrs. J. M. Barnes.

Transmitter for Belgium

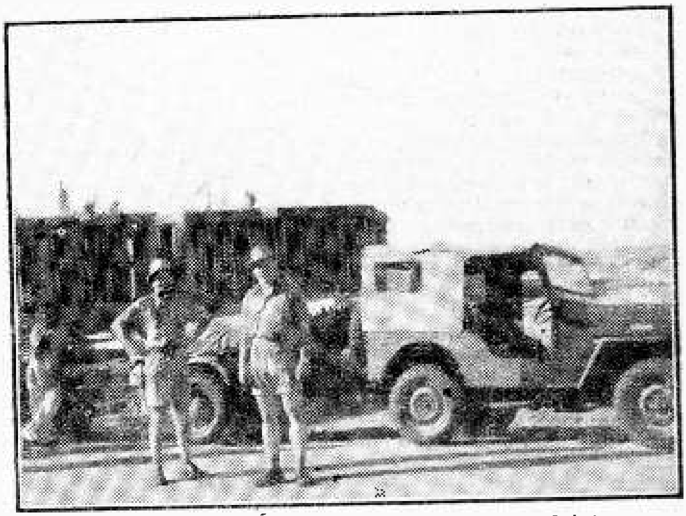
A HIGH-POWER (30 kW) H.F. communication transmitter type HS.51 has been shipped to Belgium from the Chelmsford works of Marconi's Wireless Telegraph Co., Ltd. This transmitter has been manufactured for the Belgian R.T. and T., the equivalent of the British G.P.O., and is to be installed by Marconi engineers at Ruisselede, Belgium.

The transmitter is designed for the transmission of radio-telephonic or telegraphic communications over long distances and under heavy traffic conditions.

Communications for Pakistan

PYE LIMITED are to supply and install £150,000 worth of equipment for the Sui Gas Transmission Company's pipeline communications system in Western Pakistan.

The system will include an extensive V.H.F. multi-channel route, providing speech and teleprinter channels between all the major points; a V.H.F./A.M. Fixed-to-Mobile scheme, giving complete coverage of the pipeline route for maintenance purposes; and a duplex H.F. radio-telephone or teleprinter system between Karachi, Sui and the main intermediate point.



Two members of the Pye radio unit prior to the start of their survey for a communications system in Western Pakistan.

Cable and Wireless Limited. 15,000-Mile Cable Chain

A 15,000-mile cable chain, the longest unbroken cable and landline circuit ever formed, is being set up to link Sydney with London direct, via Canada. The chain is intended as a permanent improvement in communications between the United Kingdom and Australia.

Savings Scheme

WOLF dealers throughout the country are now operating an "easy-stage" savings scheme for the benefit of prospective purchasers of Wolf Cub equipment.

A New Technique for Sound Recording

A COMBINATION OF TAPE-RECORDING TECHNIQUE WITH ORDINARY SOUND-ON-FILM

By A. G. Thomson

COST has been the principal factor limiting the use of films with sound effects and recorded commentaries for scientific, educational and commercial purposes. This limitation has been overcome by the development of a powder which, when skilfully bonded to film, provides an easier and far more economical means of adding sound to motion pictures.

Sound may be recorded on film by means of light or by varying the magnetic field, on the principle of the magnetic tape recorder. Magnetic sound tracks are applied in the form of a narrow " stripe " down one edge of film in approximately a similar position to the photographic track. A stripe which occupies the whole area normally used for the optical track is 0.10in. wide and is termed full width stripe or full striping. Since the stripe is opaque any optical track which it covers can no longer be played. It is also possible to apply a half stripe, 0.05in. wide, which may be located on either side of the centre line of the optical track, so that the latter can still be played at a slightly reduced volume level. Half striping produces a slightly lower volume of sound than full striping, but is otherwise equally effective. It is also possible to add a narrow stripe 0.03in. wide to the outside edge of silent (double perforated) film. This is known as edge-striping and has an even lower output than that of half striping, though in other respects it is equally effective.

The use of magnetic striping has led to the development of equipment specially designed to take maximum advantage of the opportunities presented by this very flexible system of sound recording. The scope for this new technique has been greatly extended by the introduction of a magnetic-optical projector, which makes it possible not only to project 16 mm. films of all types, but also to record material from practically any source. Manufactured by Kelvin Hughes for Simplex-Ampro, Ltd., it is claimed to be the only equipment in the world which records from an optical track and has a three-channel mixing unit operating from a remote control panel.

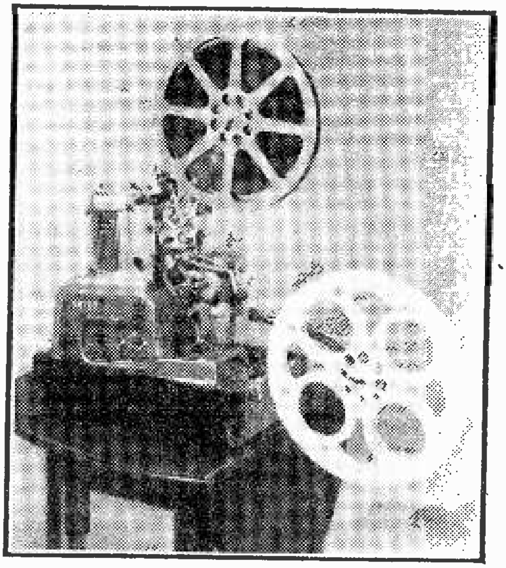
The set has been designed to give the fullest possible facilities, so that recording can be carried out in a truly professional manner. It includes a separate remote control unit, which is provided with twin channel input for recording and monitoring by meter as well as headphones. The complete equipment is supplied in three cases. One case houses the projector proper, its lower half being in the form of a tray in which the projector is mounted. The loudspeaker carrying case forms the loudspeaker baffle and holds a spare 1,600ft. film reel, together with loudspeaker cable. The third carrying case, besides housing the remote control unit, contains a Reslo ribbon microphone with a very wide frequency range, monitor head set, control cable, head cable, and power cable.

The Sound-head

The projector is provided with a footage countermeter and has an improved sound-head with no guideways. The film passes from the bottom to the top of the sound drum which rotates in an anti-clockwise direction. Since the stripe is on the outside of the drum, the magnetic head is able to follow the film and conform to its minute fluctuations. The magnetic head is adjustable in all three planes to give perfect contact with the film. The greater frequency ranges available from magnetic recording made it desirable to design an improved speaker unit, which has been backloaded and baffled to lower the low-frequency response by a full octave. The amplifier is also of a new and improved design and uses valves of standard makes.

The projector operates on 105-125 volts alternating current, but can be operated on A.C. supplies outside this range by using an Ampro transformer. It will accommodate reels from 400ft. to 2,000ft. capacity and may be used to project sound films at a constant speed of 24 frames/sec., or silent films at a constant speed of 16 frames/sec. This projector has been specially designed to play edge stripe on double perforated film, half track, or full track. It will play optical and magnetic tracks on colour or black and white film either separately or simultaneously, and can change from one half track to the other with no mechanical switchover whatsoever. It will record from two sources separately or mixed (e.g., microphone and gramophone), and it will record from existing optical track with the addition or insertion of extra material from other sources in a single operation.

One of the main advantages of the equipment is that the remote control unit can be placed well away from the projector, so that even the minute amount of noise made by the recording instrument

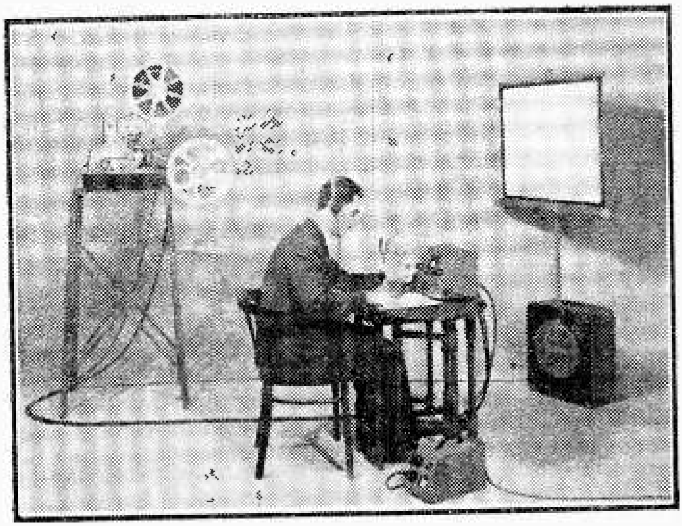


A view of the new projector.

can be completely eliminated. In fact, for fully professional results it is preferable to have the commentary read from another room. This can be easily achieved with the remote control unit which allows the projector to be operated and the recording to be fully monitored.

Operation

When recording from a magnetic track, the striped film is threaded through an erase head and into the projector in the usual manner. When the recording amplifier is switched to the record position, a red signal lamp comes on. The operator then switches on a turntable and checks the level of the opening music, which should peak at the full zero level on the programme meter. He next checks his voice on the second channel of the three-channel mixing unit. His voice should peak at full zero, but if the music is a background to speech it should be peaking at minus 3, and this will be clearly indicated on the programme meter. In the monitor 'phones the operator can hear both the level of the music and his voice. Switching on the projector he records his message. Should he make a mistake, he has merely to reverse the projector to a point prior to the error and re-record the passage. The offending section is automatically removed by a special erase head, which operates continuously during recording to ensure that no previously recorded sound track still exists.



The complete equipment, with an operator making a magnetic recording.

To record from the optical track of a film the operator plugs the output from the speaker line into the 15 ohms position on channel 2 of the remote-control unit. The optical volume on the projector is turned to three-quarters and the tone-control to the desired position. The operator can then switch the channel selector switch into the 15 ohms position and record the message from the optical track, adding music from a gramophone disc or any other source, or making additional comments at the appropriate times.

The recordings are played back in the conventional manner, using the volume-control marked microphone for the magnetic volume and the normal volume-control for the optical volume where required on half-track recordings.

There are virtually no limits to the facilities offered by this remarkably versatile equipment. From the remote-control position the operator can switch the projector on and off and monitor on his head-set by following the visual indications of the programme meter. He can mix both music and speech and record from the optical track of the film at will, or he can use the 15 ohms input from another projector or tape-recorder or sound effects. If the output of a gramophone is too small for recording purposes, he can take out the speaker plug and plug it into the sound amplifier position, controlling the tone from the recorder itself.

An inexperienced amateur doubtful of his ability to mix sound and speech together can first record the music throughout the length of the required section of a film. He can then rewind the film, by-passing the erase head, and run it through again to record whatever commentary is desired. By this means the original music recording is automatically dropped to background level behind the speech.

In order to prevent assistants on field work from altering the original commentator's carefully chosen words, the projector has been so designed that the erase head can be unplugged, thereby ensuring that the recording will not be changed.

It is evident that there are four ways in which recordings made by means of magnetic striping can be played back. It is possible to play either the original optical track or the track containing the original optical recording and the new magnetic recording. Again, by careful thought and the use of the two volume-controls selected sequence can be played back from either track or both tracks can be played together. The practical significance of these novel facilities is at once apparent.

If a film is out of date it can be half striped and the material or policy, or any important passages that should be retained, can be recorded on to the magnetic striping at the same time as new speech or new background music is being added to the magnetic track.

When a documentary film is made for use in schools several different commentaries for the various age groups are required. Formerly it was necessary to make each of these commentaries on a separate optical track. Now it is a simple matter to make a copy for the oldest group, half stripe it, and record the commentary for the youngest group. The two recordings can each be played back separately, or the sequences from both play-backs can be mixed to provide the recording for the middle group.

Training

Most hospital groups consider that films of operations play a valuable part in the training of medical students and nurses, because the camera can show close-ups that could not be seen by the majority of those present in the theatre. Before the development of magnetic optical projectors, the surgeon had to be in attendance whenever the film was shown in order to provide the necessary commentary. Now the film can be half striped and a suitable commentary can be recorded, enabling the film to be shown at any time without the surgeon being present. Moreover, by varying the recorded commentary the same film can be adapted to the requirements of any type of audience.

Nowadays, there are many industrial users who have a 16 mm. silent camera and have never attempted to reproduce sound or speech. At a very modest cost they can now have their silent films copied and striped and record suitable commentaries with effects. There are many potential applications in factories for staff training and the training of service engineers. A particularly important advantage of half stripes is that they enable the language difficulty to be overcome. For example, a film illustrating the production, operation or uses of any particular equipment can be made in Britain, copied, striped, and sent all over the world, commentaries in the appropriate language being added in each country. The method also offers an ideal solution to the language problems when films are shown in such vessels as oil tankers, whose crews may be drawn from a number of different countries.

Magnetic optical recordings of the type described are also likely to be extensively used in the motion-picture industry itself, since they offer full studio facilities at a very much lower cost. In fact, the opinion has been expressed that because of its greater efficiency and economy, magnetic recording will eventually be universally employed in place of optical tracks.

Surplus Lip and Throat Microphones

By E. G. Bulley

THE lip and throat microphones were originally developed for use by the armed forces, and are both similar in construction. The former type is worn on the upper lip and does to a certain extent prevent or limit unwanted background noise. Likewise, the throat type is placed against the throat and, by so doing, background noise is reduced.

Basically, these microphones consist of one or two carbon buttons, the former being known as the single button, whereas the latter is the double button type.

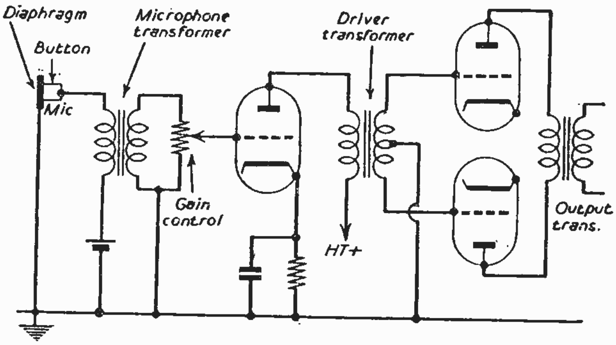
The single button type consists of a metal diaphragm which rests against an insulated dish containing carbon granules, the granules being commonly known as the button. One electrical connection is taken from a metal backplate, and the other is taken from the diaphragm. The double button type, however, can be said to consist of two single button types connected in a push-pull arrangement. This type must not be confused with the lip-type differential microphone, the latter type of microphone having two carbon buttons, one arranged on either side of the diaphragm but having only one electrically connected. It is assumed that the purpose of the other button is to assist in physical balance between the two sides of the diaphragm. Furthermore, should the reader purchase one of these microphones, he will notice that there are holes on both sides of the outer casing, these holes being located at the base of the instrument. The purpose of the holes is to allow the sound waves to enter both sides of the microphone and create equal and opposite pressures on the diaphragm.

Operation

The operation of the carbon microphone is simple, and only a brief explanation will therefore be necessary for the reader to appreciate the types that are available on the surplus market. As previously mentioned, the electrical connections are taken from the diaphragm and the case, current being fed from a suitable supply which flows through the loosely-packed carbon granules, and as the diaphragm vibrates, the pressure on the granules increases and decreases. These phenomena causes a fluctuation of current in the circuit in which it is connected.

Typical circuits utilising the single and double types are shown in Figs. 2 and 3.

Many of the lip and throat microphones are of American manufacture, the units being moulded in rubber with an elastic neck- or head-band. Nevertheless, the moulded rubber casing can be removed and the microphone used for various experiments.



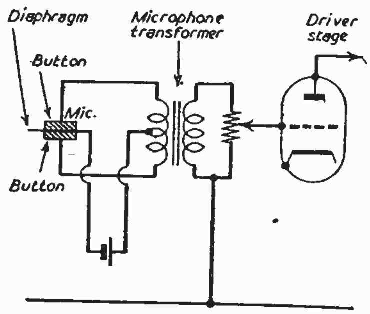
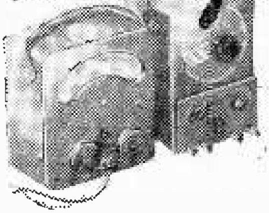


Fig. 1. (left)—Circuit using the single carbon button type of microphone. Fig. 2. (right)—Circuit employing the double-button type.

Using TEST INSTRUMENTS



Part 2 of a New Series of Articles Dealing with the Practical Application of Standard Test Equipment

By Gordon J. King, A.M.I.P.R.E.

(*Continued from page 14 January issue*)

LET us look again at the simple circuit in Fig. 4; we know, by calculation, that 200 volts are developed between points B and A—or between points B and C for that matter. Yet when we endeavour to prove this by making a voltage measurement the meter indication is nothing like it should be.

If we refer back to the voltmeter circuit of Fig. 2, we shall immediately realise that by putting a voltmeter across either of the two points we are in effect shunting either R1 or R2 by the internal resistance of the instrument.

Instrument Sensitivity (3)

The magnitude of this resistance is, of course, dependent on how much current is required to provide f.s.d. on the meter. Clearly, then, this is governed by the sensitivity of the meter itself, which in turn determines the overall sensitivity of the instrument proper. This characteristic is revealed in the term "ohms per volt."

Let us consider a meter that requires 1 milliampere for f.s.d. If we adapt this to read 1 volt f.s.d., then we find, by using Ohms law, that the meter circuit must possess a total resistance of 1,000 ohms (1 × 1,000/1 mA). We know, of course, that the meter itself has resistance, but this figure is *included* in the total resistance value, so that a 1,000 ohms of resistance exists between the actual terminals of such a 1-volt meter.

Thus, we now know that an instrument using a 0-1 milliampere movement has a sensitivity of a 1,000 ohms per volt—bearing in mind that the current to be considered is that necessary for f.s.d. A meter which has a f.s.d. of, say, 0.5 milliampere would, of course, go to make a voltmeter of 2,000 ohms per volt sensitivity—20,000 ohms per volt sensitivity would be realised by using a meter of 50 microamperes (0.05 milliampere) f.s.d., and so on.

We shall now have a much better idea what happens when we connect our, say, 1,000 ohms per volt meter—set on the 200 volts range—across points B and A of Fig. 4. The circuit will most certainly be disturbed by the total voltmeter resistance—now 200,000 ohms (1,000 × 200 ohms)—shunting R1. This is illustrated by Fig. 5, where a little simple calculation will soon reveal the error of our measurement.

We know that the total resistance of two resistors connected in parallel is equal to R1 × R2/R1 + R2. Working this out for R1 and the total resistance of our 1,000 ohms per volt voltmeter set on the 200 volts range, we quickly discover that in place of the 1 megohm resistor R1 we now have an effective resistance of 166,666 ohms.

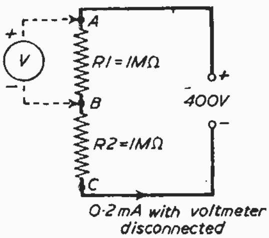
This, being still in series with R2 across the voltage source, incites a rise in circuit current from 0.2 milliampere to a little over 0.34 milliampere, whilst the voltage across R1 and the instrument resistance falls to something like 56 volts. And this is precisely what our voltmeter will register—quite a difference between this and the actual 200 volts!

From this reasoning it will be evident that if we increase the voltage setting on the range switch, say, turning it to the 500 volts position, we shall obtain a more accurate reading as then the terminal resistance of the instrument is that much larger. For this reason, when testing voltages in high-resistance circuits it is desirable to employ the highest range possible, consistent, of course, with useful scale indication.

If, on the other hand, we reduce the voltage setting, the terminal resistance of the instrument reduces accordingly, the circuit under test becomes even more heavily shunted, and as the result it is very unlikely that an increase in needle deflection will be achieved.

Engineers and experimenters who are in possession of commercial receiver service data will have noticed that circuit voltage figures are given with respect to a specific type instrument. This applies particularly to the valve electrode voltage figures. In cases where a specific instrument is not quoted, or if a meter sensitivity figure is not given, the voltage readings should be taken only indicatively. An experimenter using a 1,000 ohms per volt instrument, for example, will get an entirely different set of readings from an experimenter using a 20,000 ohms per volt instrument. For the same reason it is desirable also to know the actual voltage range to which the instrument was adjusted when the test readings were taken.

Where possible, then, one should always aim at acquiring a multi-range meter of high sensitivity. This applies more particularly to the television and radio



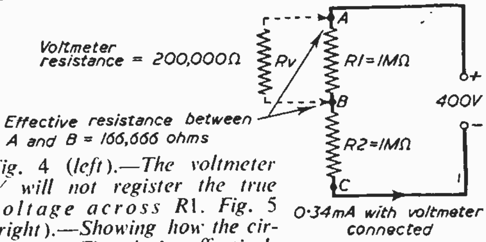


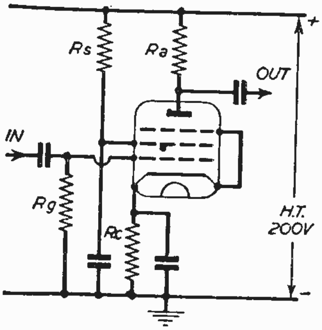
Fig. 4 (left).—The voltmeter V will not register the true voltage across R1. Fig. 5 (right).—Showing how the circuit at Fig. 4 is effectively altered by the voltmeter.

experimenter. For the electrical engineer an accurate instrument of mediocre sensitivity is all that will normally be required, for such an operator's work will generally be on low-resistance circuits where the shunting effect of the instrument will be negligible.

At this point it will be interesting to note that by using a 20,000 ohms per volt instrument, set on the 200 volts range, approximately 175 volts will be measured across R1 (Fig. 4). The accuracy would be even greater by using the instrument set on the 500 volts range.

Measuring Valve Electrode Voltages (4)

When we measure valve electrode voltages the above reasoning holds good in a large number of cases. Let us look at the circuit at Fig. 6. This shows a pentode valve connected as a typical voltage



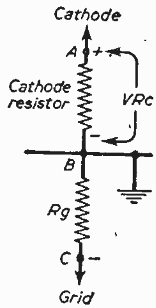


Fig. 6 (left).—A typical voltage amplifier circuit. Fig. 7 (right).—Since there is no current in Rg under normal conditions, both sides of Rg are negative with respect to cathode.

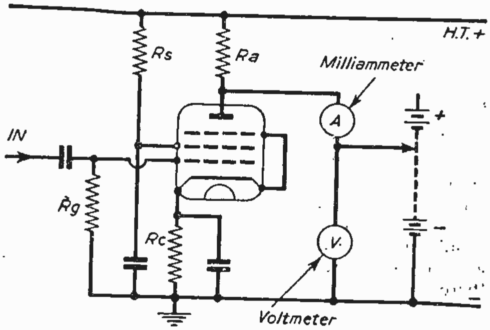


Fig. 8.—A method of accurately assessing the electrode voltage of a valve. The current in Ra is measured under normal conditions and then the electrode is energised from a low-resistance H.T. source, being measured by V. The voltage is adjusted so that A indicates the normal current in Ra.

amplifier. We shall observe that the stage embodies a cathode biasing arrangement, which means that the resistor Rc in the cathode circuit causes the cathode to rise to a positive potential relative to the control grid (grid 1) or earth, by reason of the voltage drop across it.

Clearly, then, if we connect a voltmeter across Rc we are effectively measuring the bias voltage of the valve. Moreover, an accurate voltage reading will be obtained at this point owing to the relatively high ratio between the resistance of the meter and the resistance of Rc.

It would be quite a different matter, however, if we were silly enough to make a voltage measurement between grid 1 and cathode. If we used a very sensitive instrument we should probably get a reasonable indication. But when we realise that we are obtaining such a reading by putting Rg in the meter circuit we should well expect a considerable error. Most of us know that the value of Rg might well range between 0.25 megohms and 10 megohms, and, even though the valve itself may not be taking grid current to provoke a voltage drop across Rg, the meter must pass current to take energy from the circuit to move the pointer.

This fact is brought out better in Fig. 7, which clearly shows both sides of Rg negative with respect to cathode—this is because there is no current in Rg under normal conditions. The voltage drop is VRc across the cathode resistor, so why measure this through Rg? It seems from our "Query Service" that a number of experimenters feel that unless an actual voltmeter connection is made to the control grid a measurement of G.B. voltage is not possible.

If we wish to measure the voltage on the screen of the valve, things become a little more involved. Let us assume that we are using an instrument having a sensitivity of 1,000 ohms per volt set on the 200 volts range, and that the value of the screen feed resistor Rs is 100,000 ohms. If, without the instrument connected, the screen current is 0.5 milliampere, application of Ohms law will reveal that Rs will drop 50 volts and that 150 volts will exist between the screen and earth.

The circuit is perfectly happy until we connect our voltmeter between the screen electrode and earth. In effect, this is the same as connecting a 200,000 ohms resistor between screen and earth. This resistor in conjunction with Rs thus forms a potential divider circuit from which the screen is fed.

The result is that the current in Rs increases, the screen voltage falls, and as a direct consequence the valve takes less screen current. This is indeed a complex state of affairs, and one that cannot be readily analysed, for the reduced screen current does not incite a rise in screen voltage equal to the voltage drop caused by the resistance of the instrument. If the two voltage deviations were equal and out-balancing, measurement of the screen voltage would be a relatively simple matter. Of if we could look at the screen cathode path of the valve as a pure resistance, a resistance connected in series with Rs could be substituted for the valve and analysis made as for the simple potential divider circuit shown in Fig. 4. Unfortunately this is not possible if great accuracy is required, since the voltage-current relationship of the valve does not follow Ohms law.

This reasoning applies equally, of course, to measurement of the anode potential, or any high-resistance valve electrode taking current. If it is essential to take a very accurate measurement the following procedure should be adopted.

First, take careful note of the electrode current, and then disconnect the electrode from the H.T. line. Next connect a H.T. battery or a low resistance H.T. source to the H.T. negative line of the set, and feed the valve electrode from this through a milliammeter.

(*To be continued*)

On Your Wavelength

BY THERMION

The International Short Wave League

SEVERAL of my readers, in view of my comments on clubs which claim national or international status, have written to me regarding the International Short Wave League which operates from 86, Barrenger Road, London, N.10. One of my readers says that there is an honorary secretary and honorary editors, but no mention of a treasurer. He also tells me that there is no indication of annual area elections nor do members receive a balance-sheet accounting for receipts and expenditure. In the journal issued by this League it has been stated that the league membership stands at several thousands. One reader says that his membership number is approaching 6,000. The annual subscription is 10s. a year, so there is a considerable sum received by the League in subscriptions alone. I should have thought that under such circumstances, with a comparatively large sum of money involved, there would have been an annual general meeting and balance-sheet distributed together with a list of members. After all, a man who joins an *international* organisation wants to know who his fellow members are. Personally, I have no knowledge of the League, nor have I had any complaints concerning it. I gather, however, that no one has received a balance-sheet, although when I wrote to the hon. secretary I was informed that they would be "pleased to show me all our books and records, which are in any case always open to inspection and scrutiny by members." I can only comment here that it is quite unreasonable to expect thousands of members to call at the headquarters of the League in London in order to inspect the books. The secretary does not state in his letter to me whether these books and records have been independently audited.

It is said by some readers that all they receive is a membership card and copies of a roneoed journal.

I understand, however, that no officer receives any emoluments, although it is not clear whether they receive expenses. My letter to them invited answers to the following questions: Is an annual general meeting held and are the officers elected annually? Is the secretary a permanent secretary who cannot be removed from office? As you claim to have some thousands of members at 10s. a year, this represents a considerable sum of money. Is a balance-sheet published to members showing how the money is expended? Is this balance-sheet independently audited? What benefits do the members receive? Is a list of members published as would, of course, be necessary in the event of a balance-sheet, so that members could assess revenue?

The reply was: "In view of your request for 'suitable' answers to a series of searching questions, and that the form of our answers is apparently intended to represent the other side of some 'story,' we should be pleased to show you all our books and records, which are in any case always open to inspection and scrutiny by members. Furthermore, we should be very pleased and proud to explain the whole set-up of the I.S.W.L. to you or your representative at your earliest convenience."

Accordingly, the secretary was invited to call at the office of this journal, but countered with a request for us to visit them. Surely a visit should be quite unnecessary, and it should have been easy for the secretary to have answered in writing the questions set forth above?

There is no suggestion, of course, that the club is not properly run, but in order to remove doubts in the minds of readers who have written to me I invite the League to reply to those questions so that I may publish them for the benefit of all concerned.

I belong to many clubs myself, and am always provided with a list of members, notice of annual general meetings and a balance-sheet, accounting for the club's revenue and expenditure. After all, members are entitled to know what the financial position of a particular club is, since they are jointly and severally responsible in law for the club's affairs; being unincorporated they are not a legal entity and members themselves become liable. The hon. secretary and treasurer are now invited to give answers to the questions enumerated above. I also invite correspondence on the subject from members of the League.

The Radio Amateur Invalid and Bedfast Club

I HAVE been in correspondence with the secretary and others concerned with the Radio Amateur Invalid and Bedfast Club. I do not like that term "bedfast," which is a slang term anyway. My concern is that this club appeals for donations for radio amateurs who are incapacitated and confined to bed. The club also appeals for wireless components and books, and I asked whether I could have further details such as the number of members, whether annual general meetings are held and the officers elected annually, whether a balance-sheet is produced, showing how the donations are being disbursed, together with a statement from the bank and details of all expenditure. If so, could I have a copy? I also wanted to know whether such a balance-sheet, if it exists, has been independently audited. I required to know when the club was founded, how many people have responded to the appeal for donations, and how much has been donated from the commencement. Failing this information, it was pointed out, notices of this club could not appear in this journal. Readers will remember the World Friendship Society of Radio Amateurs which I criticised very severely some time ago and which now seems to have gone out of existence.

Apparently the membership of R.A.I.B.C. at the end of November was 20 with seven local representatives, five of whom are licensed amateurs. Until I receive satisfactory replies to my questions notices, I understand, will not appear in this journal.

An Economical Quality Receiver

EIGHT STAGES IN FOUR VALVES : VARIABLE SELECTIVITY : NEGATIVE FEEDBACK

By W. N. Stevens

THE problem facing the writer was the construction of a broadcast band receiver which would give good quality and yet have simple circuitry. Primary consideration was good reproduction of the local stations, with a good selection of Continental stations. The trouble is of course, that, generally speaking, the higher the quality desired the more complex the circuitry becomes. Yet, for various reasons, components and cost had, in this case, to be kept to a minimum. Obviously, as in much radio work, the answer was a compromise. The arrangement finally chosen is shown in Fig. 1.

The Circuit

In the interests of gain, selectivity and general convenience, a superhet circuit was chosen. Ahead of the frequency changer an R.F. amplifier seemed to be desirable, for the usual reasons. On medium waves the stage gain of a tuned R.F. amplifier is considerable, but in the receiver being discussed gain was not the main aim of such a stage. Some extra gain at R.F. was desirable, but the object of the amplifier was primarily to obtain a better signal-to-noise ratio and to prevent cross-modulation distortion. In view of all this, it was decided to use an untuned amplifier, thus obviating the need for extra coils and an extra gang on the variable tuning capacitor.

Here it might be mentioned that one of the considerations involved in building the receiver was to use as many components as possible that were already on hand ; hence the unusual valve complement. The R.F. stage uses a 6AC7 high slope pentode, but this is not critical. Alternative types which come readily to mind include 6SG7, 6AG7, 6SK7 or, in the double-ended types, valves such as the 6K7. The R.F. stage is an orthodox untuned amplifier, except perhaps for the cathode bias arrangement, which will be described later. The grid resistor R1 is returned to the AGC line, with the object of preventing overloading on strong signals.

The output of the R.F. stage is capacitance coupled to the mixer stage through a variable capacitor C4, which is pre-set to the best value on completion. Since best results are obtained when the output is coupled to a high impedance, the capacitor is returned to the junction of the mixer grid, tuning capacitor and coil. In the original model the coil is the secondary winding (grid) of a standard medium-wave inductor with the primary winding left unconnected. If greater selectivity is required, normal transformer coupling can be used between the R.F. stage and the mixer. It will be seen from the circuit that AGC control is applied to the mixer stage.

Frequency Changer

This is a normal shunt-fed circuit, using standard coils. There are, however, a few points of interest.

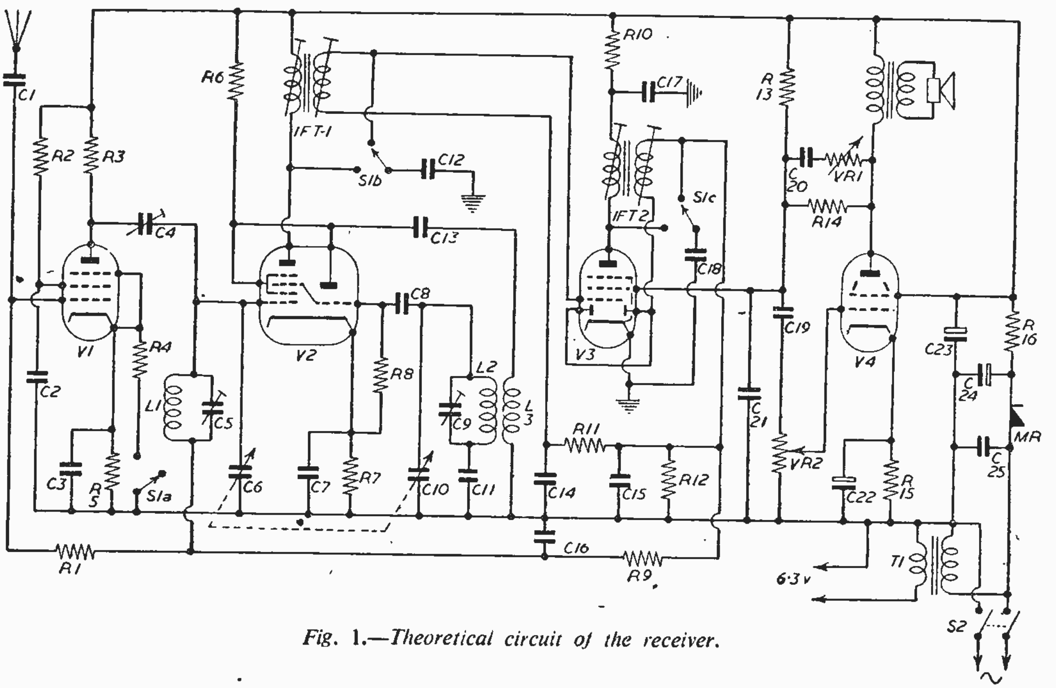


Fig. 1.—Theoretical circuit of the receiver.

Since the maximum conversion is obtained when the oscillator anode and mixer screen are at the same potential (in this case 100 volts for the 6K8), they are fed from a common point, R6 being the common dropping resistor. This arrangement simplifies wiring and does not have any deleterious effects through interaction.

The switching system in the mixer anode circuit is to enable a choice of two degrees of selectivity—Normal and Wideband. In position " 1," the 5 pF capacitor C12 is, in effect, shunted across the primary of IFT-1. The receiver is lined up in this position. By switching to position " 2," the capacitor is taken off the primary circuit and shunted across the secondary circuit, this changeover providing wide-band characteristics. Another pole on the rotary switch performs a similar operation in the anode circuit of the I.F. amplifier. At the same time, a third pole on the switch affects the gain of the R.F. amplifier. In position " 1" (Normal) the resistor R4 (220 ohms) is switched in circuit so that the amplifier is functioning at normal efficiency. But in position " 2 " (wide-band) the normal bias resistor R4 is switched out of circuit, leaving in its place a high-value resistor (R5), thereby reducing the gain considerably.

The switching system enables the receiver to be operated in the normal manner when tuning to distant stations, especially where the weaker signals require maximum gain and selectivity. When listening to local stations (and, possibly, the more powerful Continental stations) one may enjoy the benefits of a wide bandwidth in the I.F. circuits since there will be no side-band cutting and, at the same time, the reduction in R.F. gain reduces the possibility of interference from any nearby stations.

Reflex Amplifier

The third valve V3 (a 6B8 double-diode-pentode) performs four separate functions and thus enables considerable economies to be made. In the first place it accepts I.F. signals from the frequency changer and operates as a normal pentode I.F. amplifier. At the same time, the signals are rectified (demodulated) by the two diodes—which are strapped for convenience. The resultant audio voltages are picked off the diode load, fed back to the grid of the pentode and amplified at audio frequency. The A.F. output is taken off the screen - grid which is used as a triode " anode." Additionally, the audio voltages appearing across the load resistor are fed back to the grid circuits of V1 and V2, through the filter R9/C16, to provide AGC control. It should be noted that no AGC is applied to V3, because, in addition to being an I.F. amplifier, it also functions as an A.F. amplifier and must therefore operate at a fixed gain.

R11, C14 and C15 comprise the usual R.F. filter to prevent any residual R.F. from being fed into the

LIST OF COMPONENTS

Resistors :	Capacitors :
R1, 12. 470,000 Ω.	C1. 40 pF.
R2, 11, 13. 100,000 Ω.	C2, 3, 7, 16, 17, 19, 21. 0.01 μF.
R3, 8. 47,000 Ω.	C4, 5, 9. 70 pF, trimmer.
R4. 220 Ω.	C6, 10. 470 pF swing, twin-gang.
R5. 10,000 Ω (see text).	C8, 13. 100 pF.
R6. 27,000 Ω, 1 watt.	C11, 14, 15. 470 pF.
R7. 330 Ω.	C12, 18. 5 pF.
R9. 2.2 M Ω.	C20. 0.001 μF.
R10. 27,000 Ω.	C22. 25 μF, 25 v. wkg.
R14. 470,000 Ω (see text).	C23, 24. 8 + 16 μF, 350 v. wkg.
R15. 150 Ω (see text).	C25. 0.1 μF, 1,000 v. wkg.
R16. 1,000 Ω, 5 watt.	

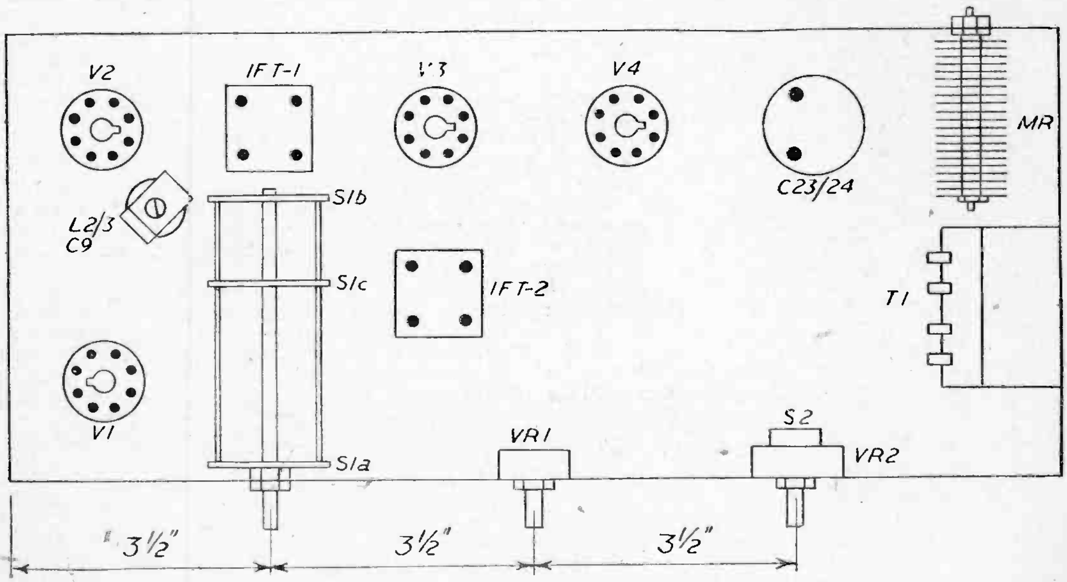


Fig. 2.—Layout and principal measurements.

audio stages and thus causing instability. The by-pass capacitors are smaller than usual so that they do not by-pass the audio voltages as well as the R.F. voltages. The reflex stage is provided with individual anode decoupling (R10, C17) as an aid to stability, although this may not be necessary in many cases (see later).

Output Stage

The final stage in the receiver is a conventional output amplifier. In the original model the valve is an EL33, simply because one happened to be available. The choice is wide and any of the usual types

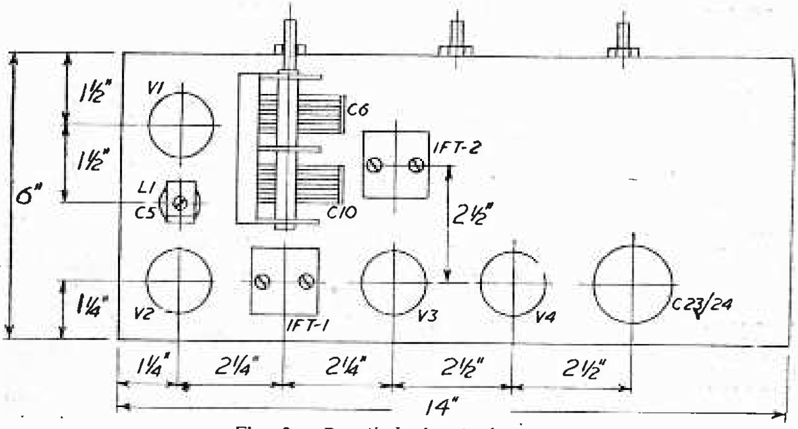


Fig. 3.—Detailed chassis layout.

may, of course, be used as convenient, although the value of the bias resistor (R15) should be noted. Of the more popular types we might mention the 6V6 (cathode resistor 240 ohms), 6F6 (410 ohms), KT63 (420 ohms), KT33C (190 ohms), etc., using a main H.T. rail of 250 volts.

In the interests of quality simple voltage feedback is provided, R14 being the negative feedback resistor. Shunted across this resistor is a tone-control system comprising C20 and VR1, the latter being the manual tone control. This simple top-cut control provides a considerable range of variation to suit most tastes and conditions. VR2 in the grid circuit is the usual manual gain control.

Power Supply

The total H.T. current consumption of the receiver is under 75 mA at 250 volts. The simplest and cheapest H.T. supply to provide this power, using components already to hand, consisted of a metal rectifier and simple smoothing filter of an 8+16 μF electrolytic and a 5-watt 2,000 ohms resistor in place of the conventional smoothing choke.

The L.T. requirements are 6.3 volts at 2 amps (or 1.5 amps if a 6V6 is used as the output valve). This is supplied by a suitable heater transformer across the mains supply.

Construction

The receiver was built into a spare cabinet which had been earmarked for such a purpose for some time previously. The chassis measured 13in. × 6in. × 2in., but it is possible to construct the receiver on a much smaller chassis, as a little "juggling" with the main components will show. Fig. 3 shows the main drilling dimensions and placing of above-chassis components.

There is little point in discussing at length the actual wiring-up of the receiver as even the beginner should have no difficulty providing that the mains parts are mounted as shown and care is taken in the usual directions. It is a good point to fit solder tags to each of the valveholder mounting bolts to provide quick earth returns. Most of the components can be mounted around their respective valveholders or from the tags of major components. In the original model it was not found necessary to fit any tag strips at all.

Earth returns for each stage should be taken to a common point to prevent earthing at different R.F. points and thus inviting instability. Particular care should be taken in wiring up the V3 circuit, but provided leads are kept reasonably short and direct there should be no troubles arising from the rather complicated action of this stage.

The matter of screened leads is best tackled in the following manner: Wire up the receiver without any screened leads at all, except the two from (a) the aerial terminal to the V1 signal grid and (b) gain control VR2. Then, should any of the usual troubles be experienced, vital leads can be replaced by leads in screened cable until the trouble is cured. The most vulnerable leads are those from the secondary of IFT-1 to the grid of V3, from the secondary of IFT-2 and any leads which pass through the chassis from L1, C6 or C10.

In the original receiver only the two leads mentioned above required screening. The use of screened cable should, of course, be avoided where possible to avoid undue losses.

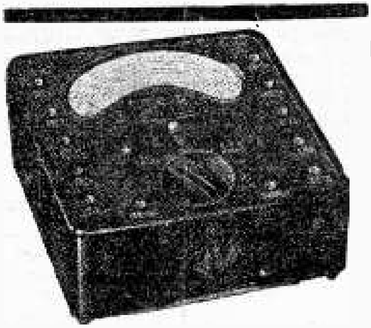
Final Adjustments

The first job on completion is, of course, to line up the I.F. transformers in the usual way. This should be done with S1 in position "1" (normal). Then the R.F. circuits may be aligned. In addition, there may be a few other adjustments required to ensure good results.

For instance, the coupling capacitor C4 should be adjusted so that adequate coupling takes place with the lowest possible capacitance. If the coupling is too tight the tuned circuit in the mixer grid will be damped and selectivity will suffer to some extent. C4 should be slackened off so that sufficient gain is obtained consistent with selectivity. When making this adjustment, remember that one side of the capacitor is at high potential.

Also, the resistor R5 may need attention. In the London area, in which the original receiver is used, anything up to 10,000 ohms will be suitable. In some areas, however, it may be necessary to reduce this value to obtain adequate gain; shunting temporary resistors across R5 in situ will soon determine how

(*Concluded on page* 110)



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0—250 ,,	0—500 ,,
0—500 ,,	

D.C. Current	Resistance
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0—5 ,,	0—100,000 ,,
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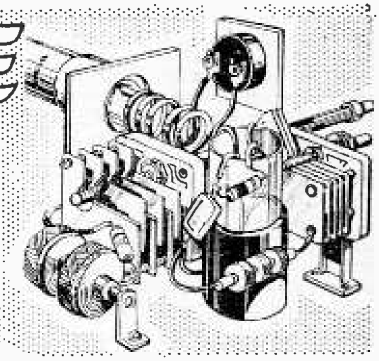
SHORT-WAVE SECTION



BUILDING COMMUNICATIONS RECEIVERS

3.—DOUBLE SUPERHETS AND TUNING INDICATORS

(*Continued from page 23 January issue*)

Double Superhets

SOME ex-service and other communications-type receivers employ two frequency changers and two sets of I.F. amplifier stages. Such a circuit might employ conventional R.F. and F.C. stages, followed by I.F. stages such as shown last month. The output from this section of the receiver would not, however, be taken to the detector stage, but to the second F.C. stage, a typical circuit for which is shown in Fig. 2. This stage changes the frequency to a different one from that already employed and further I.F. amplifier stages, all operating on this new frequency, then follow.

A number of advantages arise from such a method of operation, which increases selectivity and sensitivity greatly. With a large number of I.F. stages operating on one frequency, instability may easily arise, and this is avoided by a number of the stages operating upon one frequency, and the remainder upon a different frequency, as with the double superhet. The rejection of adjacent-channel interference is also increased.

The circuit in Fig. 2 is typical, and A.V.C. could be applied. The tuning of the oscillator coil is not variable, as with the first F.C. stage, but pre-set by means of C2. C1 is the usual coupling condenser. The selection of suitable I.F. transformers and oscillator coil is not difficult, and many standard and ex-service transformers can be used, while an ordinary " unit " coil, possibly dust cored, can be used for the oscillator circuit. If 465 kc/s transformers are used in the initial I.F. stages, 110 kc/s transformers may be used in the stages following the second F.C. stage. If, however, ex-service transformers of rather higher frequency are employed in the initial stages, then 465 kc/s transformers can be used in the later stages. Alternatively, numbers of small long-wave ex-service coils exist which may readily be used in the later stages, 465 kc/s transformers being used in the first section of the I.F. amplifier so that standard signal-frequency and oscillator coils can be used in the R.F. and first F.C. stages.

The frequency of the oscillator coil may readily be determined by adding together the first I.F. and second I.F. transformer frequencies. With 465 and 110 kc/s components, this would be 575 kc/s, which is approximately 520 metres. A coil tunable to this wavelength would be obtainable without difficulty. Fairly high initial intermediate frequencies are more usual, though not essential, and may be of about 1 to 7 Mc/s.

Typical Valve Sequences

The use of the maximum number of stages is by no means the most desirable feature, but the provision of adequate selectivity and sensitivity, with low

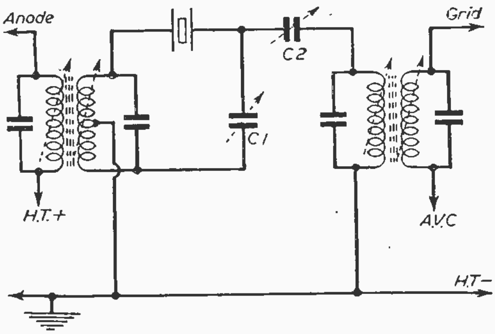


Fig. 1.—A crystal I.F. circuit.

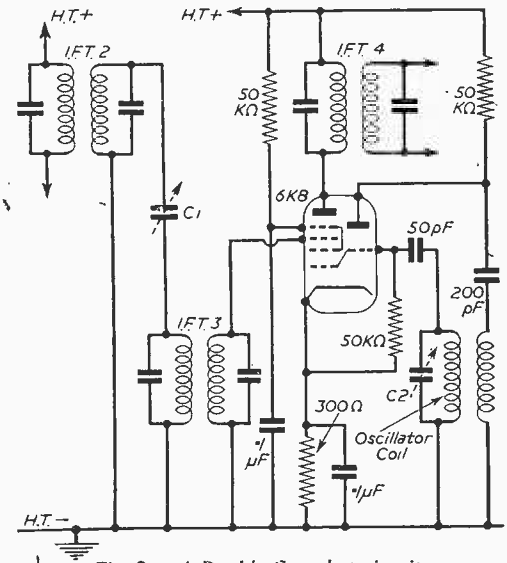


Fig. 2.—A Double Superhet circuit.

noise ratio. A study of commercial communications receivers will show that three I.F. stages are seldom exceeded, even in very expensive equipment. More than one tuned R.F. stage may be found, but is not very usual, and is best avoided in home-built equipment. Some double-superhet receivers employ no I.F. stage at the initial frequency, the first F.C. stage, with transformer or transformers, being followed immediately by the second F.C. stage, which may feed a single I.F. stage to be followed by the detector. Where two or more I.F. stages are used, the double-superhet is not very often employed, except when extremely high standards of selectivity and sensitivity are required.

It will therefore be seen that the construction of such equipment is not necessarily one of great cost, and about six to ten valves, in all, will be found a convenient number to employ. (Usually, of course, no great difficulty should arise in adding further stages later, if wanted.)

Where simplicity is important, the FC/2-I.F./DDT/Output type of circuit can give exceedingly good results, further improved by the addition of an R.F. stage. If both R.F. stages and a further I.F. stage be used, a standard of performance adequate for most purposes can be obtained. Usually, a very high audio output is not required, and a single stage, delivering 3 to 5 watts, is ample. Quality of reproduction need be by no means poor, and negative feedback, combined with "flat" tuning may be used for local-station listening, resulting in a circuit with the widest possible usefulness.

modification which increases signal strength at the receiver (such as improvements at the transmitter, or an improved aerial, etc., at the receiver) will be shown at once by an increased reading.

A tuning meter is primarily concerned with showing the point of exact tuning for any station, and may consist of a Magic Eye or moving-coil meter. For this type of indicator, the Magic Eye has the advantage of low cost, small panel size, and robustness. The meter is, however, better when comparisons of signal strength are required, and is almost essential for the signal strength type of circuit.

Meter Tuning Circuit

A simple and effective method of using a meter for tuning indication is shown in Fig. 3. The meter may be connected in the anode circuit of the frequency-changer, mixer, or I.F. valve, provided the valve chosen is under the control of the A.V.C. system. It is also feasible to group together the anode circuits of two or more valves, so that the meter reads the combined anode current.

In operation, the anode current depends upon the A.V.C. voltage, which, in turn, depends upon signal strength. Anode current is at maximum with zero signal, and at minimum with maximum signal. Resonance is thus the lowest obtainable meter reading, while the greater the signal strength of the transmitter, the lower will the reading be. Such a meter thus provides comparison of signal strengths, and accurate tuning.

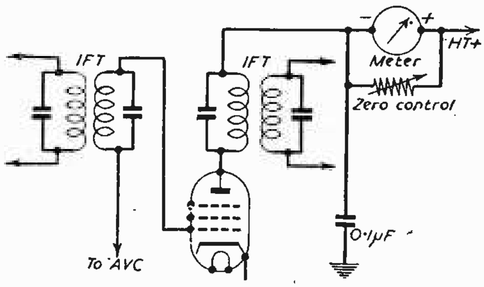


Fig. 3.—Tuning meter in I.F. anode circuit.

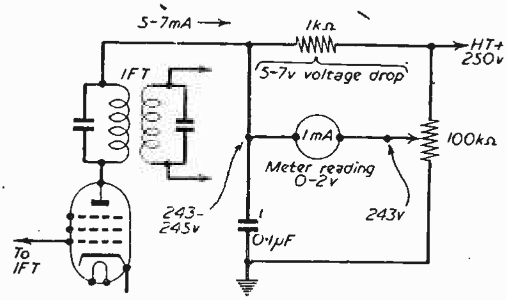


Fig. 4.—A typical signal strength meter.

Tuning and Signal Strength Meters

Many of the simpler communications type receiver have no signal strength or tuning meter. With other receivers, such a meter is built in, or can be purchased as a plug-in, separate unit, usually in a small desk-type housing, with flexible lead. A tuning meter may be added to any superhet, and will then indicate the correct tuning point for any R.T. signal, or show the relative strength of the carrier wave of such a transmitter. It is not suitable for I.C.W. Morse transmissions, since in the intervals between letters, or the symbols of a letter, there is no carrier wave to deflect the meter. The meter thus endeavours to follow the keying. When employed for its usual purpose, no such difficulty arises, and a steady indication is obtained, irrespective of speech, music, or other carrier-wave content. A signal strength device is much more sensitive to small changes than the human ear, and also provides a definite reading which may be noted from day to day, or compared with readings made from other transmissions. Any

The anode current change of an average I.F. valve type will be about 2 to 3 mA. In order that a zero signal strength indication may be obtained on the meter scale, the meter should be of a type having a full-scale deflection *under* the normal anode current rating of the valve or valves to which it is connected. The "Zero" control shown consists of a wire-wound variable shunt. In use, the receiver is tuned to a point where no signal is obtained, and the control adjusted until the meter indicates full-scale. The control is then left untouched. When a station is tuned in, the pointer will fall back to an extent depending upon the signal strength of the station. A 1 mA. or 2 mA. meter, suitably shunted, is satisfactory. The .1 μF condenser is for decoupling. Such a meter may be added to any commercial or amateur-built superhet.

The "S" Meter

The "S" or "R" (Signal strength or Readibility) meter employed in communications equipment usually has a circuit such as that shown in Fig. 4. Though frequently fitted in the F.C. or mixer anode circuit, any A.V.C. operated valve may be employed. Operation is rather different from that of the circuit in Fig. 6.

Assuming, as example, that the anode current of the valve is 5 mA. at maximum signal, and 7 mA. at minimum signal, the voltage drop in the 1 K. resistor will be 5 v. for maximum signal, and 7 v. for minimum signal. The voltage at one meter terminal would thus be approximately 243 for minimum signal, and 245 v. for maximum signal. If the meter is able to read from 0 to 2 v., and has its second-terminal maintained at 243 v. by the potential divider, it will read zero for minimum signal, the reading rising to full-scale for maximum signal. With this circuit, the receiver is thus tuned for maximum deflection. The circuit may initially be set up in such a way that zero and maximum meter readings are obtained with certain minimum and maximum signal strength levels. In practice, zero reading will be obtained with zero signal.

Initially, the 100 K. potentiometer requires to be set with the slider towards the H.T. positive end of the circuit, or a heavy current may flow as the rectifier warms up. This should be watched. When the receiver has reached a stable operating temperature, the control may be adjusted. If the meter moves the wrong way on tuning in a signal, connections to it require to be reversed. To avoid possible damage due to turning the potentiometer slider too far towards the negative side of the circuit, the potential-divider may be made up from one fixed and one variable resistor or potentiometer.

A second circuit giving similar results is shown in Fig. 5, the potential-divider circuit being fixed, and the 1 K. resistor variable. The operation of this circuit is basically the same as that in Fig. 4. The 2 KΩ resistor and .1 μF condenser are included for decoupling.

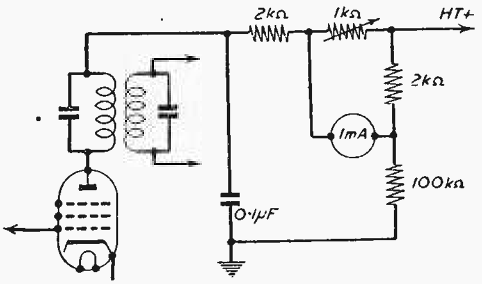


Fig. 5.—An alternative method of connecting the meter of Fig. 4.

Magic Eye Circuits

The magic eye is usually operated directly from the A.V.C. circuit, the A.V.C. voltage controlling the anode current of the triode section of the eye. Many ex-Service magic eye or tuning indicator valves are cheaply obtainable, and will generally be satisfactory. It should be noted that a small number of such eyes have no triode section, and a separate valve would be required, here, if such an eye were used. In addition, the triode section control grid voltage required for zero shadow angle (or sensitivity of the eye) varies from type to type. This value may be modified within limits by changing the load resistor value. Reduced target and anode voltages reduce the A.V.C. voltage required for zero shadow angle. The control voltage ranges from about 8 to 22 volts for an eye such as the 6U5, down to 3.3 to 8 volts for types such as the 1629.

Fig. 6A shows the usual circuit. The 100 K. resistor and .05μF condenser may be omitted where no instability arises. Used in this way, the eye will show accurate tuning positions for any transmitter powerful enough to operate the A.V.C. system, and also give some indication of signal strength.

An improved circuit is shown in Fig. 6B, and enables the voltage applied to the control grid of the eye to be adjusted. Generally, the .5 megohm control may replace the A.V.C. circuit fixed resistor found in this position. With this circuit, a sensitive eye may be adjusted until its range corresponds to zero and maximum signal strengths. A further method is to employ a certain shadow angle as reference, and have the .5 megohm control panel operated, with a scale. When the signal strength of a station is to be read, the control is then adjusted until the exact shadow angle is obtained. The control pointer will then indicate the relative signal strength, against its scale. With the control left in a middle position, the eye can be used for tuning only in the usual way.

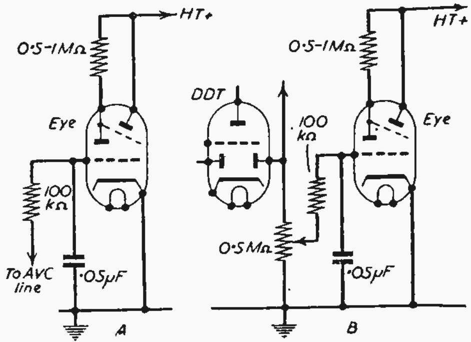


Fig 6—Magic eye tuning indicator circuit

Where manual R.F. or I.F. gain controls are fitted, the influence of these must not be overlooked. For example, the meter reading would fall back if gain were reduced in any preceding stage, or in a following stage which comes within the A.V.C. network. This difficulty may be overcome by employing a switch to cut out any R.F. or I.F. cathode or screen-grid gain control, gain being at maximum when the switch is closed. Volume can, if required, be kept down by the A.F. volume control, this having no effect on the meter reading.

Such a precaution is only necessary when making definite readings of signal strength. The meter or eye will, of course, continue to function as a tuning meter, irrespective of the setting of a manual control in another stage. Such a manual control should not, however, be used in the stage where the meter is employed.

In addition, it should be assured that the beat-frequency oscillator (if present) is not operating, as in some circuits this will change the signal reaching the second detector in such a way that the A.V.C. voltage is modified.

Diode-transistor Loudspeaker Receiver

A VALVELESS MIDGET OF INTERESTING DESIGN

By Capt. Graham

TESTS showed that one transistor is practically useless for broadcast reception. More than one calls for bias resistors, transformers, etc., imposing pre-set loads, and limiting the output of the final transistor to an output which is much less than it could give if it were unhampered. Diodes work on very high frequencies, and so it occurred to me to use a diode to feed a transistor. The result was that the transistor gave out a remarkably higher output. Further tests showed that a pre-set bias is not necessary for broadcast reception. A very simple circuit was therefore evolved with only one diode and one transistor, which works to its full capacity in a most efficient manner, gives an output sufficient to work a loudspeaker, and has very good fidelity. In fact, it is so good that for the past nine months it was used in preference to four other expensive receivers. Also, recordings on a new Ferrograph 2B are superior to recordings from a commercial Hi-Fi valve tuner

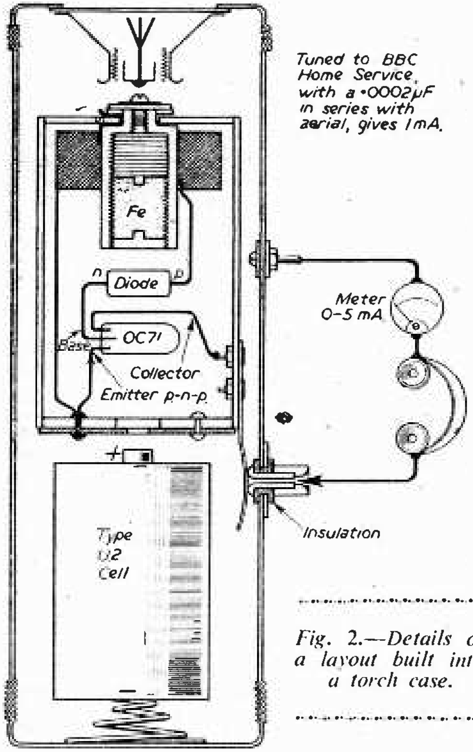


Fig. 2.—Details of a layout built into a torch case.

diode. There is no background noise and negligible crackling during a storm and high-voltage low-current discharges. A first-class horizontal aerial and earth is necessary. High-" Q " coils and wiring with short leads avoid capacity losses. Care should be taken not to overload the transistor by powerful local stations. In all other respects there are no snags except that the transistor must be correctly and carefully soldered ; any false connection will destroy it. If not overloaded it should last a lifetime, at negligible cost.

The Circuit (Fig. 1)

The Brimar GD3 germanium diode is connected with the red end to the coil centre tap, to rectify and supply a modulating negative potential to the transistor. The other end of GD3 is connected to the base of a Mullard OC71 germanium junction transistor of the p-n-p type.

When the aerial is disconnected, the transistor base is at the same D.C. potential as the grounded emitter ; the meter reads zero, and then the transistor does not allow any current from the battery to flow through it. But when the aerial is connected and the coils are tuned to a station, the meter shows a reading, and now the transistor does allow the battery current to flow through it to work the loudspeaker.

Consider what happens during half of a cycle of a radio-carrier frequency. When the grounded end of the coil is positive and the centre tap is at a negative potential, the coil is supplying current derived from the aerial. Electrons tend to flow from negative to positive just as in the valve theory we all know. The rectifier diode GD3, being connected as it is, accepts the electrons from the negative centre tap. Electrons pass through it to the base of the transistor and because it is p-n-p type the base likewise accepts. Electrons flow through the transistor to the grounded emitter, which is at the same positive potential as the grounded end of the coil attracting these electrons. This completes one circuit and current has passed through the transistor.

If instead of the 3-volt battery a micro-amp meter is connected, it shows a reading. This proves that some of the electrons from the coil flow from base to collector, through the transformer, the 5 mA meter, the μA meter to the earthed end of the coil, completing another circuit, and some of the aerial current may flow through the transistor in this circuit, since both the emitter and the collector are at the same potential as the grounded end of the coil in so far as these electrons are concerned.

From the foregoing it becomes evident that a very pronounced change takes place in a transistor when a current flows through it: Without a current and with base at same potential as the emitter, it does not pass battery current, but with a negative potential at base and current flowing through, a secondary effect takes place, it does pass a very considerable current. Furthermore, this greater current is controlled by the transistor to pass through in very definite proportions, depending upon the amount of aerial current flowing at any instant or depending upon D.C. potential at the base and a steady current flowing, and so curves can be plotted. Negative pulses produced by the diode are enormously amplified and are passed through the transformer. Since these half-cycle pulses are modulated by music, etc., sounds are reproduced in the speaker.

Battery Effect

There are two good reasons why a very much greater current passes from the battery. Firstly, the three-volt battery has a higher voltage than the small fractions of a volt at the base, and it can give a current far in excess of requirements, whereas the diode can only supply the few microamps available from the aerial. And secondly, because the junction transistor can pass an excessive current which will destroy it, even with a small voltage. It is constructed with fair contact surfaces and thin junctions having little resistance and high efficiency when working as stated.

If the battery connections were to be reversed with the negative terminal connected to earth, the transistor would allow such a high current to pass through it from the battery that it would be destroyed and the milliamp meter would also be damaged. Hence the warning: be very careful to connect the transistor and the battery correctly. Test with a high-resistance voltmeter having one milliamp full-scale deflection in place of the mA meter. If the transistor or battery is wrongly connected, the voltmeter will show almost the full battery voltage, but if correctly connected it will show a very small reading near zero. Do *not* use an ohmmeter to test a transistor; some such meters will pass a damaging current. Use a voltmeter in series with a battery, then you know that the maximum current will be less than full-scale deflection current, and the meter reading will show what proportion of the current is passing through. Half of full-scale deflection represents ½ milliamp, etc.

During the positive half-cycle the diode naturally rejects and current does not pass through with wrong polarity to interfere with the proper working of the transistor which now has a period time of half a cycle to completely dispose of the negative pulse it received. The .002 μF condenser is to by-pass any stray R.F. from interfering, and it retains some of the negative potential and acts as a bias device. The meter reads a shade higher when this condenser is connected from base to ground. If the diode is shorted or removed, and the base connected to a tapped coil, the reception is not much better than with the diode alone; apparently some sort of a mixture of various conditions takes place in the transistor which as yet cannot adequately deal with R.F. all on its own; still thinner ones or composite ones may be evolved in time even for R.F. amplification, and short aerials.

This receiver works like a D.C. valve amplifier. If the coil is disconnected and a small D.C. negative potential is applied to the diode (p) or the transistor base, the meter shows a mA reading in definite proportion and curves can be plotted as for a valve. These curves show a remarkably high slope which works out to over 60 mA/v. There is no receiver valve which can give such high efficiency, mostly not a tenth of it.

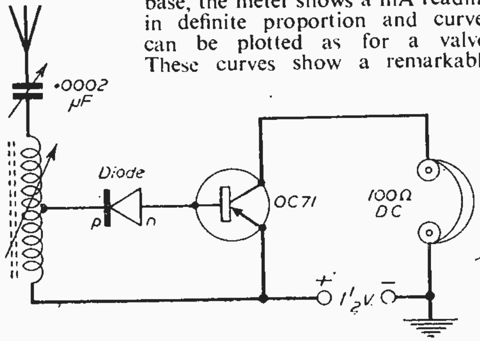


Fig. 3.—A basic arrangement.

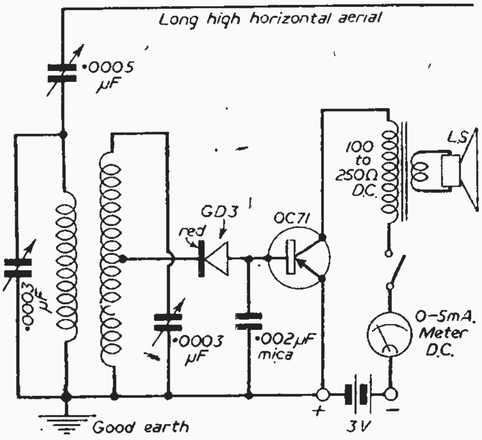


Fig. 1.—The final circuit.

Coils

Home-made coils can be made quite easily with good efficiency by making radial slots in a round disc of insulating material; 28 or 30 s.w.g. insulated wire is wound starting with 2in. inner diameter and zig-zagging from one side of one slot to the other side of another; single layers are wound one on top of the other forming an interlaced spider's web spiral on each side, with an air space between each section for which an odd number of 7 or 9 slots are needed. Aerial coil number of turns will depend upon the size of aerial, 60 to 70, may be more, and 100 for the diode coil. Such pancake coils are very convenient for soldering a tap to any desired turn. Plug-in coils can be made by removing the glass bulb of old 4 or 5 pin valves and slotting the base with a saw cut into which the disc is attached and glued. Separate coils about 3in. apart and tune to the Third programme. If the condensers are nearly fully meshed, all is well for the medium band, if only half or three-quarter meshed, remove a few turns and try again. Now tune in any station accurately for highest meter reading not exceeding 3 mA and 3 volt battery. Reduce series aerial capacitance if meter reads too high and retune accurately. Now bring the coils slowly closer together; the meter will rise and then begin to drop. Note the distance between coils; best magnetic coupling is when meter begins to drop as coils are being separated. Use "open" wiring to start with, then fit receiver into any small battery receiver cabinet.

Output Transformer

The output transformer for the speaker should be a good one with low resistance primary not exceeding 250 ohms D.C. That means a large one to accommodate the many turns of thicker gauge wire needed for efficiency. Too high a resistance or a mis-match will cause the meter to dip badly to lower readings on loud passages of music broadcast. The meter should give a reasonably steady reading for good fidelity. If meter dips appreciably, reduce volume by reducing aerial condenser capacitance and retune. Best results are at 1 to 2 milliamps and 3 volts, with present-day transistors. If meter tends to show a higher reading, reduce battery voltage. Do not overload the transistor, it can be burned out in Bedford by tuning in either the Third or Home stations. The aerial series condenser is, therefore, necessary for attenuating, but since it increases selectivity it is all to the good and it acts as a volume control. At 3 mA the meter begins to dip, loud passages become slightly distorted and the transistor is beginning to be overloaded so reduce the signal. The .0005 series condenser is never full in at Bedford for BBC stations, only for foreign stations which can be heard on the speaker or using low-resistance phone in place of transformer. The war surplus balanced armature or moving-coil phones of about 100 ohms are best for this. Clear signals can be heard with meter reading only .02 mA when the speaker begins to sound.

Diodes vary, transistors more so. The meter is very useful for testing. It should give no reading with aerial disconnected if the transistor is a good one. Some show a leakage, of .02 mA or more. The meter is a very accurate tuning indicator. It can be used to find the best tap for the diode, the best tap for any aerial to improved reception selectivity. For best coil coupling and for plotting curves.

A relay could be used instead of the transformer to switch on an alarm bell when BBC begin to broadcast in the morning. The receiver can be used for plotting field strength of a transmitter aerial and directional properties. It automatically switches off battery current when the BBC stops broadcasting; the meter drops to zero. A small receiver was built into a tube of insulating material the same size as a U2 battery with a metal pip at the top to make contact with an aerial instead of a bulb, and a metal disc at the bottom to contact with an ordinary U2 battery pip supplying positive potential, and its negative to the pocket battery case to which a small bolt was fixed for earth and one end of phone leads. The other lead from phones connects to another bolt on the metal battery case but insulated very carefully from the case. This bolt makes contact with a small bronze spring at the side of the U2 receiver and thus to the collector. The emitter is connected to the metal plate at the bottom of U2 receiver. One end of a single coil is likewise connected, to the plate, the other end to the pip at the top and centre tap to diode (p) other end of diode to base of transistor. The small coil was pre-tuned by a dust core to suit the small aerial and the Home station. The aerial was naturally long enough to give loudspeaker results but not long enough to overload. (Figs. 2 and 3).

News from the Clubs

NEWARK AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: R. Clayton, 160, Wolsey Road, Newark.

MEETINGS are held on the first Sunday evening of each month in the Northern Hotel, at 7 p.m., together with a mid-monthly meeting in Northgate House, the date of the latter being announced at the preceding Sunday meeting.

New members and visitors are always welcomed.

READING RADIO SOCIETY
Hon. Sec.: L. A. Hensford (G2BHS), 30, Boston Avenue, Reading, Berks.

MEETINGS of the above Society will take place at the Abbey Gateway at 7 p.m. on January 8th and 29th, 1955. On February 12th Mr. E. W. Berth-Jones, B.Sc., of the Record Engineering Dept. of E.M.I., will give a lecture and demonstration.

CLIFTON AMATEUR RADIO SOCIETY
Hon. Sec.: C. H. Bullivant (G3DIC), 25, St. Fillans Road, Catford, S.E.6.

THE main event during November was the visit to the clubrooms on November 19th of Mr. W. H. Andrews (G2YG). Mr. Andrews gave an account of the Metropolitan Police radio system and demonstrated the mobile equipment used.

The programme for January is as follows: 21st, Discussion; 14th and 28th, Constructional Evenings.

Meetings are held every Friday evening at 7.30 p.m. at the clubrooms, 225, New Cross Road, S.E.14.

WIRRAL AMATEUR RADIO SOCIETY
Hon. Sec.: A. C. Wattleworth, 17, Iris Avenue, Claughton, Birkenhead.

MEETINGS are held on the first and third Wednesday in the month at the Y.M.C.A., Whetstone Lane, Birkenhead. The meetings commence at 7.45 p.m.

Visitors, particularly short-wave listeners and novices, will be most welcome.

TORBAY AMATEUR RADIO SOCIETY
Hon. Sec.: L. H. Webber (G3GDW), 43, Lime Tree Walk, Newton Abbot.

IT has been decided to hold a Social Evening and Dinner at 7.30 p.m., on Saturday, February 5th, 1955, at the Oswalds Hotel, Babbacombe, Torquay, for members and their ladies.

Reservations may be made through Donald Cawley (G2GM), 1, Littlegate Road, Paignton, Devon, at 8s. 6d. each.

WARRINGTON AND DISTRICT RADIO SOCIETY (G3CKR)
Hon. Sec.: G. H. Flood, 32, Capesthorne Road, Orford, Warrington, Lancs.

RECENT events have included a demonstration of radio control for models by W. Sanson and his home constructed power launch.

The results of the society's inter-club top band contest are: Tx 1st, G3CSG N. Kendrick, of Wirral; 2nd, G3ELL I. Griffiths, of Liverpool; 3rd, G3ITY E. Yates, of Chester. Rx, 1st., N. Richardson, of Chester; 2nd, A. H. D. Looney, of Liverpool; 3rd, G. H. Flood, of Warrington.

Meetings are now held on the first and third Thursdays in each month, at the King's Head Hotel, Winwick Street.

BRADFORD AMATEUR RADIO SOCIETY
Hon. Sec.: F. J. Davies, 39, Pullan Avenue, Bradford, 2.

ON January 11th Mr. G. F. Craven will give a lecture entitled "Oscilloscopes—Design and Construction." The meetings will commence at 7.30 p.m. at Cambridge House.

ROMFORD AND DISTRICT AMATEUR RADIO SOCIETY (G4KF-P)
Hon. Sec.: N. Miller, 18, Mascells Gardens, Brentwood, Essex.

THE weekly meetings are held on Tuesdays at 8.15 p.m. at R.A.F.A. House, 18, Carlton Road, Romford, Essex.

BRIGHTON AND DISTRICT RADIO CLUB (G3EVE)
Hon. Sec.: T. J. Huggett, 15, Waverley Crescent, Brighton, Sussex.

THE club meets every Tuesday at the Eagle Inn, Gloucester Road, Brighton. Meetings commence at 7.30 p.m. The club transmitter is on the air on 80 metres and top band, using both 'phone and c.w.

WELLINGBOROUGH AND DISTRICT RADIO AND TELEVISION SOCIETY
Hon. Sec.: J. Graves, 1, Millers Close, Finedon, Wellingborough, Northants.

THE above club meets each Thursday at 7.30 p.m. at their headquarters in Silver Street, Wellingborough (above Co-op. fruit shop).

Lectures are being arranged by the newly formed committee; a club transmitter is being built and morse classes have commenced. It is hoped to arrange visits to places of interest and exchange visits to other clubs in the area.

New members will be welcomed at the club-room any Thursday and details of membership can be obtained from the secretary.

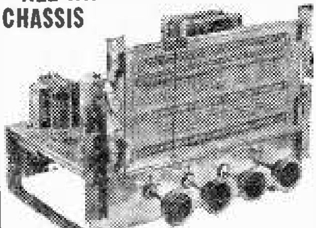
NORTHAMPTON SHORT WAVE RADIO CLUB (G3GWB)
Hon. Sec.: A. J. Kightley, 23, Garrick Road, Northampton.

THE club will be organising some "Listening Competitions" on the amateur bands during the winter months.

SOUTHEND AND DISTRICT RADIO SOCIETY (G5QK)
Hon. Sec.: J. H. Barrance, M.B.E. (G3BUJ), 49, Swanage Road, Southend-on-Sea, Essex.

MR. H. R. SPINKS, a radio engineer who has been working his amateur station in the Far East for several years, answered questions fired at him by members at their recent meeting in the Ekco Canteen.

THREE COMPLETELY ASSEMBLED "ALL-WAVE" SUPERHET CHASSIS



The three receivers are for operation on A.C. mains, and employ the very latest miniature valves. They are designed to the most modern specification, great attention having been given to the quality of reproduction which gives excellent clarity of speech and music on both gram. and radio, making them the ideal replacement chassis for that "old Radiogram," etc.

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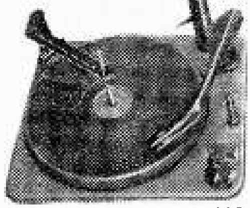

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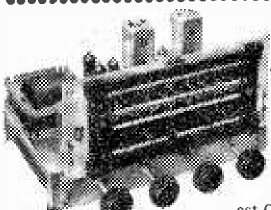

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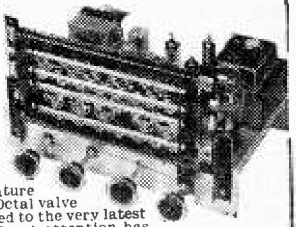

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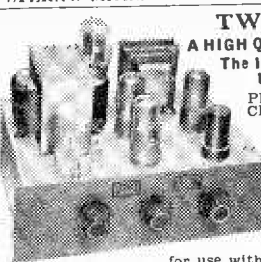

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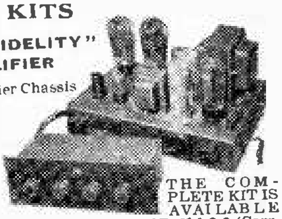

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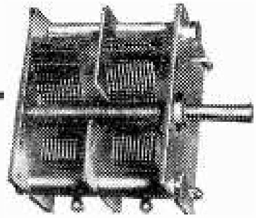

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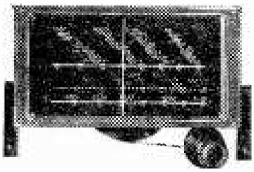

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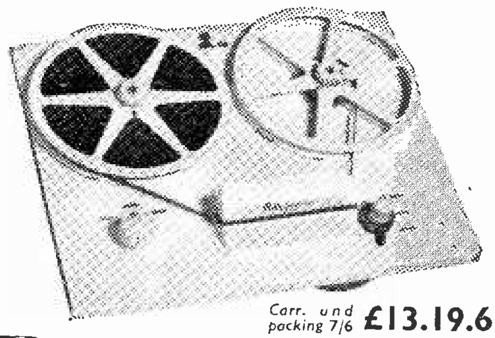

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The Beginner's Guide to Radio

The Twenty-second Article of a Series Explaining the Fundamentals of Radio Transmission and Reception. This Month Rectifiers are Dealt With

By F. J. CAMM

IT must be remembered that Ohm's law for alternating current, or rather the formula relating to it, differs from that relating to direct current. We have seen that in an alternating current circuit, Ohm's law expresses a relation between the E.M.F., of the circuit, the current flowing and the circuit impedance (E, I, and Z respectively) from which E equals IZ. This brings us to the question of what is known as the R.M.S. value, or the root mean square value of alternating current or voltage. It is the square root of the mean value of the squares of the instantaneous values taken over a complete cycle, and when an alternating current or voltage is specified, it is almost invariably the root mean square value that is used. It is sometimes referred as *the effective value*. In brief, this means that 230 volts A.C. is not the same thing as 230 volts D.C.

Rectifiers

It is important to remember in mains transformers that after transforming the voltage it is still alternating current and must therefore be converted into D.C. This is achieved by either *half-wave or full-wave rectification*, and this achieved by a particular type of rectifier.

Even after rectification, the current is still too "rough" as it is a pulsating D.C. supply, and smoothing must be introduced.

Rectifiers are of two types, the valve rectifier and the metal rectifier, although there are other types, such as chemical rectifiers, the Tungar rectifier, the vibrating reed rectifier, as used in car radio, the rotary convertor, the mercury vapour rectifier and the copper-oxide rectifier. For radio purposes, a selenium metal rectifier is mostly used today.

Valve and metal rectifiers are available in half-wave or full-wave types ; the symbols for these are illustrated in Fig. 96.

Now a rectifier suppresses the flow of current in one direction and it therefore follows that a half-wave rectifier gives pulses at half frequency, and a full-wave rectifier at double frequency. Neither, however, actually delivers direct current but a pulsating current of fixed polarity. Rectifiers are used for rectification of the H.F. signal, or to put it another way, for high-frequency rectification as well as for providing power supplies for high-tension purposes.

Signal rectifiers, whether of the valve or metal type are much smaller than those required for power supplies since the requirements are smaller. Typical signal rectifiers are the Westector and germanium diodes. It is important to note that half-wave rectifiers for power supplies are only used where the current supplies are very small. If a current greater than that of an individual valve, whether employed for full-wave or half-wave rectification is called for, then two or more valves may be connected in parallel.

Metal rectifiers are also used in voltage doubler or bridge circuits, as shown in Figs. 97 and 98. The *voltage doubler* as shown in Fig. 97 uses a metal rectifier, and it is connected together with fixed condensers to provide a bridge circuit, resulting in a step-up in voltage. The condensers used in the voltage doubler circuit are of critical value, and the makers' recommendations must be adhered to.

In the circuit shown, the bare rectifier circuits are illustrated ; the A.C. input may consist of a mains supply or, as is more usual, a mains transformer. The D.C. output will, of course, be fed into a suitable smoothing circuit to be dealt with later.

Smoothing Chokes

Reference has been made to the necessity for smoothing and for this purpose a choke is employed. A choke is a simple component consisting essentially of a length of wire wound on a former built up from

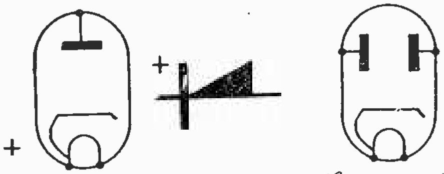


Fig. 96.—A half-wave valve rectifier, a metal rectifier and a full-wave valve rectifier.

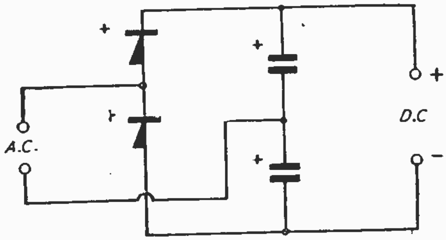


Fig. 97.—A meta rectifier voltage doubler circuit.

a number of iron laminations by the method already described for low-frequency transformers. The simplest type of iron-core choke is one intended for coupling together two valves on the choke capacity principle, or for connecting a loudspeaker to an output valve. The essential design data is an induc-

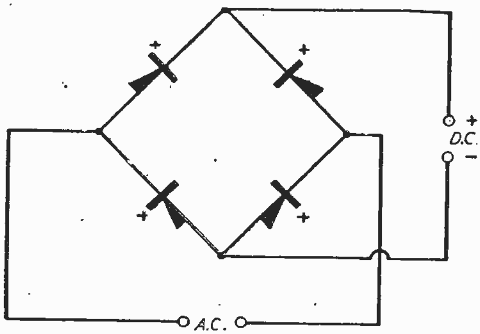


Fig. 98.—A bridge rectifier circuit.

tance of not less than 50 henries at the normal working current, a D.C. resistance of 2,000 ohms or less, and a safe current carrying capacity of not less than 20 mA. When dealing with currents above, say, 50 mA, it is advisable to employ a smoothing choke of greater dimensions and having a lower D.C. resistance. It is also an advantage for the choke to be of the constant inductance type, so that its inductance does not vary measurably when the current passing through the winding is varied. In order that a choke should show such characteristics, there must be an air gap in the core. That is to say, the T- and the U-pieces should not touch each other, but should be arranged with a small gap between them. The iron-cored choke can be used for any purpose where a choke is required, but it is specially suitable for use in powerful mains receivers for smoothing or feeding the loudspeaker. It can also be used successfully as a loudspeaker field replacement choke. Smoothing chokes generally should have an inductance of not less than 30 henries, when carrying the maximum D.C. current. In some instances it is found convenient to employ the field coil of an energised moving-coil loudspeaker as a smoothing choke, but in that case it is essential

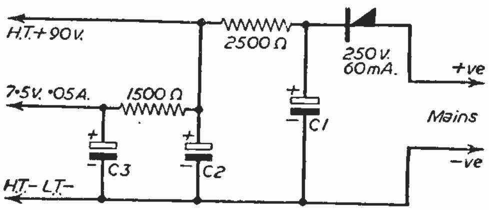


Fig. 99.—A half-wave rectifier with resistance smoothing.

that there should be a fairly considerable surplus H.T. voltage, since the resistance of the field winding is generally about 2,500 ohms.

Resistance for Smoothing

A resistance may be used for smoothing where the current requirements of the set are low, but it must be remembered that whereas a choke has a low resistance, a resistance will cause a much greater voltage drop and necessitate adjustment of other values in the circuit. The circuits in Figs. 99 and 100 show choke and resistance smoothing respectively.

It is important to remember that any coil may be considered as a choke, even a tuning coil, for the correct definition of a choke is that it is an inductance, and all coils have inductance. Inductance is a term often misunderstood, but an idea of its meaning can be grasped by considering it as providing resistance to alternating or H.F. current. No matter how a length of wire is coiled, its resistance to D.C., which is governed by Ohm's law, does not change, the resistance of a wire being proportional to its length. That is to say, the resistance of 2 yds. of wire of a given gauge will be twice that of 1 yd. of wire of the same gauge. The impedance or reactance of the coil, however, to alternating current varies greatly. For example, the length of wire used for the average H.F. choke has a resistance to D.C. of about 300 ohms, whilst its inductance may be approximately 250,000 micro henries. This means that its impedance to low-frequency current has a frequency of 1,000 cycles per second (equivalent to the highest note of the human voice), is 1,500 ohms, whilst the impedance to a current 100,000 times per second (the frequency equivalent to a wavelength of 300 metres) is 1,500,000 ohms.

Low-frequency Chokes

A similar state of affairs exists with regard to low-frequency chokes, for one which is rated at, say, 20 henries would have an approximate D.C. resistance of 250 ohms. But the impedance of the choke to an alternating current of 50 cycles would be about 6,000 ohms, or 12,000 ohms if the frequency were doubled. These examples show one important use of inductance. An inductance coil or choke can be designed to provide an easy path for direct current whilst offering a considerable resistance to alternating current, or by using a smaller inductance value to

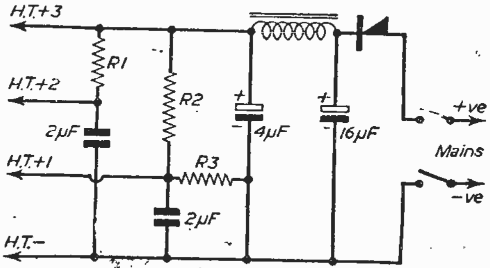


Fig. 100.—A similar circuit, but with choke smoothing.

offer a comparatively low-impedance to low-frequency alternating current, and a high-impedance to high-frequency current. This, in brief, means that the impedance of a choke increased with inductance and frequency, and vice versa. *(To be continued.)*

A Valve-Voltmeter

On the right is a view of the finished instrument.

A TEST-SET OPERATING DIRECT FROM A.C. MAINS

By "Radio Engineer"

AFTER building several valve voltmeters, some bad, and some better, I ultimately built one operated directly from the mains; that is to say, I omitted the H.T. winding, using a filament transformer at slightly reduced voltage. The object was to keep the cost down as much as possible, at the same time seeing that the efficiency was not impaired. Simple to use and not too big was the thing I was after. The accompanying illustrations will give an idea of the resultant build-up.

The first question was . . . to what extent the mains variation would affect the accuracy of the meter.

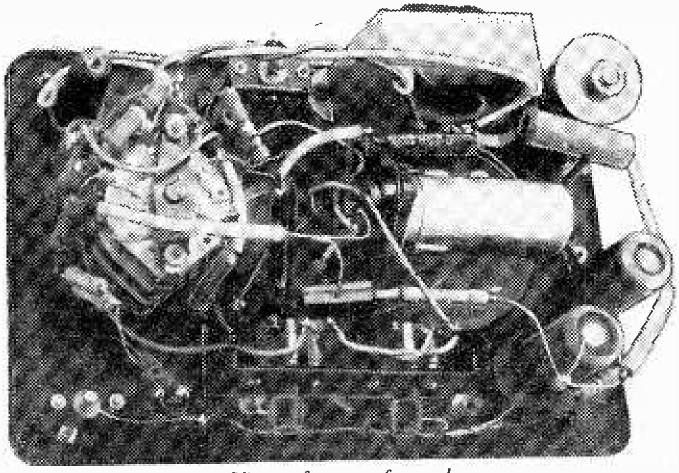
I made a check on two commercial valve voltmeters and one which I had already built and which had P.P. with primary 325-0-325 volts, F.W. rectification, and the results in all cases were the same. When in use with the mains voltage reduced by 10 per cent. on 250 volt mains, the accuracy of reading on the 100-volt scale was 5 volts lower; exactly the same result as with one directly fed from the mains, so, unless one buys or makes one's own with stabilised P.P. and multivalve balancing arrangement, there is not much hope in expecting accuracy of two per cent. or less from the average valve voltmeter.

Design

The main emphasis around which I have built the latest valve voltmeter is as follows:

Input resistance 10 meg. on D.C. and A.C. up to 1,000 volts. The A.C. is rectified by two separate diodes built in the probes. One reads up to 250 volts, 50 c/s. to 150 Mc/s—the second can be used on 10 volts to 1,000 volts or more, depending on the condenser rating selected. The first valve is a 6AL5 double-diode. The 1,000-volt probe has an EY51 valve rated at 5 k/w. R.M.S. so it is quite capable of handling 1,000 volts A.C. The valve being wire-ended and with small dimensions makes it very suitable for fitting into a probe, but the frequency is limited to about 10 Mc/s—this one is primarily built for ranges between 500 to 1,000 volts A.C. As will be seen from the circuit, a double-triode is bridge connected, and a 0.5 mA. meter is used as balance indicator. P.P. as mentioned; L.T. transformer; 2 RM1; two 8μF electrolytics; 10 K. smoothing resistor, and neon parallel with D.C. output is fed to 10 K. potentiometer (zero set) via 2.2 K. to the anodes of 12 AU7 and the meter.

The positive input terminal is connected to the earth side, that is to say, to H.T. negative, and the H.T. negative is positive from the P.P., so that if the negative lead is connected first, some deflection may be obtained—ignore this—the final reading with both leads connected will be correct. The input voltage is fed through a 10 meg. chain of resistors assembled around a ceramic switch, having three wafers; two of them are one-pole five-way, and the third one is for switching in and out the calibration controls. The original switch used was three-wafer, one-pole five-way—the third was altered accordingly.



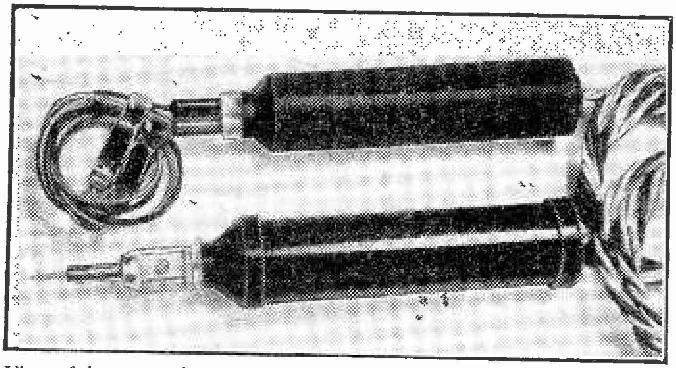
View of rear of panel.

Case

The case is made of .024in. thick tin-plate, which is very easy to bend and the brackets holding all the components can be easily soldered to it. It is composed of four parts, the top and bottom bent round 1/16in. to 3/32in. to form the lids. The centre piece is a strip 3in. wide and 28in. long bent on to ¾in. round steel to make rounded corners, joint soldered, and bottom lid soldered to it. Ventilation holes drilled on both sides with two holes opened up 3/16in. or ¼in. to be able to reach with screwdriver the calibration controls (see Fig. 3), without opening the instrument.

The top lid of the case is made in a similar manner to the bottom, except that dural or aluminium panel is added to strengthen the lid. The lid serves as a chassis to hold all the components, which are fixed on the brackets. The brackets are made of 5/16in. round brass drilled and tapped both ends and the ends of the strip are soldered to the back of the lid to act as the pillars. Five will be needed—two for the transformer, two for the bracket which holds the calibration controls, and one short pillar to hold the rectifiers. All the necessary holes should be drilled for switch, zero set, fuse, neon, mains in, and two terminals, and one to take A.C. socket for probes.

As can be seen from the photograph, the A.C. socket is four points, but three are quite satisfactory and this is shown in the diagram. The sockets and plugs must be of very high insulating quality (not from H.T. battery). In the prototype, they were made from polystyrene of ⅝in. diameter. The valve-holder is also fixed on a strip of tin-plate and soldered to the lid. This also should be well made and preferably shock-proof with rubber mounting,



View of the two probes. Top, the 250-volt and below the 1,000-volt probe.

LIST OF

Valves 12AU7
6AL5
EY51
1 ceramic switch, 1 p.
3-pin socket, 2 plugs.
2 terminal sockets an
1 10K W.W. potentio
2 5K W.W. preset (ca
Chain of resistors 10
½ w. (see diagram).
Remaining resistors 2
1 neon G.E.C. and ho
1 fuseholder 250-500
2 RM1 150 v. each.
1 filament transformer
2 0.75 ohm 10 w., W.
1 M.C. meter 0.5 mA
2 8 μF 450 v. D.C. el
3 0.01 μF mica-mould
2 0.002 μF mica-moul
1 0.01 μF bakelite-mi
1 0.02 μF 1,200 v. D.C

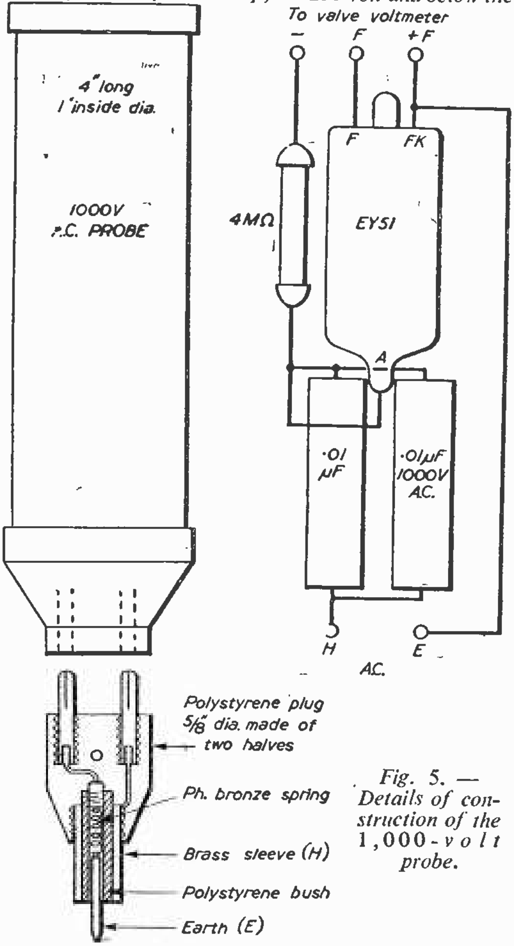


Fig. 5.—Details of construction of the 1,000-volt probe.

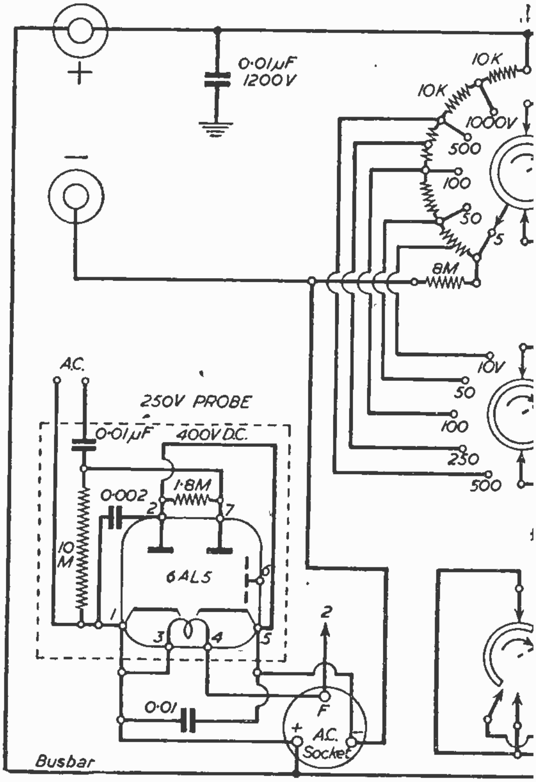


Fig. 1.—Full circuit

not forgetting the hole for meter. The side of the lid is drilled to take 8 B.A. screws, and nuts are soldered inside the case to hold the lid, and finally holes are made for a leather strap or handle.

The two H.T. electrolytics are fixed with a strap made of tinplate and soldered. Before commencing assembly, a coat of black paint and "Panl" should be applied to the outside to give a professional finish. The panel on the top should be numbered and letter stamped and polished.

'ONENTS
-0.3 a.
-0.3 a.
-0.09 a.
wafers.

n controls).
tal, H.S. 1-2 per cent.

cent. H.S. ½ w.
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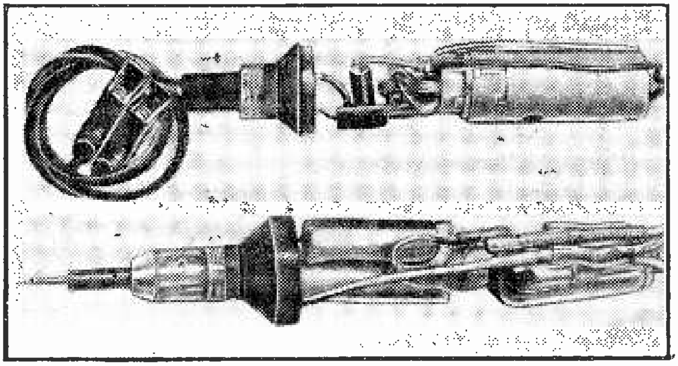
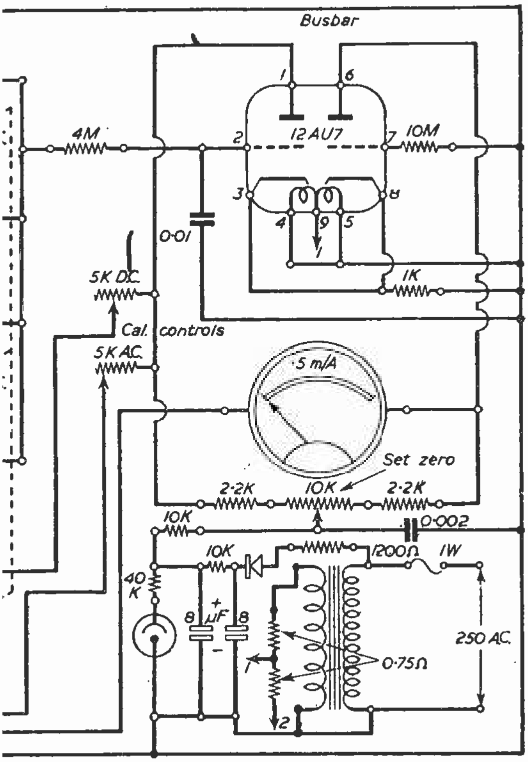
D.C.
. D.C.
0 v. D.C.
0.01 μF 1,000 v. A.C.)

Assembly

Make wire busbar, connect all negatives to one side of the mains and L.T., but do not connect anything to the case except one 0.01 μF condenser. Do not fix switch and calibrating control bracket—it will leave you more room for soldering if unconnected.



Interior details of the two probes.



ils of the voltmeter.

The photograph will give a good idea of the lay-out. The ceramic switch will have to be dismantled and cut to 2¼in. high, the bottom wafer stripped of all contacts except two continuity shorting, and two more shorting contacts are riveted on.

The shorting ring is cut in half and the other half removed, so that as you rotate the switch, one half of the shorting ring will be in continuous contact on five positions. This wafer is on the bottom of the switch, the first one when you start to assemble the switch. The shorting ring of the second wafer will be exactly opposite the shorting ring of the third wafer, just engaging number one point, so that when the switch is assembled you will get five contacts to your left and five to your right, and on the bottom wafer continuous contact to switch A.C. and D.C., calibration on and off. The top wafer holds all the 10 meg. resistors, and the middle one is for the A.C. range, and holds wire tapping from 10 megs. resistor chain. The order of reading on A.C. is different from D.C. Solder all selected resistors as in Fig. 4. The resistors should be two per cent. H.S. The accuracy of the instrument depends on them. When all resistors are fixed, connect D.C. calibrating control, check all the wiring against the diagram, plug valve in and connect meter; positive side of the meter should be from No. 6 pin on valve. Negative from No. 1 pin via calibration control, through wafer No. 1, from there to negative on the meter. Do not forget 250 mA fuse; it is very important to have one because you deal directly with the mains voltage. The D.C. side of the instrument is now ready. Set the switch to 100 volts D.C. and plug in. The neon should now be alight and the pointer will travel across the scale (H.T. is on before valve warms up); as soon as heaters are warm, the pointer will settle down on zero. If it does not, adjust "zero set." Leave the meter on for 10 to 20 minutes and in the meantime try all ranges on the switch and note if pointer alters its zero. It should stay on all ranges except 5 volts. It will move 0.2 volts here, but no more. Take a reading against known voltage from H.T. or L.T. battery and adjust with calibration control. For example—connect 90 volt battery with the help of calibration control, bring pointer to 90 volts on 100-volt scale and, if the resistors are carefully selected, you should be able to read on all D.C. ranges. The same process is to calibrate the A.C. side. If one has a meter, 10 K. or 20 K. per volt, connect it across input terminals of valve voltmeter, and then compare the reading.

For the sake of argument the writer has tried the A.C. range with mains voltage of 250 volts; meter set to 250-volt scale and adjusted for full deflection, and after re-checking on all A.C. ranges the result

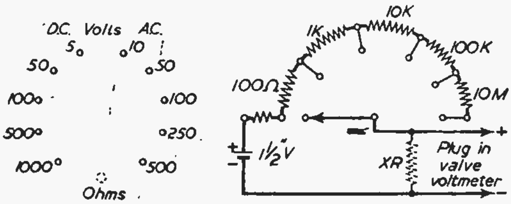


Fig. 6.—The ohms' adaptor. The unmarked resistor has a value between 8·2 and 9·2 Ω.

was not far out. It is as well to point out that the success of the valve voltmeter depends on the 10 meg. chain of resistors and they should be 2 per cent. or better. The rest of the resistors can be between 2-5 per cent. tolerance.

A.C. Probes

A.C. voltages in D.C. valve voltmeters do not easily mix. They are very simple to look at until one tries to make them read on a D.C. scale. The most important factor is the flow of current through the diode when the input is zero, making the pointer move from zero. It depends on the cathode temperature and the load resistance. The best way to control the flow is to connect a similar diode to it.

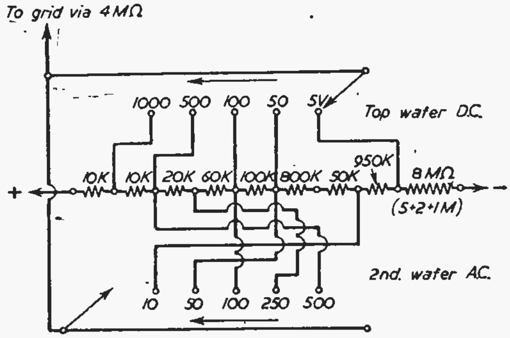


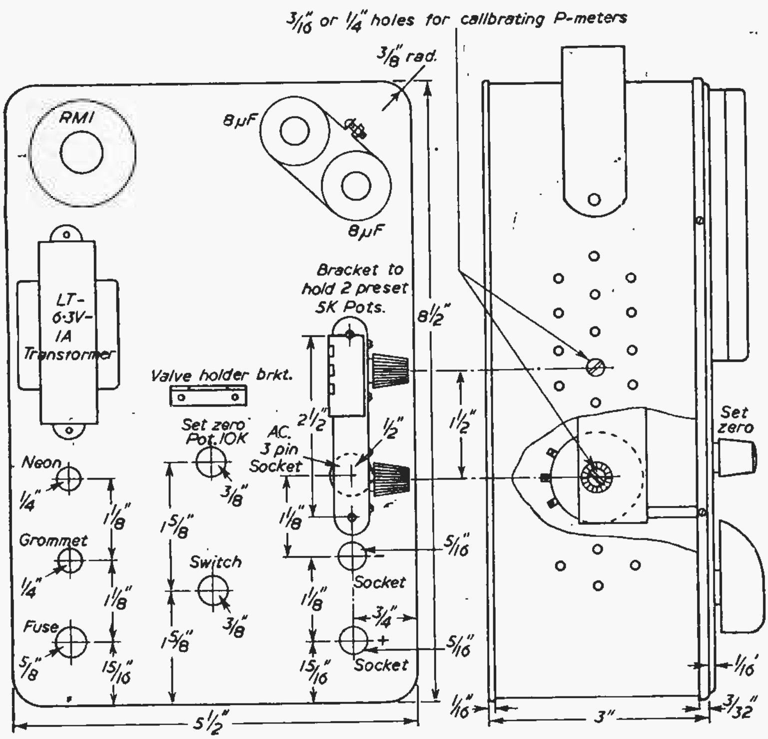
Fig. 4.—Wiring arrangement for the resistors.

The 250-volt probe is a simplified rectifier—amplifier type; input capacitor is 0.01 μF, load resistor 10 megs. Diode No. 1 is known as the shunt diode rectifier. This is followed by a second incidental diode 1.8 MΩ resistor and 0.002 μF capacitor, making a low-pass filter for smoothing out fluctuation present in the D.C. output of the first diode.

A valve voltmeter hardly uses any current so the loading resistance can be 10 megs. This minimises the load of the circuit under test and gives higher D.C. output from the first diode. The double-diode circuit is negative peak responsive and adjusted to read on D.C. scale. The positive and negative error is very small and with the help of calibration control, it will read very well on 10-volt scale. I have used a probe as high as 400 volts without doing any harm—the maker's rating of 6AL5 is 250-volt R.M.S. The terminals on the end of the probe are fitted in a plug and when the plug is withdrawn the test leads can be plugged in. It is made of polystyrene. Both A.C. contacts for testing are assembled in the tube so that the inside one which protrudes is at earth potential and the outside contact is high potential or condenser side. The earth potential is spring loaded.

When testing experiment it has been found to be not very easy to reach various points with a solid single end probe (by this it is meant that both contacts

(Concluded on page 114)

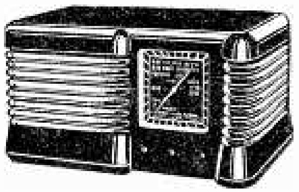


Figs. 2 and 3.—Details of a suitable case, with drilling data.

PLASTIC CABINET as illustrated, 11½ x 6½ x 5¼in., in walnut or cream, ALSO IN POLISHED WALNUT, complete with T.R.F. chassis, 2 waveband scale, station names, new waveband, backplate, drum, pointer, spring, drive spindle, 3 knobs and back, **22/6.** P. & P., 3/6.

As above with Superhet Chassis, **23/6.** P. & P., 3/6.

As above complete with new 5in. speaker to fit and O.P. trans. **37/6.** P. & P. 3/6 with Superhet Chassis, **39/6.** P. & P. 3/6.



Used metal rectifier, 230 v. 50mA., **3/6** ; gang with trimmers, **6/6** ; M. & L. T.R.F. coils, **5/-** ; 3 Govt. valves, 3 v/h and circuit, **4/6** ; heater trans., **6/-** ; volume control with switch, **3/6** ; wave-change switch, **2/-** ; 32 x 32 mfd., **4/-** ; bias condenser, **1/-** ; resistor kit, **2/-** ; condenser kit, **4/-**.

M & L Superhet Coils with circuit, **6/6** ; iron cored 465 IFs, **7/6** ; min. gang, **5/6** ; volume control with switch, **4/-** ; wave-change switch, **2/6** ; heater trans., **7/6** ; 4 v/h, **1/6** ; 4 Ex Govt. valves, metal rectifier and Xtal diode with circuit, **14/6** ; 25 x 25 mfd., **1/-** ; 16 x 16 mfd., **3/3** ; condenser kit (17), **7/6** ; resistor kit (14), **3/6.**

Medium and Long Wave Crystal set, in attractive plastic cabinet incorporating Germanium diode, **16/-.**

Headphones to match above, per pair **7/6.**

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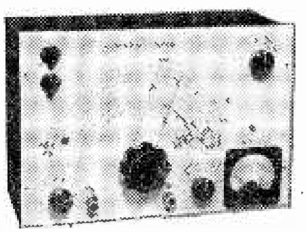

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Drop thro' 280-0-280, 200 mA., 6 v. 5 amps., 5 v. 3 amps., **27/6.**

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350-0-350 70 mA. 4 v. 5 a., 4 v. 2.5 a., C.T., **18/6.** P. & P. on above transformers 2/-.

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500-0-500 250 mA. 4 v. C.T. 5 a. 4 v. C.T. 5 a. 4 v. C.T. 4 a., **39/6.**

P. & P. on the above transformers 3/-.

32 mfd., 350 wkg.	**2/-**
16 x 24 350 wkg.	**4/-**
4 mfd. 200 wkg.	**1/3**
40 mfd., 450 wkg.	**3/6**
16 x 8 mfd., 500 wkg.	**4/6**
16 x 16 mfd., 500 wkg.	**5/9**
8 x 16 mfd., 450 wkg.	**3/9**
32 x 23 mfd., 350 wkg.	**4/-**
32 x 32 mfd., 350 wkg. and 25 mfd. 25 wkg.	**6/6**
25 mfd., 25 wkg.	**11d.**
250 mfd., 12 v. wkg.	**1/-**
16 mfd., 500 wkg. wire ends	**3/3**
8 mfd., 500 v. wkg., wire ends	**2/6**
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Ex Govt. 8 mfd. 500 v. wkg., size 3½ x 1¾, 2 for	**2/6**
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50 mfd., 180 wkg.	**1/9**
65 mfd., 220 wkg.	**1/6**
8 mfd., 150 wkg.	**1/6**
60 + 100 mfd., 280 wkg.	**8/6**
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Auto-trans. input 200/250 HT 500 v. 250 mA. 6 v. 4 a. twice 2 v. 2 a.	**19/6**
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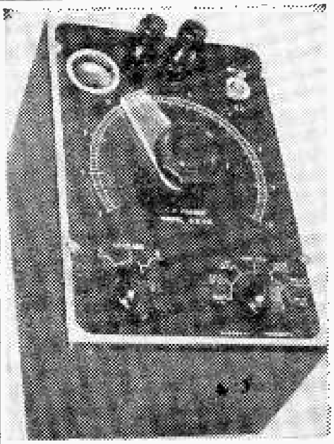

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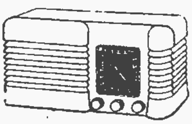

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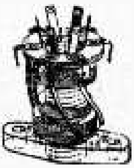

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TRANSMITTING TOPICS

STARTING ON TOPBAND

By O. J. Russell, B.Sc.(Hons.), (G3BHJ)

THE topband has a considerable fascination for a number of amateurs. It is, of course, the ideal band for short distance work, and is consequently a great favourite for Sunday morning get-togethers and discussion of work on other bands. Moreover, contacts on the experimental V.H.F. bands are very often arranged via topband contacts, so that communication can be established between experimenters, while tests and adjustments are made to the V.H.F. equipment without a possible loss of contact, or even without obtaining a contact. Further, the DX man anxious for difficult feats is already arming himself for the coming Transatlantic and Worldwide DX tests scheduled for the winter. In addition, the thrill of European DX and the "Worked All British Countries" Contests, plus Club contests, low-power field days, field days, transistor experiments and others, make the topband a rewarding band for the amateur. Moreover, the Radio Amateurs Emergency Network makes great use of topband for exercises and field and mobile experiments. Finally, of course, the topband makes a convenient jumping-off ground for the beginner in amateur work, as the freedom from some of the vagaries of the lower bands enables worthwhile operating experience to be accumulated without much difficulty from QRM, despite the fact that the band is "shared" with essential coastal and shipping services. In fact, the great help given by amateur stations during the great gale is yet another illustration of the worthwhile aspect of operation upon this band.

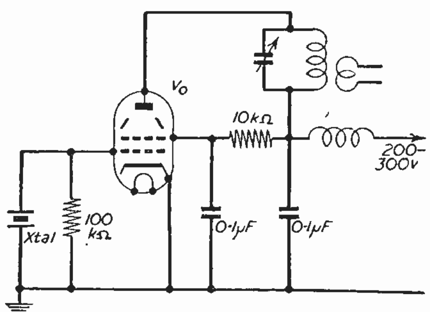


Fig. 1.—The simplest type of rig for Topband operation. (Vo 6V6, 6L6, 6F6, 6K6, EF50, EF91, 6AM5, 6AM6, TT11, QVO4/7, 6BW6, KT66, 807, etc.)

Equipment

Topband "rigs" may vary from the ultra-simple to the over-complicated, but the power limit of ten watts does enable some attractively simple arrangements to be constructed. For the "simplest possible" set-up, a straight crystal oscillator unit will be found eminently satisfactory, particularly if the crystal frequency is chosen so as to avoid the powerful coastal stations. A typical example of the circuit of a straightforward crystal oscillator capable of running at inputs of up to 10 watts is shown in Fig. 1.

The simple tuned-anode type of grid-plate oscillator will be found particularly easy and straightforward to get running. Suitable oscillator tubes are the 6V6, 6BW6, 6AM6, 6K6 and 6L6. Even the EF50 will operate at some 5 watts or so, and give a healthy signal. There is certainly no trouble in running the 6V6, 6BW6 or 6L6 at at least 7 watts input, even with restricted power supplies. In fact, a 6L6 oscillator may be run at over 10 watts input. It should be noted that the significance of this is that by using suitable coils, the transmitter may be operated on 80 metres or 40 metres by using the right crystals and tuning coils. Thus, in the event of a breakdown of the main transmitter, the small set would serve to keep a schedule in emergency. The component parts are so few that the expense need not prove a drawback to anyone.

Operation

However, there are a few points of operation which may be explained, so that optimum operation can be obtained. The anode tuned circuit must, of course, tune to the required band or frequency of operation. However, the crystal will not oscillate unless the tuned circuit is tuned somewhat higher in frequency than the crystal frequency. In fact, starting with the anode circuit tuned considerably higher than the crystal frequency, R.F. output will increase as the tuning condenser is increased in capacity (circuit tuned in the direction of lower frequencies). This increase suddenly stops sharply at a critical point, and output decreases to zero abruptly. If a plate milliammeter is included in the anode circuit, the reading will decrease as oscillation becomes stronger, only to jump suddenly to a high value at the point where oscillation ceases. A flashlamp bulb loosely coupled to the tuning coil by a turn or two of wire will glow more and more brightly until the critical point is reached, when the glow ceases as an indication of stopping of oscillation.

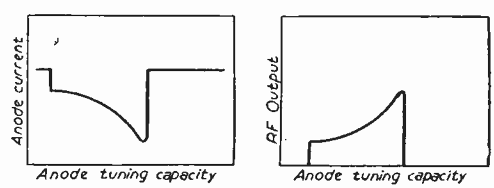


Fig. 2.—Behaviour of the simple circuit of Fig. 1 when tuning the Anode Tuning Condenser.

As maximum R.F. output is generated just on the edge of the critical point, it would seem desirable to work as closely as possible to this point. This is, however, not the best method of operating, as a chirpy note, failure of the oscillator to follow keying and similar troubles may result. It is necessary to tune a little to the high frequency side of the critical point and accept a slight loss of R.F. output for the trouble-free operation thus given. It also follows that when a coupled load such as an aerial circuit is coupled into the crystal oscillator it will also react somewhat upon the anode tuning adjustment, so that one should not strive to extract the last ounce of R.F. from the circuit but rather operate somewhat away from the critical adjustment point. In this way good R.F. output and trouble-free keying will result. Fig. 2 illustrates the "critical point" effects.

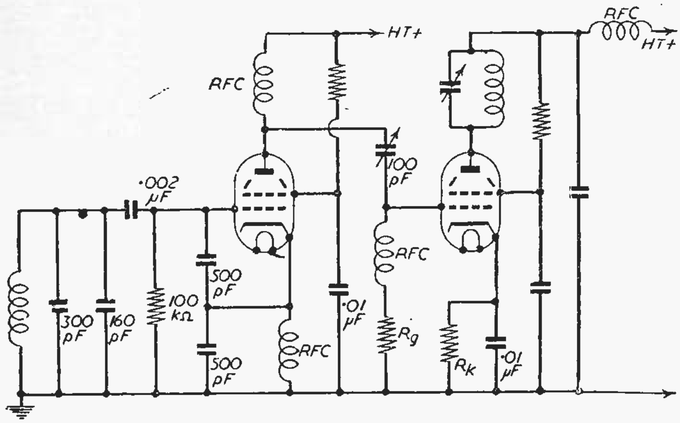


Fig. 3.—A simple VFO/PA rig for topband working. Rg and Rk vary with the PA valve. Generally Rg will be around 20,000 ohms. Rk should give sufficient protective bias to prevent the PA valve drawing excessive current under key-up conditions. The usual L.F. amplifier cathode resistor value will serve.

Keying for such a simple set-up may be effected either by a key directly in the anode lead or by a key in the cathode lead. The cathode jackplug should be by-passed by an .01μF condenser which serves also to prevent key clicks. Screen keying may also be tried if desired. The monitored note should be sharp on keying and free from chirps. It should be noted that even on topband a crystal oscillator if overloaded may give a chirpy note.

Crystal oscillator arrangements, however, are unlikely to appeal to some, as the VFO with its ability to put the signal into any conveniently clear spot on the band makes rockbound operating unpopular with many. Despite this, a number of operators have done, and still are doing, very good work on 160 with straight crystal oscillator rigs. The writer has used such an outfit for some time and beyond having to grind the original crystal to dodge coastal interference found operation enjoyable.

However, the VFO ability of dodging QRM is too valuable to pass over, so that some simple form of VFO must be mentioned. It is quite feasible, of course, to go on the air with only a VFO. The writer, in fact, has done a little QRP work in that direction, but it is not a procedure to be recommended to the beginner. Some form of VFO/PA is needed. In this respect the newer miniature valves should not be overlooked, as very compact units may be constructed with them. Such valves as the EF91, 6AM6 or the 5763 make ideal VFO valves. The PA may be a 6V6, 6K6 or 6L6 or even an EF50 in standard sized valves, but the use of miniature valves such as the 6AM5, the 6BW6 and the 5763 should be considered if no standard types are on hand. Despite their size the miniature valves handle healthy inputs. The 6BW6, for example, has identical electrical characteristics to the 6V6 and will handle some 20 watts of input. It will certainly get *hot*, for the maker's ratings permit a maximum bulb temperature of 250 deg. Centigrade. This is to avoid any alarm at the heat generated when the 6BW6 runs at full input! However, on 10 watts in a topband set the 6BW6 is well within its ratings with average PA efficiency. The only point to watch is that the compact miniature tubes may need a little more care in layout and wiring up if R.F. feedback is to be avoided.

Fig. 3 gives, therefore, a simple VFO/PA circuit. There are some points of interest, however, as while the VFO may run happily on 1.8 Mc/s. if operated on half frequency, that is in the broadcast band, enough doubling will take place in the anode circuit to drive the PA. Also note that the drive to the PA is taken through a variable condenser rather than through a fixed one. The variable condenser is adjusted so that only enough drive is provided for the PA. Tighter coupling, that is a high value of capacity, will give little more drive but may cause pulling of the VFO. The rig may be keyed in the VFO cathode, or preferably in the PA cathode lead. It is also desirable to feed the VFO with neon stabilised H.T. However, if the PA is arranged to draw a safe load from the

(*Continued on page* 105)

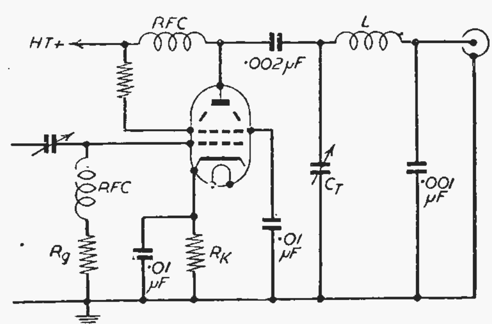
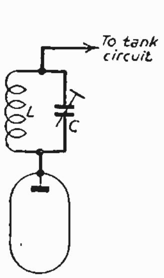


Fig. 4.—A Pi tank modification of the circuit of Fig. 3. Generally CT should have a value of around 200 pF, and the tank inductance should be tuned to enable resonance to be reached with approximately 200 pF total tuning capacity in circuit. CT may be arranged by paralleling a high-grade mica condenser with an air variable to give the required 200 pF.

power pack when not excited, the output of the pack will not soar so much as when the PA is cut off completely in idle periods. This in itself is often enough to prevent chirp on a topband VFO rig.

Tuned PA

A conventional tuned tank PA is shown in Fig. 3, but a PI network tank circuit may appeal to many.



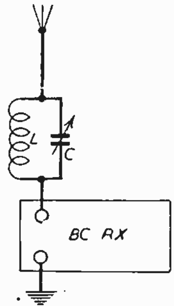


Fig. 5.—Traces of TVI may be alleviated by a tuned trap in the anode circuit of the PA and oscillator stages. A few turns of wire of ¼in. diameter are resonated by an air trimmer to the TV channel. Fig. 6.—Image type of BCI may be cured by a wavetrap in the broadcast receiver aerial lead. Additional traps may be added if necessary. The traps are tuned to the transmitter frequency causing BCI.

For a topband set-up there is little point in making the output capacitor variable, especially if feeding a coaxial line feeding an aerial tuning unit. Therefore, for a rig intended to run at 10 watts input at 300 volts H.T., i.e., say, 33 mA at 300 volts, the constants shown in Fig. 4 will be found quite suitable. A 1,000 pF output capacitor such as a high-grade mica type will be suitable, while the tank coil inductance should be such as to give resonance with a total anode capacitance of around 200 pF. These values should give an optimum operating Q value for the loaded tank circuit.

TV Interference

It should be noted that in *all* cases it is assumed that operation will be into an aerial tuning network, and that the rigs described will be link-coupled into such aerial tuning units. In this way harmonic rejection will be obtained and the possibility of TVI lessened. It must be mentioned that while TVI is not such a problem on topband as on the higher bands, it is still a possibility, particularly in weak signal areas on the fringe of TVI service areas. One method of value for suppressing TVI is the use of a tuned TVI trap (Fig. 5) inserted in the PA anode circuit. A few turns of wire are resonated with a small air condenser to the TV channel. This precaution and the use of a similar trap in the VFO anode may reduce mild TVI to nothing. Where *real* TVI is experienced, only the full gamut of anti-TVI devices will be effective, but really stringent TVI measures are not always needed on topband.

One type of interference occasionally noticed when operating on topband are BCI complaints. These are generally due nowadays to second channel interference on superhet receivers, rather than to swamp effects on straight receivers. It will be found in cases of " second channel " BCI that the frequency of topband operation is given by adding twice the BC receiver IF to the frequency to which the BC receiver is tuned. These second-channel images tune sharply just like a normal signal, but may, of course, be superimposed on a BBC channel when operating at certain topband frequencies. Thus a BC receiver of 465 IF if tuned to 900 kc/s may receive the image frequency of $900 + 2 \times 465 = 1{,}830$ kc/s, if it has poor aerial circuit selectivity. As 1,830 kc/s is a popular topband frequency, trouble may easily arise in this way. The remedy is to supply a wavetrap tuned to the offending topband frequency and fit the trap in the aerial lead of the broadcast receiver. This does not, of course, solve the problem in the case of receivers with built-in frame aerials, and the simplest solution is to avoid the topband frequencies which give an image frequency that falls on the Home or Light programme frequencies. Generally, however, BCI problems are generally curable on topband, although the closeness to the broadcast band does tend to accentuate some forms of BCI.

Image BCI

It will be appreciated that with the usual 465 kc/s IF for broadcast superhets, image BCI may occur when working on any frequency between 1.8 and 2 Mc/s in the topband. This will show up as image interference on signals between 870 kc/s to 1,070 kc/s in the broadcast band. In the London area the region around 1,830 kc/s is one that might cause trouble to BBC listeners. However, in some areas where the BBC programme is received on some other channel, image BCI might be caused when working on some other topband frequency. Differing intermediate frequencies may also cause image signals to appear on frequencies a little outside the range of 870 to 1,070. Thus a 456 IF broadcast receiver might respond to images tuning (apparently) at from 852 kc/s to 1,052 kc/s on the receiver corresponding to actual topband operation in the range 1.8 to 2 Mc/s. Depending on the area of operation and the local BBC frequencies, therefore, it may be necessary to protect two or even three spots on the broadcast receiver corresponding to programme channels. Fortunately, in such cases two or three wavetraps may be inserted in series in the aerial lead of the receiver thus interfered with, and each trap may be tuned to a different spot. By this means even bad or multiple image interference may be cured. With this one point of BCI interference, therefore, topband operation is generally plain sailing, so that a rig for operation on 160 metres adds a further source of enjoyment to amateur activities.

AMPLIFIER DESIGN

11.—TUNED AMPLIFIERS

By R. Hindle

(*Continued from page 12 January issue*)

A Series of Articles Dealing with the Theoretical Considerations of Amplifier Design, and Containing at a Later Stage Constructional Details of Various Types of Amplifier.

Mismatch

THE tetrode is somewhat different with regard to output loading. It will be seen from Fig. 42 that an increase in loading (making the slope of the load line less) will run the valve more into the curved regions at the extremes of the load line and so would give rise to increased distortion but a decrease in load making the line slightly steeper would have less effect on the distortion produced. Generally speaking, however, one has to be more careful to match the tetrode or pentode than the triode. Of course, the same factor of variation in the impedance of a speaker with frequency, as was mentioned previously, applies also to the case of a tetrode and this also tends to be more serious in its results with the tetrode.

Converting to Tetrode Working

The comparison between triode and tetrode working is easily tried out with the units the construction of which has been described, and it is very likely that the constructor will prefer to leave the tetrode connection in operation for general use in view of the fact that the output is six times as great for substantially the same input. All that has to be done with both versions of the output amplifier is to break the link between pins 5 and 6 of V1 (Fig. 38 and Fig. 41), leaving the output transformer connected to pin 5. Pin 6 is then connected directly to H.T., conveniently on the electrolytic smoothing capacitor to the tag to which the H.T. end of the output transformer is already connected. The bias resistor, R2, has then to be reduced to 240 ohms either by substitution of one of the correct size or by connecting across the 300-ohm resistor one of 1,000 ohms. The matching of speaker may need to be altered if the triode was given its correct load of 4,000 ohms but as was explained earlier a tapping giving a load of 5,000 ohms was used for the triode connections as this was the nearest available ratio and in this case no change had to be made for tetrode.

When discussing untuned amplifiers it was stated that the frequency of operation of the signal did not alter the basic theory of amplification, and it is true that the resistance-capacitance type of coupling there discussed would work equally well at any frequency if the resistive load at that frequency was of the order mentioned in the design data. The first R.F. amplifiers were, in fact, resistance-coupled triodes, but, unfortunately, the amplification obtained was very much less than was to be expected from the size of load used. The basic reason for this, as a matter of fact, was also dealt with when dealing with audio amplification. The reader will perhaps remember that the amplification of the upper audio frequencies was limited by the inevitable stray capacitances, and as these were found to be more effective the higher the frequency it is not surprising that they are even more effective at the much higher radio frequencies. These stray capacitances, even with reasonably careful construction, are likely to be about 40 pF, and are effectively in parallel with the load resistor. The load specified for the amplifier (Fig. 14, on page 342 of the June issue) was 100KΩ for the triode case, but the reactance of the strays even on medium wave ranges is only about 4,000Ω, and on the short waves will be only a few hundred ohms. The gain on the medium wave range works out then (using the formula (3) on page 233 of the April issue) at only three times. For the pentode case the specified load was 220KΩ, and the gain is gm. Req (page 343 of June issue) or about four times on the medium wave range instead of 176 times as was found to apply at the audio frequencies where the effect of the strays was negligible.

This is not the whole story, unfortunately, and even the very limited gains quoted above are impracticable for other reasons. The anode load has its effect on the input impedance of the valve. When explaining the Miller Effect it was pointed out that with a resistive load a capacitance is fed back to the input circuit. When the anode load is predominantly capacitive, as in the case now being discussed, the effect is equivalent to a resistance across the grid circuit. Now if, as would be usual, there were a tuned circuit at the grid the resistance would have the effect of damping it and so reducing its selectivity and lowering the amplitude of signal existing in the tuned circuit so that the gain is still further reduced. In fact, in the average case under these circumstances it is very likely that there will be a reduction instead of an increase in signal.

Reasons for R.F. Amplification

If R.F. amplification is so hard to achieve why bother about it at all? Audio amplification, we have seen, is reasonably easy and gains of well over 100 times per stage are practicable, so at first glance the solution would appear to be first to convert the signals into audio by means of a detector and then to amplify. There are many reasons why this is not

(*Continued on page* 109)

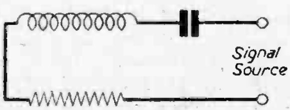


Fig. 44.—Series tuned circuit.

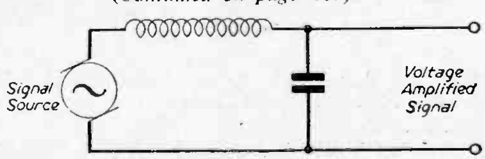


Fig. 45.—Use of series circuit for voltage amplification.

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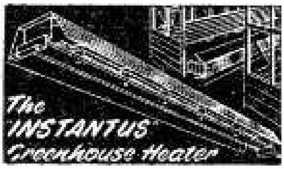

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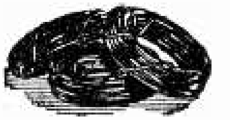

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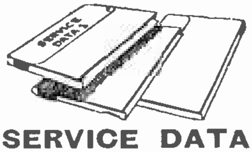

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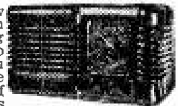

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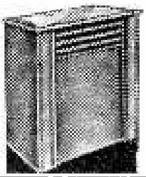

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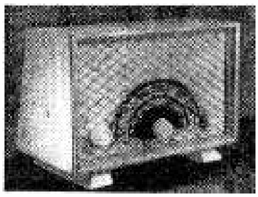

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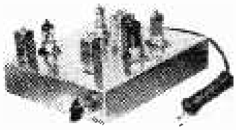

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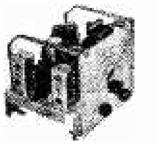

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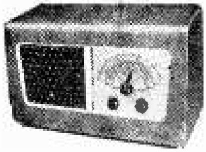

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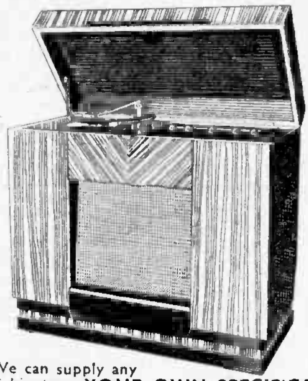

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a practicable solution. First, a perfect detector cannot be set up. A detector is basically a non-linear conductor and the voltage at which the resistance changes from a high value to a low one is not sharply defined. The characteristic shows a gradual curve, and over this range distortion is produced. Now a small input signal will never move off this curve and so the audio will be distorted before it reaches the audio amplifier, and nothing done there will restore it. For satisfactory results it is essential that the signal fed to the detector should be large, so that the detector is swung well over the curve and into the straight part of the characteristic. Not many people are so favourably placed that all the signals that they wish to listen to are so strong that they will provide a detector directly with a sufficiently large input; and so some form of R.F. amplification is inevitable. Secondly, a high degree of selectivity is required, particularly for modern conditions. This is best achieved for ordinary purposes by means of a number of tuned circuits. Other methods that may provide adequate selectivity with perhaps only one tuned circuit invariably limit the bandwidth to which the equipment will respond (as will be seen later). All the tuned circuits could be put before the detector, but gain will suffer even further and also the detector circuit itself has the effect of damping the tuned circuits at its grid and so preventing the selectivity that is being sought. There are detector circuits that aim at avoiding this damping, but they have their own problems.

We have then to face the problem of R.F. amplification, and there is, in fact, a very convenient way of preventing the ill effects of stray capacitance; that is to cancel it out with a reactance of the opposite kind. Now inductive reactance is opposite in kind to capacitive reactance, and if an inductance of reactance equal to that of the strays is added to those stray capacitive reactances there will be no residual reactance and we are left only with the resistance of the circuit. This is, of course, what tuning means. The apparent snag is that a capacitance and an inductance can have equal reactances only at one frequency; above that frequency capacitive reactance decreases and inductive reactance increases. This snag can be changed into a virtue by using an inductance smaller than would be required to cancel out the capacitive reactance, and then adding more capacitance in the form of a variable capacitor. The capacitor can then be adjusted to cancel the inductance at the frequency required at the time; in other words, the circuit can be tuned so that it will select the wanted transmission and reject those not wanted. The strays now become part of the tuning capacitance, and can have no ill effects apart from reducing the amount of capacitance required of the variable component for a given frequency.

Tuned Circuits

It is necessary now to give some consideration to the nature of circuits combining inductance and capacitance. A circuit consisting of both inductance and capacitance is a tuned circuit; it inevitably has resistance as well for neither the metal plates of the capacitor nor the metal wire used to wind the inductance can have zero resistance. The currents flowing in the tuned circuit have to pass via the resistive paths, and so there is a power loss. The reactance of an inductance is $2\pi fL$ and the reactance of a capacitor is $-\frac{1}{2\pi fC}$, the minus sign in this case being used quite arbitrarily to indicate that capacitive reactance is exactly opposite in character to inductive reactance. The circuit has a resonant frequency, being the frequency at which the two reactances are equal numerically. The resonant frequency can thus be easily found. It is the frequency at which

$$2\pi fL = \frac{1}{2\pi fC}$$

$$\text{i.e., } 4\pi^2 f^2 LC = 1$$

$$f^2 = \frac{1}{4\pi^2 LC}$$

and the resonant frequency $f^2 = \frac{1}{2\pi\sqrt{LC}}$

Series Resonance

Now if the inductance and capacitance are considered as being in series as in Fig. 44 the reactances, being equal and opposite, will cancel out and a zero reactance is presented by the two together. There is still the resistance of the components, however, and this is shown in Fig. 44 as a separate component so that it will not be forgotten. This resistance, then, is the only opposition to the flow of current and the magnitude of the current is determined entirely by the resistance and not at all by the inductance or the capacitance. This current has to flow through the capacitance, however, and a voltage is produced across the component according to Ohm's Law; similarly, a voltage is produced across the inductance and as the current is the same in each case and as the reactances are equal the voltages generated across each component will be the same (so far as the resonant frequency is concerned and for the moment conveniently forgetting the resistance that is, in practice, integral with the components). As the reactances are of opposite sign, however, the voltages across the individual components are of opposite polarity and will cancel each other out, just as two batteries of equal voltage, if connected in series incorrectly by connecting like poles (e.g., positive to positive instead of positive to negative), will cancel each other out and give zero voltage. So the total voltage applied by the source in Fig. 44 appears across the resistance (for the time being considered as a separate component) and satisfies in the light of Ohm's Law the original stipulation that the resistance was the only effective opposition to the flow of current.

By restricting the resistance in the series tuned circuit there is no reason why quite a large current should not pass through the circuit even with a quite modest applied signal voltage; if the perfect components without resistance could be made the current would be infinity with the smallest voltage! In practice the resistance can be made so low that the resulting current flowing produces across the inductance (and also across the capacitance, each component considered separately) a voltage very much higher than that originally applied from the source and thus a voltage amplification can be obtained in the tuned circuit alone, even without any valve or other device connected to it. The degree of magnification obtained in this way depends on the ratio of reactance of either component to the resistance of the circuit. This ratio measures the "goodness" of the circuit and is called the circuit "Q." Be careful to note, however, that to make use of the amplification of a series tuned circuit the output must be taken across only one component of the tuned circuit (either inductance or capacitance) as shown in Fig. 45.

Parallel Tuned Circuit

A series tuned circuit obviously has a low impedance, as the resistance has been reduced to a minimum to give the best Q, and the two main reactive components cancel out, whereas we were searching for a large impedance with which to load an amplifier, so the search has to be continued elsewhere. In the series tuned case a voltage from the signal source was seen to drive a common current through each component and it was found to produce large voltages across each component. In the parallel tuned case (Fig. 46) the signal voltage is common to (i.e., across) both inductance and capacitance and the current divides between the parallel arms. The magnitude of current flowing in each arm is determined, again using Ohm's Law, by dividing the voltage by the reactance of each arm, but as at resonance the two reactances are numerically equal the current flowing in the two arms of the parallel circuit will be equal. The reactances are of opposite sign, however, and therefore the currents will be flowing in opposite directions and so will cancel out. If the circuit could be quite without resistance, then no matter how large the signal voltage applied no current would flow into the parallel circuit (except for the initial flow to charge the capacitor) because the current at a given instant in the inductance is supplied by the current flowing in the capacitor at the same instant but in the opposite direction, and none is required from outside. Inevitably, resistance is again present and some current is taken, in fact, but only to replace that taken by the resistance and transformed into heat. Clearly again, the lower the resistance the less power will be taken from the signal source for a given voltage, and so the higher the Q of the circuit the higher is the apparent impedance of the whole circuit; it can be very much higher than the reactance of one arm of the circuit. This is the circuit of use for the present purpose, a circuit with a high impedance that can be used as a load for a valve.

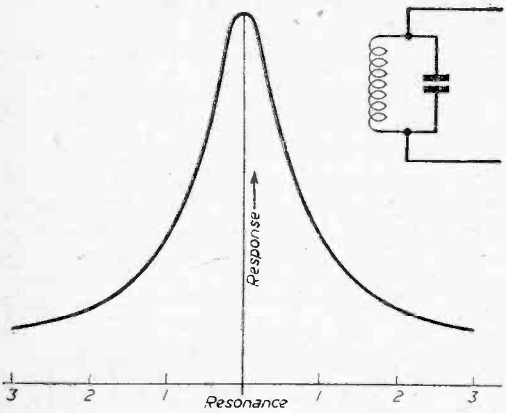

Fig. 46 (Top).—A parallel-tuned circuit. Fig. 47 (Bottom).—Resonant curve. Parallel impedance plotted against $Q \times \frac{\text{Ks's off Resonance}}{\text{Resonant frequency}}$.

(To be continued)

ECONOMY QUALITY RECEIVER

(*Continued from page* 82)

far this value must be reduced. It is suggested that resistors of 6,800, 4,700 and 3,900 be tried experimentally if a reduction is considered necessary.

Another component which may need alteration is R14, which provides the negative feedback path. Naturally, the lower the value of this component the greater will be the feedback—and the lower the overall gain. Raising the value of R14 will increase the gain but reduce the amount of feedback. Again it is a matter of compromise; suggested values for R14 are 250,000 ohms, 500,000 ohms, 750,000 ohms and one megohm. If possible, use the lowest value mentioned to obtain maximum feedback.

During alignment it may be found that the receiver tends to develop self-oscillation as the I.F. transformers are brought into alignment. This is not an uncommon occurrence in superhet receivers and is generally due to long, straggling leads, poor solder connections, incorrect operating conditions or a poor physical layout and screening. Or, of course, any combination or permutation of these faults. Quite often this trouble can be cured by wiring in stopper resistors (of around 220 ohms) direct to the signal or screen grids of the I.F. amplifier. Similarly, inadequate screening of vital leads can produce the trouble through inductive coupling.

However, in the case of a reflexed amplifier, all the usual precautions may still be inadequate. Fig. 1 shows that the amplifier has individual anode circuit decoupling (R10, C17). These components may not be necessary and, indeed, the receiver may first be tried without them. But if there is any tendency towards oscillation, the filter may help considerably to eliminate the condition.

If I.F. instability of a stubborn nature persists, check that all earth contacts are sound, that valve screening is satisfactory (earth pin 1 of the 6B8 if a metal type is used and take all earth returns to this point) and that all other factors previously mentioned are in order. Should the oscillation still persist it may be necessary to shunt the secondary of IFT-1 with a damping resistor the value of which must be chosen by experiment and may be anything from about 220,000 ohms down to 39,000 ohms. The largest possible value which will stop the oscillation should be used if selectivity and gain are not to be seriously impaired. The fitting of such a damping resistor should be looked upon as a last resort when it becomes obvious that nothing short of a complete rebuild is likely to cure the trouble! Another system is to neutralise the amplifier by connecting a very small capacitance (of only a few pF) between the anode and grid.

Lest prospective constructors feel that the building of the receiver appears to be beset with troubles, perhaps it is advisable to state that I.F. instability is likely to occur in any home-constructed superhet, and the above notes should be taken in a general way, applicable to this and most other superhets. For there *should* be no troubles of this nature with the receiver, but a combination of bad layout and wiring *could* result in instability as it can in other receivers.

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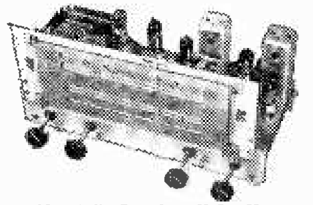

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5in. RADIO SCREWDRIVERS.—Sheffield made blade, 2¼in. x ¼in. Ins. handle, 5.000 v., **4½d.** each.
CONDENSERS.—New Stock .001 mfd. 6 kV. T.C.C., **5/6.** Ditto, 12.5 kV., **9/6**; 2 pf. to 500 pf. Mica, **6d.**; .001, **Mica** or Tub. T.C.C. 500 v., .01 Sprague 500 v., .02 N.S.F. 500 v., .1 mfd. 350 v. Micramould Tub., **9d.**; Hunts Moldseal 500 v. .005, .01 mfd., **9d.**; .05 mfd. and .1 mfd., **1/-.** .25 mfd., **1/6**; .1 mfd., 600 v., **1/3**; Tubular .5 mfd. 350 v., **1/9.**
SILVER MICA CONDENSERS.—10%.
5 pf. to 500 pf., **1/-.** 600 pf. to 3,000 pf., **1/3.**
DITTO 1% (ex stock).
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SENTERCEL RECTIFIERS. E.H.T. TYPE FLY-BACK VOLTAGES.—K3/25 2 kV., **4/3**; K3/40 3.2 kV., **6/-**; K3/45, 3.6 kV., **6/6**; K3/50 4 kV., **7/3**; K3/100 8 kV., **12/6**; K3/160 14 kV., **18/-.** **MAINS TYPE.**—RM1, 125 v., 60 ma., **4/-**; RM2, 100 ma., **4/9**; RM3, 120 ma., **5/9**; RM4 250 v. 275 ma., **16/-.**
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PEN TORCHES.—Drydex, chromium plated with vest pocket clip. Complete. New battery and bulb. Listed 3/4. **Our Price 2/6.**
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ALUMINIUM CHASSIS.—18 s.w.g. Plain, undrilled, folded 4 sides and riveted corners lattice fixing holes. Strong and soundly constructed with 2½in. sides. 7in. x 4in., 4/6; 11in. x 7in., 6/9; 13in. x 9in., 8/6; 14in. x 11in., 10/6; and 18in. x 16in. x 3in., 16/6.

CHARGER TRANS. PRIM.—0/200/250 v., sec. 0-9 v.-15 v. (for charging 6 v. and 12 v.) 1.5a., **13/6**; 2a., **16/-**; 3 a., **18/6**; 4 a., **21/-**; 6 a., **26/-.**
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COPPER ENAMEL WIRE.—¼ lb. 14 to 20 s.w.g., **2/-**; 22 to 28 s.w.g., **2/6**; 30 to 40 s.w.g., **3/6.**
SWITCH CLEANER Fluid, squirt spout, **3/9** tin.
TWIN GANG TUNING CONDENSERS.—.0005 mfd. midget with trimmers, **8/6**; 375 pf. midget less trimmers, **6/6**; .0005 Standard size with trimmers and feet, **9/-**; less trimmers, **8/-**; ditto, soiled, **2/6.**
VIBRATOR POWER PACK (Jeff-Travis-U.S.A.).—Compact Steel Case 7in. x 6in. x 4in. 12 v. Input. Output, 90 v. H.T., 6 v. and 1.5 L.T. Complete, **25/-**; p. & p., **2/6.** Suitable Battery Portable Sets.
LOUDSPEAKERS P.M., 3 OHM.
3in. Plessey, **12/6.** Goodmans 4in. square, **15/6.** 5in. **14/6.** 6½in., **16/-.** 7in. Elliptical, **18/6.** 8in. R. & A. **17/6.** 10in. Plessey, **25/-.** 6½in. with trans., 7,000 ohms to 3, **19/6.**

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465 Kc/s Slug tuning Miniature Circular Can, 2¼in. by 1¼in. diam. Fits octal V-holder cut out. High Q and good bandwidth. By Pye Radio. Two mounting feet.

BRAND NEW, 6/9 PAIR

Oscillatory Circuits

AN EXPLANATION OF THE WORKING OF THE VALVE AS AN OSCILLATOR

By E. E. Apps

(Continued from page 50 January issue)

REFERRING back to the simple feedback oscillator as described in Part I, it is of interest to note that this type of oscillatory circuit is the basis of the reaction receiver as originally used. The feedback of negative-resistance or energy tended to neutralise the damping of the positive resistance of the circuit, and thus the circuit amplified up to a point where oscillations were set up.

The Reinartz Circuit (Fig. 1)

This was a circuit that had one coil only for aerial and grid reaction circuits. The aerial and grid tappings should be noted. The reaction is applied by means of a variable condenser connected between anode and the bottom end of the coil. This circuit was, a few years ago, a favourite with short-wave enthusiasts, and gave very good reception if care was taken with the setting of the reaction condenser.

Power from the Oscillatory Circuit

In transmitters and radio-frequency heating apparatus it is desirous to draw large amounts of power from the oscillatory circuit (Fig 2). Here the total current flowing through the valve is made up of I_o plus an oscillating component whose instantaneous value is represented by i_o. The current in the coil L is also composed of $I_o + i_L$. The current in the capacity C consists only of an oscillating component whose instantaneous value is i_c. When the circuit is self-oscillating, the peak value of the oscillatory anode current is limited by the magnitude of I_o. The oscillatory anode-filament PD is similarly limited by the H.T. voltage. Thus, it will be seen, that the larger the value of the mean anode-current and the D.C. voltage applied to the anode, the larger will be the power in the oscillatory circuit.

The Meissner Oscillator (Fig. 3)

This circuit, as will be seen from diagram, has no conductive coupling. The oscillatory circuit is coupled inductively to both grid and anode coils. Where it is inadvisable to tap the coils, this circuit is advantageous.

Resistance-coupled Oscillator (Fig. 4)

This uncommon type of oscillator makes use of a resistance, as a coupling between anode and grid circuits. When the two circuits are tuned so that $L_1 C_1 = L_2 C_2$, the E.M.F. generated by the valve, the potential across the anode circuit, and the potential across the coupling resistance, are all nearly in phase, and the phase of the potential applied to the grid differs by 180 deg. from that of the E.M.F. generated in the valve. Thus conditions for oscillation are set up and, in this case, frequency stability is high.

Relaxation Oscillators (Fig. 5)

In a circuit in which the frequency is governed by the capacitance and resistance, and there is a swing from one state of quasi-equilibrium to another, the name of relaxation oscillator is given. As there is no inductance in the circuit, the type of oscillation produced differs considerably from a tuned circuit oscillator. The wave-form is generally non-sinusoidal, and there are harmonics of considerable amplitude. The frequency generated can be varied by the capacitance or resistance, between very wide limits. Fundamental frequencies can be as high as 1 Mc/s or as low as 1 cycle per *minute*. Fig. 5 shows a simple type of glow discharge oscillator. When a D.C. voltage of a magnitude greater than the striking voltage of the tube is applied, current will flow through R and the voltage across C will rise until the striking voltage is reached. The current through R then increases rapidly and the condenser discharges until the potential across it equals the extinction voltage of the tube. The condenser is now charged again until the striking voltage is again reached. The period of the tube flashes can be varied by adjustment of R and C. When C is large, flashes at a very low rate can be produced. The amplitude is comparatively small, but can be increased by a circuit tuned to the operating frequency inserted in the resistance arm.

Multivibrator Oscillator

This is a relaxation oscillator of a much better type. It is essentially a two-stage resistance-coupled amplifier, in which the voltage developed by the output of V2 is applied to the input of V1. As each valve produces a phase shift of 180 deg., thus causing the output of V2 to supply to V1 an

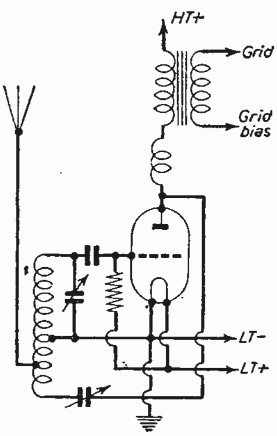

Fig. 1—The Reinartz circuit.

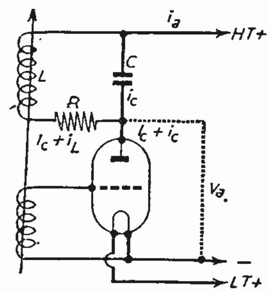

Fig. 2.—Tuned-anode oscillator showing current flowing in different parts of the circuit.

input voltage of the correct phase relationship, oscillations can be maintained.

Action of Multivibrator

If a minute voltage of a positive potential appears at the grid of V1, this voltage is amplified by both

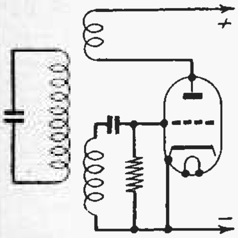

Fig. 3.—Meissner oscillator.

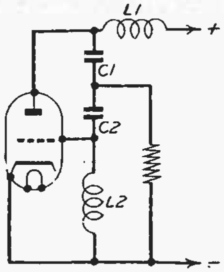

Fig. 4. — Resistance-coupled oscillator.

valves and reappears at the same point. This action continues very rapidly, so that the grid potential of V1 rises whilst the grid potential of V2 falls. A point is reached when the anode current of V2 is reduced to zero by the falling grid potential, and the anode current of V1 is large. However, the leakage through the grid circuit resistances gradually restores the grid potentials to normal. When this leakage reaches a point when anode current commences in V2 the process is repeated in the reverse direction. The frequency is determined by the grid resistance R and the grid capacitance C1, and is given approximately by $f=\frac{1}{(C_1+C_2)R}$ if all four resistances are equal to R. Fig. 6(A) shows that the wave-form of the current in the anode circuits is rich in harmonics, so that, if a standard frequency of known value is used to control the frequency of the multivibrator, it is possible to obtain a large number of frequencies all related to the known frequency. It can be thus seen that the multivibrator is a useful means of generating known frequencies for measuring purposes. If, for instance, a standard tuning-fork of a frequency of 1 kc/s were employed to generate a standard frequency, it would be possible to use the harmonics generated either directly or with a higher frequency vibrator synchronised by a harmonic of the 1 kc/s.

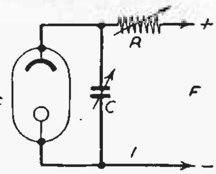

Fig. 5.—Glow discharge oscillator.

The frequency at which this circuit oscillates is governed, of course, by the values of C and R, and it may be changed by changing the values of these. This forms a very convenient way of making a variable-frequency oscillator, and will be familiar to many, of course, in the television field, being used for timebase operation.

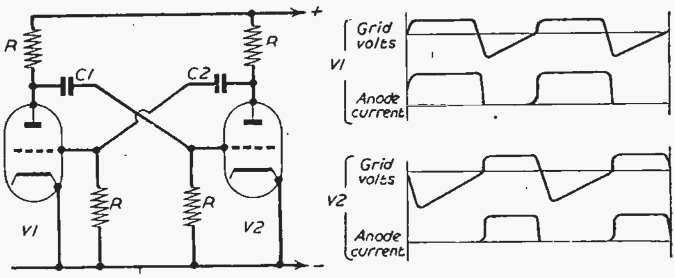

Fig. 6.—Simple multivibrator and current and voltage curves.

A VALVE VOLTMETER *(Cont. from page 98)*

are terminated in one end). Having earth end pushed by spring ⅜in. out, it gives extra length when it is not easy to reach with the top terminal.

1,000 Volts A.C. Probe (Fig. 5)

This probe was built for 500 volts and 1,000 volts A.C. It is important to note that it is not suitable for high frequencies.

The probe is made of bakelite tube of 1in. dia. inside, 1/16in. thick, 4in. long; the covers are of ebonite, the terminal socket of polystcrene. It is much safer than a metal probe. All connections are insulated with plastic sleeving and the joints are brushed over with polystyrene cement. The three outgoing wires are all plastic covered and two of them must be capable of carrying 1,000 volts D.C. Also, condenser must be at least 1,200 volts D.C. if it is to be used for A.C. 1,000 volts. When dealing with mains voltage always make sure that the earth potential is connected first.

As you can see from the photograph, the segment below the volts scale is left uncalibrated. In my own case, I shall calibrate it to read decibels. The ohms range can be added in the form of external adaptor which would consist of switch. H.S. resistors. 1½-volt battery, four terminals as in Fig. 6. It will read 0-100 ohms to 100 megs. Resistors on the switch can be connected in series or parallel. The meter will read from left to right so that the highest unknown value will be near the full deflection end. Only slight modification will be necessary on the valve voltmeter. One more contact must be added to the D.C. wafer. This contact is connected to the negative terminal. It will then give full deflection of the voltmeter with 1 volt only. If you use the 5-volt position on D.C. you will need 5 volts for full deflection, and the adaptor unit will have to be much bigger to take 5½ volt cells.

To save the cost of two filament resistors, the L.T. transformer can be dismantled and about six turns taken off to drop the voltage to about 6 volts on no load. Reduced F voltage gives greater stability, but if reduced too much, it will take too long to warm up.

When calibrating the instrument, start with D.C. side, check on all ranges, adjust calibrating control in such a way that error on all ranges will be no more than 2 per cent. When calibrating, always check zero set. With the A.C. range, proceed as with D.C. and the result should be as good as with D.C. Always allow about two to five minutes to warm up.

R.S.C. A4 HI-FIDELITY 25 WATT AMPLIFIER

A new design for 1955. "Push-Pull" output. "Built-in" Tone Control Pre-amp. stages. Increased sensitivity. Even further improved performance figures. Includes 7 valves, specially designed sectionally wound output transformer, block paper reservoir condenser and reliable small condensers of current manufacture. TWO SEPARATE INPUTS CONTROLLED BY SEPARATE VOLUME-CONTROLS allow simultaneous use of "Mike" and Gram., or Tape and Radio, etc. etc. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut." Frequency response ±3 db. 30-30,000 c/c. Six negative feedback loops. Hum level 66 db. down. ONLY 20 millivolts INPUT required for FULL OUTPUT. Certified harmonic distortion only 0.35% measured at 10 watts. Comparable with the very best designs.

ENTIRELY SUITABLE FOR SMALL HOMES OR LARGE HALLS, CLUBS, GARDEN PARTIES, DANCE HALLS, etc.

etc. For ELECTRONIC ORGAN or GUITAR. For STANDARD or LONG-PLAYING RECORDS. FOR ANY "MIKE" or PICK-UP. **9 GNS.**

Size approx. 12-9-7½in. For A.C. mains 200-230-250v. 50 c/cs. Outputs for 3- and 15-ohm speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Unapproachable value at **9 Gns.**, or ready for use, **50/-** extra. If required, cover as illustrated can be supplied for **17/6**. H.P. TERMS AVAILABLE.

R.S.C. 10 WATT "PUSH-PULL" HIGH-FIDELITY AMPLIFIER A3

Complete with integral Pre-amp. Tone control stage (as A4 amplifier), using negative feedback, giving humproof individual bass and treble lift and cut tone control. **Six Negative Feedback Loops.** Completely negligible hum and distortion. Frequency response ± 3 db. 30-20,000 c.p.s. Two independently controlled inputs. Six B.V.A. valves. A.C. mains 200-230-250 v. input only. Outputs for 3 or 15 ohm speakers. Kit of parts complete in every detail. **£7/19/6.** plus 5/- carriage or ready for use, **45/-** extra. Illustrated leaflet, **5d.**

H.M.V. LONG PLAYING RECORD TURNTABLE WITH CRYSTAL PICK-UP (Sapphire Stylus). Speed 33⅓ r.p.m. For A.C. mains 200-250 v. Limited supply. Brand New Cartoned. Perfect. Only **£3/19/6.** Plus carr. 5/- (Normal price £8 approx.).

BATTERY SET CONVERTER KIT. All parts for converting any type of Battery receiver to All Mains. A.C. 200-250 v. 50 c/cs. Kit will supply fully smoothed H.T. of 120 v., 90 v. or 60 v. at up to 40 mA, and fully smoothed L.T. of 2 v. at 0.4 to 1 a. Price, complete with circuit, wiring diagrams and instructions, only **48/9.** Or ready to use, **8/9** extra.

PERSONAL SET BATTERY SUPERSEDER KIT. A complete set of parts for construction of a Unit (housed in metal case) to replace Batteries where A.C. Mains supply is available. Input 200-250 v. 50 c/s. Outputs 90 v. 10 mA. and 1.4 v. 250 mA., fully smoothed. For 4-valve receivers. Price complete with circuit. Only **35/9.** Or ready for use, **42/6.** Size of unit, 5½ x 4 x 1¾in.

BATTERY CHARGER KITS
For mains 200-250 v. 50 c/s.
To charge 6 v. acc. at 2 a., **25/6.**
To charge 6 or 12 v. acc. at 2 a., **31/6.**
To charge 6 or 12 v. acc. at 4 a., **49/9.**
Above consist of transformer, full wave rectifier, fuses, fuseholders and steel case. Any type assembled and tested. **6/9** extra.

THE SKY CHIEF T.R.F. RECEIVER. A design of a 4-stage, 3-valve 200-250 v. A.C. Mains receiver with selenium rectifier. It consists of a variable Mu high gain H.F. stage followed by a low distortion grid detector triode. The next stage is a further triode amplifier with tone correction by negative feedback. Finally comes the output stage consisting of a parallel connected double triode giving ample output at an extraordinarily low level of distortion. Point to point wiring diagrams, instructions, and parts list, **2/6.** This receiver can be built for a maximum of **£4/19/6** including attractive Brown or Cream Bakelite or Walnut veneered wood cabinet 12 x 6½ x 5½in.

ELECTROLYTICS (Current production. Not ex-Govt.).

Tubular Types			
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8µF 450 v.	1/11	16µF 450 v.	2/9
8µF 500 v.	2/11	24µF 350 v.	2/11
16µF 350 v.	2/3	32µF 350 v.	2/11
16µF 450 v.	2/9	32 mfd. 450 v.	4/9
24µF 350 v.	3/6	40µF 450 v.	4/11
32µF 350 v.	3/6	64µF 450 v.	3/9
25µF 25 v.	1/3	8-8µF 350 v.	3/9
50µF 12 v.	1/3	8-8µF 450 v.	3/9
50µF 50 v.	2/3	8-16 mfd. 450 v.	2/11
Can Types		8-16µF 450 v.	3/11
8 mfd. 350 v.	1/3	16-16µF 450 v.	4/11
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A PUSH-PULL 3-4 watt HIGH-GAIN AMPLIFIER FOR £2/19/6. For mains input 200-250 v. 50 c/s. Complete kit of parts including circuit, point to point wiring diagram, and instructions. Amplifier can be used with any type of Feeder Unit or Pick-up. This is not A.C./D.C. with "live" chassis, but A.C. only with 400-0-400 v. trans. (Output is for 2-3 ohm speaker.) Supplied ready for use for **25/-** extra. Carr. 2/6. Descriptive leaflet, **7d.**

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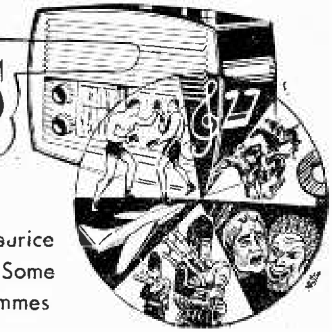


Our Critic, Maurice Reeve Reviews Some Recent Programmes

Somerset Maugham Festival

THE most notable event since my last contribution has been the *Somerset Maugham Festival*, in honour of the famous author's eightieth birthday. I heard the following plays :—" Lady Frederick," " The Circle," " For Services Rendered " and " Sheppey." There were also adaptations of some of his novels and short stories and, as I write, there is more to come.

It can be said, without qualification, that everything gave unalloyed pleasure. Mr. Maugham boasts of being an entertainer first, last and all the time and a right royal one he is. He never philosophises or tries to " teach " his listeners in the Shavian manner. Nor does he boggle over sex, which rides triumphantly through much of his best work. But he can point a moral and underline it, too, as in the terrific anti-patriotic finale to " For Services Rendered," which created such a furore when originally produced in the West End, or the anti-gambling and other high-toned moralities of " Sheppey." Everything in short makes for perfect radio fare ; not better than Shaw and some others, of course, but different and all that could be asked of an author.

There was much fine acting during the Festival and the productions seemed uniformly good. I particularly liked almost everyone in " The Circle "—Ronald Squire is always Ronald Squire. Monica Gray and Belle Chrystall in " For Services Rendered " and Sonia Dresdel in " Sheppey " stood out. Charles Leno in the latter title rôle was rather too much on one note, whilst Rachel Gurney in " Lady Frederick " was not quite the " femme fatale " conveyed by the dialogue. By the way, surely the dressing-room scene in this is one of the best things of its kind in English comedy since the screen scene in " The School for Scandal " which it slightly resembles.

Other Plays

Among other good plays were two American ones, " The Wooden Dish " and " Winter Journey." The American drama always has great vitality, gusto and charm whatever else it may either possess or lack. These two pieces made no exception. " The Wooden Dish," by Edmund Morris, was one of those plays I mentioned in connection with " Return to Tyassi " which fail in the West End in spite of glowing tributes from the Press. It was a dramatic tale of the sad conflict between age and youth and the demands of the latter on the former. Joan Miller, Bessie Love, Finlay Currie and many others wrung our withers and our hearts according, doubtless, to the age group of each one of us listening.

" Winter Journey," by Clifford Odets, was a " backstage " play posing no problems concerning society and its welfare and containing those two powerful and popular puppets Sam Wanamaker and Constance Cummings, as well as Guy Kingsley Pointer, Reginald Tate, etc. I enjoyed both.

I cannot stay on radio drama any longer except to mention that " The English Captain " also had excellent qualities, but that " Mr. Mysterious " afforded an exception to an otherwise exceptionally good month.

Ted Ray for Humour

" Ted Ray Time " seems to have a fair share of humour whenever I have heard it. Ted himself, with Harold Berens, should assure this. Audrey Jeans effectively takes Kitty Bluett's place. Saturday night's " Variety Playhouse " always seems a hundred per cent. better when Vic Oliver is the host and master of ceremonies.

There have been some irritating changes in the hitherto fixed times for the presentation of " Music Magazine," " The Critics " and Alistair Cooke's " Letter from America," either of the original transmission or the repeat. Furthermore, the repeat times are distinctly variable and cannot be relied upon. Although doubtless plenty of listeners are glad of the changes, I do hope there are many who, like myself, have been annoyed and inconvenienced.

" The Adventures of Sherlock Holmes " have long been a classic in their special genre. Like Gilbert and Sullivan, Oscar Wilde and Dickens, they carry the Victorian flavour in its most attractive guise into our more sophisticated age irrespective of the current fashion in greenback " whodunit." Their charm is perennial proof of their quality. The present series has afforded great pleasure to the older listener who remembers their original appearances in the lamented *Strand*, as well as to those unacquainted with them. The casting of Sir John Gielgud and Sir Ralph Richardson as Holmes and Watson was sufficient proof of the importance that was, I submit, correctly attached to the series. Val Gielgud, John Cazabon and William Fox complete the almost perfect cast.

Music

Music, too, has been in full spate, as it ever is. I liked an original programme of French and Russian numbers conducted by Jean Martinon, whilst the following week he included that most famous of modern—40 years old now—masterpieces, Stravinsky's " Petruschka," just as lovely in the concert hall as the theatre. Artur Rubinstein was his ever brilliant self in a Beethoven concerto and a Liszt programme. There can be few finer Liszt players to-day. Moiseiwitsch gave a Schumann recital and included the fascinating but seldom heard " Kreisleriana." Here, too, is a master in a certain type of music.

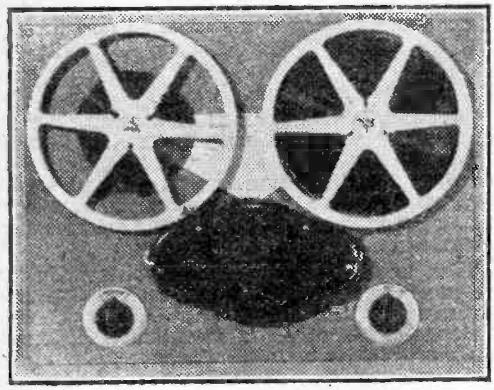
News from the Trade

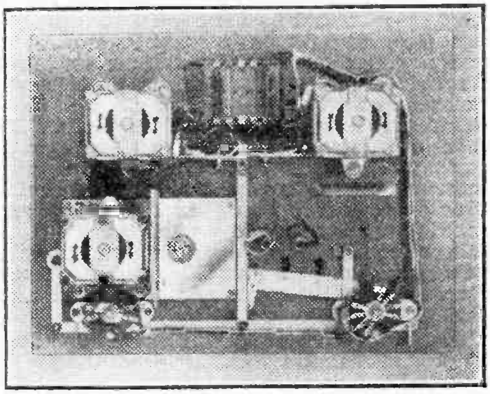
The Brenell Tape Deck

THE new Brenell Tape Deck is introduced as a high-quality unit at a moderate price.

Of particular interest is the new toggle-action grip between capstan and pinch wheel which ensures a tape drive free from slip and which eliminates one of the major causes of "wow" and flutter. The capstan is directly coupled to a heavy flywheel which is driven by a rubber belt from a motor of adequate power.

Three independent motors are employed to ensure reliable operation with simple switching. Braking is arranged mechanically and gives an effective, quick stop action with complete freedom from tape tearing yet leaving the tape correctly set for immediate recording or playback.





The new Brenell Tape Deck showing underside with switch interlock.

Three speeds are available with a playing time of :—

2 hours at 3¾in. a second.
1 hour at 7½in. a second.
½ hour at 15in. a second.

The record/playback head is a high-impedance type and does not require a matching transformer. It is fitted with a heavy gauge Mumetal screen to ensure elimination of 50-cycle hum due to magnetic fields from motors, transformers, etc.

The erase head is a low-impedance type which requires to be fed from a low-impedance winding on the oscillator coil.

The tape drive is from left to right, using the upper track to conform to British Standards.

With overall dimensions of 15in. by 11½in., with 3¼in. below deck, this instrument costs £15.10s. complete. — Brenell Engineering Co., Ltd., 2, Northington Street, London, W.C.1.

The RD Junior Amplifier and Control Unit

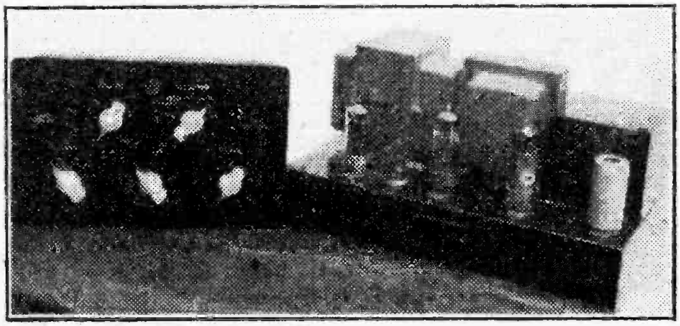
THE RD Junior Amplifier and Control Unit are being introduced to replace the present RD Baby de-luxe Mk. II amplifier and RD Junior Mk. II pre-amplifier respectively.

They are both virtually entirely new designs but we have used the present models as standards of comparison to summarise the main improvements.

Amplifier: Total harmonic distortion at 8 watts now only .12 per cent. Frequency response: ±.25db 20-30,000 c.p.s. Output Transformer: Sectionalised and fitted C-core lamination material. Three alternative output impedance selected by simply plugging in appropriate impedance plug. Correct feedback resistor automatically fitted, no soldering required. Presence Control: Optional presence control fitted to enable optimum performance when using new G.E.C. "FR" loudspeaker.

Control Unit: Treble control now continuously variable. In the circuit used this results in a more satisfactory characteristic, lacking the "blare" associated with some forms of control when boost is applied. A switched bass control has been retained as here the more satisfactory characteristic is obtained with a circuit employing switching. Tape Jacks: Previously only included on the Senior model, are now fitted to the front panel.

The Main Amplifier costs £16 and the Control Unit, £9.—Rogers Developments Co., Rodevco House, 116, Blackheath Road, Greenwich, London, S.E.10.



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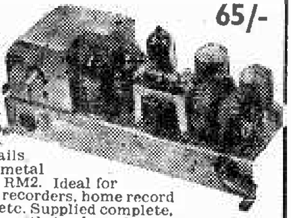

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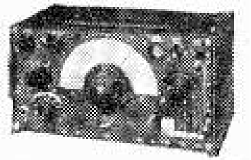

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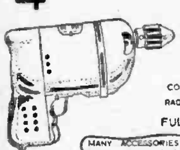

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Open to Discussion

For the Deaf

SIR,—Your correspondent E. W. Lark (January issue) writing of his difficulty in fitting a relative's National Health deaf-aid earpiece for radio reception direct from the receiver may not know of the several excellent matching devices which are fed from the "extra speaker" sockets on the set. It is a simple matter to match either high or low impedance magnetic or crystal earpieces to the standard output arrangement of the set. The person using the deaf-aid earpiece adjusts the volume control incorporated in the matching device to suit himself.

A most satisfactory type of radio receiver for a deafened person is the self-contained battery-operated portable. Output is ample for his deaf-aid earpiece and the built-in speaker is an obvious advantage to other people with normal hearing. The same matching device is used, this being plugged into two sockets connected across the primary of the output transformer in the set.

With a view to a more permanent arrangement, I should be pleased to hear of a transformer manufacturer who can offer output transformers for mains and for battery output valves with two separate secondary windings, one to match a 50 ohms deaf-aid earpiece and the other a 3 ohms loudspeaker.—P. J. CARTWRIGHT (Stockton-on-Tees).

Changing Listening Conditions

SIR,—I heartily agree with the letter on p. 761, December issue.

Certainly under to-day's chaotic listening conditions, especially on the medium-waveband, there is not one set in the normal commercial range which could satisfy the discriminating listener. I have tried several very large sets but without success, and unless the receivers have a variable selectivity switch and vernier dials there is not much hope to get any of the stations, especially as the Americans are occupying just the same wavelength as the Russians, so that interference and oscillation are provoked. A good frame aerial could also help to better the reception, but I am afraid the normal radio trade makes good business, so why worry?

Why are so-called international agreements made like the Copenhagen wave plan, if nobody keeps to it? Germany, for example, got only VHF-senders allocated.—A. K. RICHTER (Bristol).

Amplifier Design

SIR,—Further to my letter asking if Mr. Hindle would deal with cathode follower *output*, and perhaps evolve a circuit. I would like him, if dealing with the matter, to refer also to what I call "horse and pony" output.

It seems likely that if, say, two 6V6 valves are used in pull-push (cathode follower output) then the characteristics (which includes distortion) of 6V6 are multiplied, probably by four. Similarly in regard to the two 6J5s used to feed the 6V6s.

Example: Two 6J5s feeding two 6V6s (290 volts cathode-f. output):

Remove one 6V6 and substitute a KT66.

Remove the 6J5 now feeding KT66 and substitute 6C5.

(Of course, K and g volts ought to receive attention, but never mind that for the moment.)

It seems likely that instead of multiplying 6V6 and 6J5 characteristics by possibly four, you now have four different characters in your output, each of one only. It may be that, by proper designing, a circuit far in advance of anything yet produced can be evolved on these lines—the four different valves cancelling out each other's peak tendencies. In any case, using this method on my Williamson (cathode output) I can accept much more volume, and the bass is reed-like instead of muffled drum-like, if you know what I mean by that—and instead of one "brilliance" there are two "brilliances," one being on the violins and the other nearer the bass. By that I mean a "realism" in the music.—O. G. KERSLAKE (Orpington).

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for receivers described in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of cover.

A Six-valve A.C. Superhet

SIR,—Reference the above set, details for the construction of which appeared in your July issue.

I thought you may be interested to know I recently built this set, and after checking, plugged into the mains, connected a short indoor aerial and switched on. Without any adjustment whatever, I found I was receiving Moscow Radio "loud and clear." I had not even touched the tuning condenser!

(I have since fitted a "magic eye" type of visual tuning indicator—an idea I would commend to your readers as being a simple yet accurate means of bringing the circuits into perfect alignment.)

I consider this a tribute to the soundness of PRACTICAL WIRELESS circuits and Messrs. Osmor Radio's coilpacks and components.—H. SEXTON (Sanderstead).

High Fidelity

SIR,—After reading the most excellent and humorous article on High Fidelity by "Grid Current" published in your December issue, I feel I must put pen to paper and express my views, although they concur in many respects to those of your critic.

No doubt other "hams" like myself keep life and soul together by servicing domestic equipment, and have encountered the fact that when the equipment is returned to its expectant owner, he immediately adjusts his "tone" control, because he does not like the setting you have left. In many cases the frequency output response is cut at certain frequencies by as much as 50 per cent. One setting of this "tone" control may appear "muffled" by one individual, while another considers it to be quite adequate and correct.

Now the only solution, in my opinion, for any equipment to be labelled "high fidelity" is that such equipment should possess bass boost, treble boost and both bottom and top cut-off controls or any combination which would control the extremities of the frequency response.

Possibly in the near future one manufacturer will strike a note of genius and provide us with a middle-cut control, just to please the "boys" who like their supersonic bangs and screeches alone!

One further note to this epistle is that I am afraid that I fall into the category who delight in volume when it is there to use.

I have found that at certain levels the balance of reproduction is perfect but at higher volume both bass and high frequencies tend to mingle, particularly with the reproduction of L.P. records. Many people think this is due to the loudspeaker, but here again I do not agree. The American trend to this problem was partly solved by a Phono-preamp circuit which appeared in a recent American publication. The controls consisted of two rotary switches with 10 different selections, each of the selections being coded by letters. The article provided a list of both British and American labels together with the code letters at which the switch selectors must be set when playing each particular label. This of course compensates for the different recording characteristics of each particular label.

However, the question of high fidelity is not solved at any one end of the equipment alone, as the question remains entirely with the person who operates the controls.

In finishing, I feel I must congratulate both you and your staff for providing a most enjoyable year of really first class publications. I can only add that I hope that PRACTICAL WIRELESS has a most successful year in 1955.—B. G. HAVENHAND (nr. Royston).

SIR,—I agree with the comments of your correspondent, Mr. S. T. Pinder, in his letter in your January issue and in connection with my contribution "What is Hi-Fi?" For any degree of pleasurable listening, balance is perhaps one of the most important matters, but the Hi-Fi enthusiast usually claims a large measure of a reality of reproduction.

We have heard in a number of recent demonstrations some astonishing reproductions of percussion, broken glass, and other "noises," but somehow although one admires the accuracy of such reproductions there appears to be still something lacking in the reproduction of certain musical instruments and orchestral effects. This in spite of assumptions that extended range covers harmonics, and deals with transients, and that cross-modulation and phase distortion is not present.

One is left with a feeling that in many cases the extension of the top range has satisfied the Hi-Fi enthusiast that he has put realism into his reproduction.

A non-technical but keen violinist recently suggested to me that Hi-Fi reproduction now gave a fairly true rendering of violin tone in a general sort of way, but it was still incapable of giving reproduction which would discriminate between the tonal qualities of a good violin played by a master and an inferior instrument. It would be interesting if some of your readers with a keen musical ear and some knowledge and experience of instrumental work, would give us their considered and critical opinion of Hi-Fi reproduction such as is so called to-day.

Are there still some fields to conquer in this direction?—"GRID CURRENT" (Middlesex).

Series Modulation

SIR,—Your correspondent C. McLean in the December issue of PRACTICAL WIRELESS uses the subject of series modulation as a plea for the granting of higher power.

I should like to draw his attention to your article in the November issue, which gives some good examples of modulation at a very reasonable cost to anyone wishing to build them. The most reasonable one being of course, clamp modulation, and, if Mr. McLean will also consider it, there is NBFM. Any of these will modulate a full 150 watts efficiency, enough for the needs of the most exacting amateur.

On the subject of higher power, I would rather suggest a decrease to something like 75 or even 50 watts maximum, and if your correspondent should ever visit this country and listen to the 14 Mc/s 'phone band when the DL4 stations are in full swing with their BC610 and ET4336 transmitters, he will see my point of view.—K. SMETHURST (DL2UY) (B.A.O.R. 39).

Modern Reflex Receiver

SIR,—I built the "Modern Reflex Receiver," two months ago, for use on A.C. mains with a transformer for supplying the heater current. On moving to my present address, I found that the supply was D.C. As the normal current dropper was rather large and would not fit into my cabinet, I tried a 60 watt bulb in series with the filament and found that it worked excellently, the supply being 230 v. D.C.

I have now fitted the lamp to the set and so have a compact reading lamp and wireless.

Perhaps other readers will find the above suggestion useful. The set gives good volume on all stations, using the fender as an aerial. The set measures 7in. x 7in. x 4in.—H. PARKER (Clacton-on-Sea).

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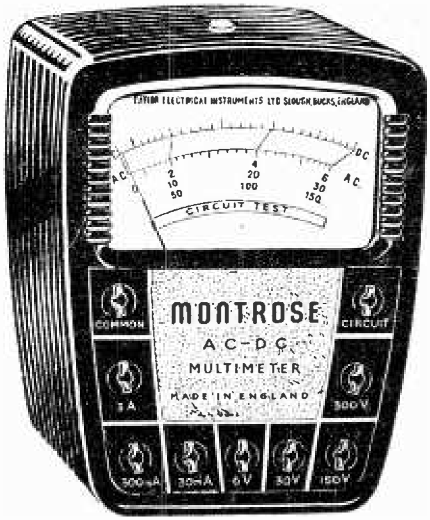

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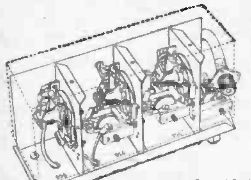

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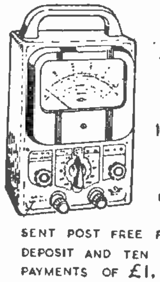

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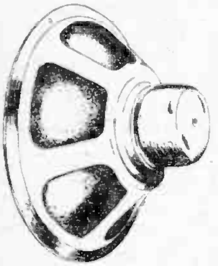

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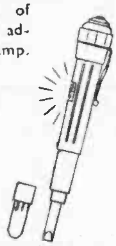

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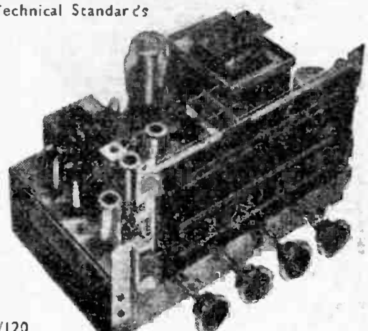

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PRACTICAL WIRELESS. Feb., 1955

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