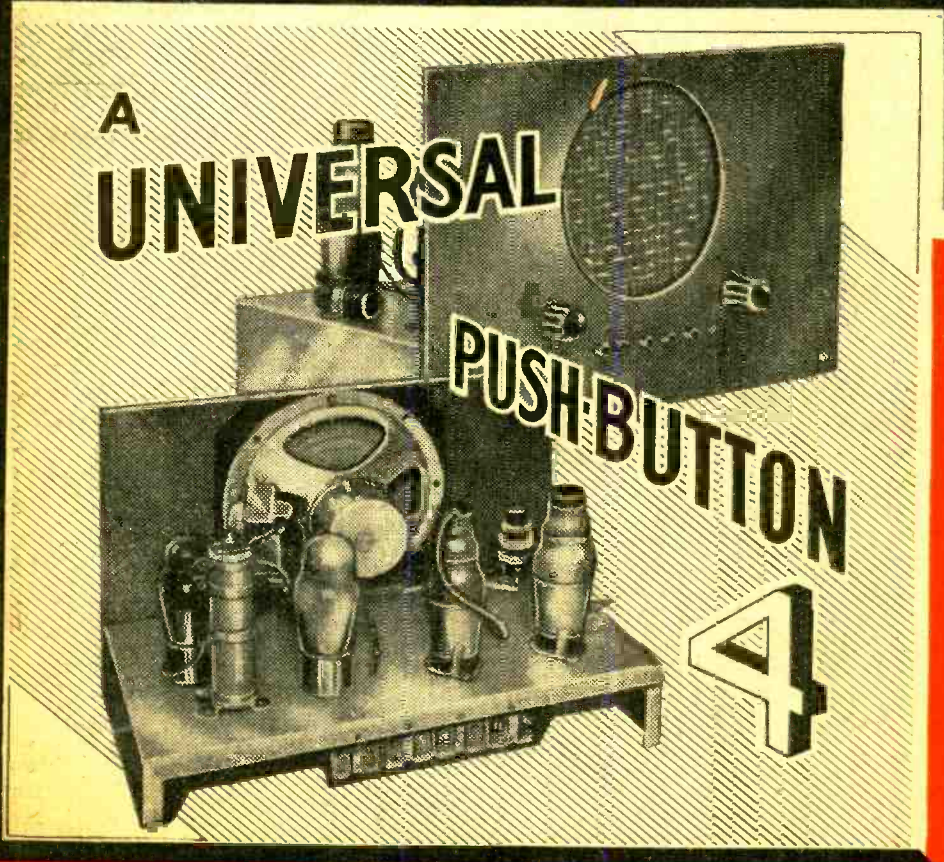
BEGINNER'S GUIDE TO RADIO

1/-

Vol. 30. No. 574
AUGUST 1954

EDITOR:
F.J.CAMM

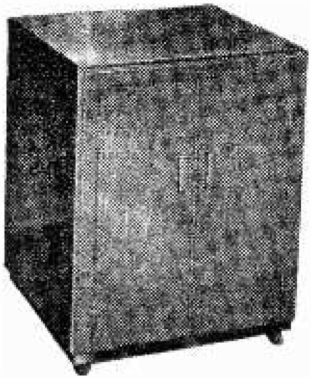
PRACTICAL WIRELESS



IN THIS ISSUE:

AMPLIFIER DESIGN
IMPROVING THE TAPE DECK AMPLIFIER
SURPLUS R.F. PENTODES
WIDE-BAND COUPLERS
MAINS SUPPLIES FOR BATTERY VALVES
NOISY RECEPTION
STABILISED POWER SUPPLIES

Never before SUCH VALUE, EYE-APPEAL AND WORKMANSHIP...

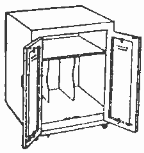


These two Cabinets set a new standard in value and workmanship. The traditional excellence so long associated with W B is evidenced in pleasing design, finest materials and superb finish; here are cabinets that will enhance any room, provide ample storage space in compact form.

'MELODY' TV and RECORD CABINET

(As illustrated)

Accommodates TV or radio receiver on top; room inside for 150 10" or 12" records. Highly polished French walnut veneer finish, interior in lacquered birch. Fitted with easy-running castors and has removable record index cards clipped inside doors. Rubber buffers at back of cabinet. No Purchase Tax. Size: 26" x 20" x 18½". Price **£9.17.6**



WHITELEY ELECTRICAL RADIO CO. LTD.
MANSFIELD · NOTTS

'SYMPHONY' RECORD CABINET

Capacity: 250 300 10" records. Top is large enough to take record player or medium-size TV or radio set. Highly polished French walnut veneer finish, interior in lacquered birch. Easy-running castors, removable record index cards in doors, rubber buffers at back of cabinet. No Purchase Tax. Size: 29¼" x 20" x 14½". Price **£9.7.6**

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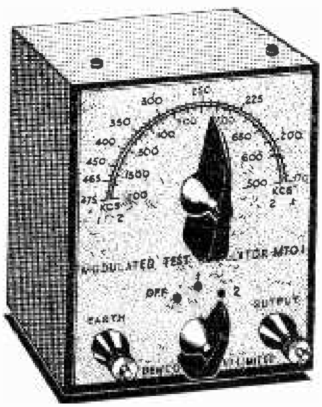
MAXI-Q REGD. STOP PRESS! *WE PROUDLY PRESENT OUR* LATEST HIGH STANDARD LOW PRICED INSTRUMENT WHICH WE KNOW WILL BECOME A PRIZED AND INDISPENSABLE POSSESSION IN EVERY CONSTRUCTOR'S SHACK



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★ Provides a modulated signal suitable for I.F. alignment also trimming and tracking R.F. circuits.

★ Frequency is continuously variable from 170-475 Kc/s and 550-1600 Kc/s.

★ Operates from a single 9 volt grid bias battery which is housed within the unit.

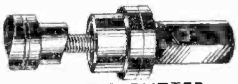
Price £3.15.0 obtainable from all reputable stockists or in case of difficulty direct from works. Send for our General Catalogue (9d. post free).

DENCO (CLACTON) LTD. 357/9 Old Road, Clacton-on-Sea, ESSEX

OSMOR radio products ltd. (Dept. P50)

418, BRIGHTON ROAD, SOUTH CROYDON, SURREY. 'phone CRO 5148-9

OSMOR COILPACKS give quality and performance right out of proportion to their midget size and modest cost. They have everything that only the highest degree of technical skill can ensure—*extra selectivity, super sensitivity, adaptability*. Size only 1¾in. x 3¼in. x 2¼in., with variable iron-dust cores and polystyrene formers. Built-in trimmers. Tropicalised. *Prealigned*, receiver-tested and guaranteed. Only 5 connections to make. All types for Mains and Battery superhets. and T.R.F. receivers. Ideal for the reliable construction of new sets, also for conversion of the 21 Receiver, TR1196, Type 18. War-time Utility and others. Send to-day for particulars !

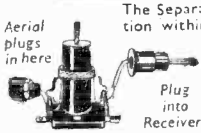


CHASSIS CUTTER

Type	Hole Sizes	
1	1in. x 1¼in.	Illust. price list on request.
2	⅞in. x 1⅛in.	
3	¾in. x 1¼in.	
4	1¾in. x 2in.	

I.F.s. 465 k/c. Permeability-tuned with flying leads. Standard size 1⅜in. x 1⅜in. x 3½in. For use with OSMOR coilpacks and others, 14/6 pair. **MIDGET I.F.s.** 465 k/c. ¾in. x ¾in. x 2⅜in. 21/- pair. PREALIGNED 1/6 extra. Both types.

TYPE METRES
1 — 141-250
2 — 218-283
3 — 267-341
4 — 319-405
5 — 395-492
6 — 455-567
7 — 1450-1550
8 — 410-550 k/c



The Separator may easily be tuned to eliminate any one Station within the ranges stated and fitting takes only a few seconds. Sharp tuning is effected by adjusting the brass screw provided.
Complete with plug, socket and full instructions—nothing to add.

7/6 POST FREE *Satisfaction guaranteed.*

OSMOR STATION SEPARATOR

SEPARATE COILS

4/- EACH

A full range is available for all popular wavebands and purposes. Fully descriptive leaflet and connection data available. Just note these 5 star features :—

★ *Only 1in. high.* ★ *Packed in damp-proof containers.* ★ *Variable iron-dust cores.* ★ *Fitted tags for easy connection.* ★ *Low loss Polystyrene formers.*

We keep stocks of many radio components for use in published circuits, including :

"WIRELESS WORLD"

No Compromise T.R.F. Tuner. Midget Mains Receiver. Sensitive 2-Valve Receiver ; Television Converter, etc. Midget Sensitive T.R.F. and Many Others.

"PRACTICAL WIRELESS"

Coronet "FOUR," Beginners' Superhet. Modern High Power Amplifier 2 ; Attache Case Portable ; R1155 Convertor ; A.C. Band-pass 3 ; Modern 1-Valver ; 3-Speed Autogram, etc., etc.

FREE! Send 5d. (stamps) for literature including The really efficient 5 valve Superhet Circuit, 6-valve ditto, 3-valve (plus rectifier) T.R.F. circuit. Battery portable superhet circuit. Coil and Coilpack leaflets, radio and component lists, and interesting miniature circuits, etc.

OUR TECHNICAL DEPT. WILL BE PLEASED TO ANSWER (BY LETTER ONLY) ANY ENQUIRY RELATING TO CIRCUITS IN WHICH OSMOR COILS OR COIL PACKS ARE USED OR ARE INTENDED TO BE USED.

BRIMAR VALVES

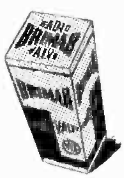
More Reliable than EVER !

Brimar's long experience in the manufacture of special quality TRUSTWORTHY valves is now being reflected throughout the entire Brimar range.

Improved production methods, new and better assembly jigs, tighter control on the composition of materials, and the closer supervision of vital processes have resulted in valves with more uniform characteristics, greater mechanical strength and a higher standard of reliability as shown in the 12AT7.

The 12AT7 is a very reliable frequency changer and is widely used in modern TV receivers, VHF and UHF communications equipment. It is also frequently employed in industrial equipment, computors, navigational aids and test equipment.

Use the BRIMAR **12AT7**—with improved performance —at NO EXTRA COST



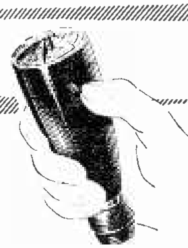
now is the time to BRIMARIZE!

BRIMAR	MULLARD	MARCONI OSRAM	COSSOR EMITRON
12AT7	ECC81	B152 & B309	12AT7

Standard Telephones and Cables Limited FOOTSCRAY, KENT. FOOtscray 3333

Another Fine acos

CRYSTAL MICROPHONE...



Desk Stand or Hand

MIC 36 SERIES

MODEL Nos.

Microphone without switch and with table stand - -	**MIC 36 3**
Microphone with switch and table stand - - -	**MIC 36 4**
Microphone without switch and with floor stand adaptor - -	**MIC 36 -5**
Microphone with switch and floor stand adaptor - - -	**MIC 36- 6**

All models are suitable for hand use.

This new ACOS microphone has all the signs of being a "winner". It is a very handsome instrument—and its performance matches its looks. The die-cast microphone insert has a high sensitivity with a pick-up field that may be considered as omni-directional. Alternative models, with or without switch are available with suitable adaptors for floor or table stands.

SPECIFICATION

Output level: –55 db. ref. 1 volt/dyne/cm2.
Nominal capacity: .002mfd.
Omni-directional frequency response: Substantially flat from 30-7,000 c/s.
Recommended load resistance: Not less than 1 megohm dependent on the low frequency response required.

always well ahead

Retail Price in Gt. Britain

Models without switch - - -	**£3-3**
Models with switch - - -	**£3-8**

Acos crystal devices are protected by patents, patent applications and registered designs in Gt. Britain and abroad.

COSMOCORD LIMITED · ENFIELD · MIDDLESEX

Practical Wireless

EVERY MONTH
VOL. XXX, No. 574, AUGUST, 1954

Editor: F. J. CAMM

22nd YEAR OF ISSUE

COMMENTS OF THE MONTH

By THE EDITOR

The Interference Problem

IN the early days of radio there were many complaints of interference caused by re-radiation from receiving aerials. In those days when it was necessary to turn the reaction knob to its fullest extent in order to build up signals radiated from low-power transmitters, because of the comparative inefficiency of valves and deficiency in design, the BBC frequently broadcast advice on how to avoid it. Complaints were very general. To-day, the trouble is all but vanished so far as radio sets are concerned.

Now owners of TV sets complain of interference from electrical apparatus, including radio sets, forgetful of the fact that TV can and does undoubtedly cause interference with radio reception. The complaints are widespread and TV owners are pressing for the compulsory suppression of all electrical apparatus likely to cause interference. Suppressors cost a comparatively small sum. Soon there will be an outcry on the part of owners of radio receivers pressing owners of TV sets also to fit suppressors. It is a point when they voice their own grievances in this respect that they often overlook.

RADIO SHOW ARRANGEMENTS

SIR MILES THOMAS will open the National Radio Show, at Earls Court, on August 25th. It will remain open until September 4th. For the first time it will include a demonstration by the BBC of outside TV broadcasts as well as studio broadcasts on sound and TV. This year the Royal Navy rejoins the Army and the Royal Air Force in the Services Section and radio controlled models will be among the electronic sideshows.

TV programmes from seven different sources—six of them within the exhibition—will be seen continuously on the screens of several hundred domestic receivers, and cameras used will include the small industrial types and the "roving eye," which is a self-contained camera and transmitting unit, making it free of cable connections.

BBC STATISTICS

EVEN statistics can be interesting, as Doctor Kinsey has proved! Figures recently issued by the BBC are certainly so, but it would be wrong to draw false conclusions from them. Statistics may indicate a trend, but not an irrevocable trend. Sign posts, it was once said, often point both ways. We are referring to the drop in listening reported by the BBC, who draw the conclusion that it is due to the competition of television. Not entirely so, in our view. It would appear that those on the sound side of radio have given up what they consider to be an unequal struggle with the new medium and the sound programmes suffer in quality as a result. To-day, indeed, some of the main programmes merely consist of a series of silly, childish party games, such as "Twenty Questions," "Round Britain Quiz" and "What's It All About." There are far too many programmes of this sort, which do not require a great deal of effort or brains in their creation and production. Sound programmes have definitely deteriorated. The BBC should remember that it still draws most of its revenue from the largest percentage of its customers—the listeners. It would appear to us that some fresh blood is required in the BBC on the production and programme planning side.

It is unfortunate perhaps for viewers that many of the TV programmes are based on the same old sound radio formula. "Down You Go," for example, underestimates the intelligence of viewers. The viewing public has not yet grown critical and is hypnotised by the marvels of the new entertainment medium, as in sound broadcasting; listeners were blinded by the scientific miracle of radio and would listen to any set which could squawk even though the sounds were unintelligible. Our programmes in toto are not bad but they are in need of great improvement. If it were not so the question of alternative commercial programmes would not arise.

"THE PRACTICAL MOTORIST AND MOTOR CYCLIST"

WE are pleased to be able to announce that we have overcome some of our production difficulties which prevented us from meeting the almost unprecedented demand for our new companion journal, *The Practical Motorist and Motor Cyclist*. Number three is now on sale, and greatly increased supplies are available. Many readers of this journal also read our companion journals and they will welcome this news. Even so, to avoid disappointment we do urge all readers to place a regular order with their newsagent to ensure delivery of future issues.—F.J.C.

ROUND the WORLD of WIRELESS

Radio for Police Squads

IT is reported that Birmingham police are to fit radio communication equipment to the machines of their motor-cycle squads.

New Ediswan Representative

MR. J. O. WILSON has joined the Edison Swan Electric Co. Ltd. as representative to Southampton district office.

Mr. Wilson was formerly representative attached to the Domestic Appliance Division of the English Electric Co. Ltd. He also spent fourteen years with Kennedys, (Bournemouth) Ltd., electrical wholesalers, attaining the position of assistant manager, Southampton branch.

During the war Mr. Wilson served for seven years in the Royal Artillery and reached the rank of staff captain.

" Clearadio "

ONE of the features of this year's National Radio show will be a demonstration of " Clearadio," the BBC's V.H.F. system designed to provide interference-free reception.

Visitors to the show will be invited to listen to programmes broadcast over the present medium wave and then by the very high frequencies and judge for themselves the difference in sound.

Broadcast Receiving Licences

THE following statement shows the approximate number of licences issued during the year ended April, 1954. The grand total of sound and television licences was 13,455,061.

Region	Number
London Postal ...	1,628,177
Home Counties ...	1,442,147
Midland	1,243,694
North Eastern... ...	1,621,831
North Western ...	1,261,933
South Western ...	1,010,350
Wales and Border Counties	628,921
Total England and Wales	8,837,053
Scotland	1,093,561
Northern Ireland ...	223,609
Grand Total	10,154,223

Hattie Jacques, Max Bygraves, Adele Dixon and Spike Milligan are seen recording another edition of " Paradise Street," a weekly comedy series broadcast in the Light Programme.

New Research Building

MR. R. L. SMITH-ROSE, C.B.E., director of the Radio Research Station at Ditton Park, Langley, Bucks, recently turned over the first spadeful of soil on the site for a new building which will take an estimated £250,000 to £300,000 to build.

It has been designed by Mr. H. A. Snow, senior architect at the Ministry of Works, and will replace the wooden huts that have so far housed the equipment used by the research workers. When the building is completed in about two years, time the staff of 100 will be increased to 300 and the work of the station expanded a great deal.

East African Link

AT an overall cost of approximately £100,000 or so, an important addition to the communications system of East Africa was recently made with the completion of a V.H.F. multi-channel radio link between Nakuru in Kenya and Jinja in Uganda, affording an immediate increase of 12 channels to the four already available between Nairobi and Kampala, with provision for 12 more in 1955 and another 12—36 in all—when traffic demands justify their introduction. Stand-by equipment allows for 36 alternative speech circuits to be automatically available in the event of breakdown or deterioration of those in use.

Pleasure Cruise for Dealers

A PARTY of 127 people sailed from Tilbury on Saturday, May 22, in the liner *Arcadia* on the start of the Philips Mediterranean cruise. A number of dealers decided to pay for a passage for their wives so that they could accompany the party, the dealers invited being those who had made the most outstanding contribution to the Philips crusade to put radio sets and record-playing equipment " back on the map." First port of call was Ceuta in Spanish Morocco, then Naples and finally Barcelona on May 30. A farewell party was held towards the close of the return journey.

I.P.R.E. Yorkshire Section

A YORKSHIRE Section of Incorporated Practical Radio Engineers was inaugurated at the Midland Hotel, Bradford, on June 9.

S. Gordon Bromby was elected chairman, with a supporting committee consisting of Messrs. R. N. Balmforth, A. Booth, A. R. D. Hall, F. Wade and R. P. B. Williams. The address of the local secretary, P. A. Senior, is 5, Calverley Moor Avenue, Thornbury, Bradford 3. Including members, 159 engineers and traders were present at the film lecture given for Mullard Ltd. by C. H. Gardner, who is a vice-president of the I.P.R.E. This followed the business of the meeting.

Direction-finding Equipment

THE equipment division of Mullard Ltd. recently installed a Mullard "Discovery" direction-finding set on the world's largest cable ship, H.M.T.S. *Monarch*. The *Monarch*, one of four cable ships for which Mullard have contracts to supply direction-finders, operates in any part of the world.

She will soon be employed on the arduous task of laying part of the transatlantic repeater telephone cable.

Anniversary of Pioneer

JUNE 18, 1954, marked the sixtieth birthday of a famous personality of the Danish Press — Mr. George W. Olesen, editor-in-hief and publisher of the monthly magazine *Radio Ekko*. He has been an amateur radio operator since 1914 and served as a ship's wireless operator in his younger days.

Mr. Olesen founded the *Radio Ekko* seventeen years ago and under his editorial guidance the paper still remains the only Scandinavian radio magazine known and read in all continents of the world. His sixtieth birthday coincides with his thirtieth anniversary as an editor-in-chief, for he headed the weekly journal *Radio-Uge-Revue* in 1924, when his wireless articles soon began to gain popularity.

Syrian Contract

MARCONI'S Wireless Telegraph Co. Ltd., and International Aeradio Ltd. have together secured a substantial contract for radio communication and direction-finding equipment from the Ministry of Defence of the Republic of Syria.

This contract entails the planning and engineering of a complete radio communications network, which is to include automatic and manual V.H.F. direction-finding stations (both mobile and static), with associated V.H.F. ground and air communications facilities. A training school for personnel of the Syrian Air Force is also to be provided.

Radio Show

THE National Radio Show will be opened at Earls Court, London, on August 25 by Sir Miles Thomas, chairman of the British Overseas Airways Corporation, and will remain open to the public until September 4.

Hotel Wireless Licences

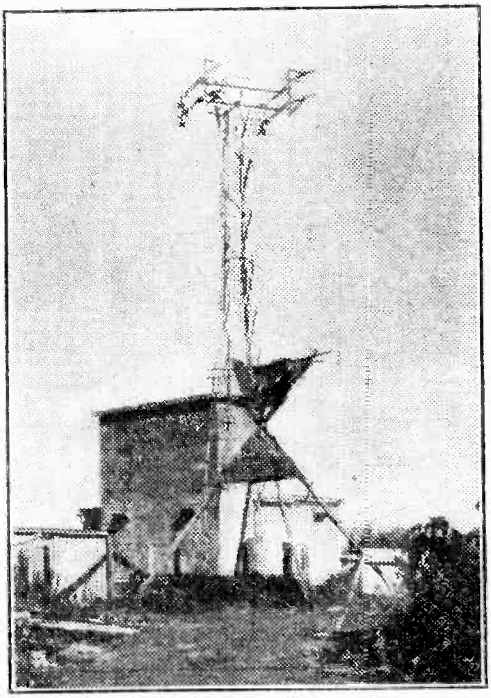
UNDER the Wireless Telegraphy Act, 1949, of which Section One came into force on June 1, it is still necessary for hotels and boarding-houses to have broadcast receiving licences.

A normal licence covers the use of a set in the public rooms of the hotel and private rooms of the proprietor, but each permanent guest or boarder with his own private receiver must take out his own licence. There is also a new comprehensive type of licence which is taken out by the proprietor to cover his own sets and all private sets owned by his guests or boarders.

R.S.G.B. Exhibition

THE Council of the Radio Society of Great Britain have approved the plans for the eighth R.S.G.B. Amateur Radio Exhibition to be held on November 24th to 27th at the Royal Hotel, Woburn Place, London.

P. A. Thorogood, M.A.S.E.E., G4KD, general manager of the Electrical Engineers Exhibition, has agreed to be exhibition manager for the eighth exhibition. Mr. Thorogood is a past member of R.S.G.B. Council and is an active amateur on 145 Mcs. and 70 cms.



Repeater station and yagi aerials on Loldiani Mountain, 10,000ft. above sea level. Duplicate 36-channel V.H.F. multi-channel radio-telephone link was recently completed. (See paragraph opposite.)

Obituary

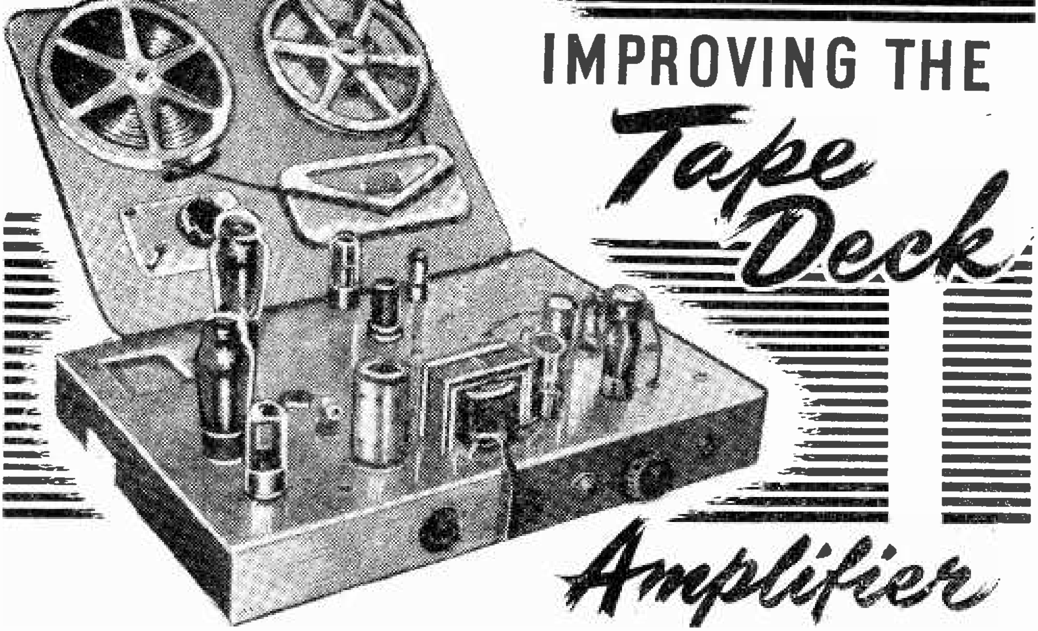
WE regret to record the death on Monday, April 26, of Mr. P. Moseley, managing director of Osmor Radio Products, Ltd., South Croydon, Surrey, at the age of 32.

He was a keen radio enthusiast and controlled his business of the manufacture of coils, coil assemblies and radio components since 1947.

"Blackpool Night"

FOR consecutive Wednesday evenings during the summer months Light Programme listeners will again hear "Blackpool Night."

The cream of the country's variety talent is attracted to the theatres of Blackpool to entertain the thousands of holidaymakers that flock there each week. Many of these top artistes will be heard in the series.



IMPROVING THE Tape Deck Amplifier

MODIFICATIONS AND AN ALTERNATIVE BIAS AND ERASE OSCILLATOR ARRANGEMENT

By C. L. White, Assoc.Brit.I.R.E.

COMPARED with the original Wright and Weaire tape deck around which the associated electronic equipment was designed, the new tape deck is such that it is worth while to see what can be done to improve the original amplifier performance. Not only has the deck been improved, but since 1952 much experience has been gained in the manufacture of magnetic tape which, among other things, has resulted in a higher signal-to-noise ratio: combining the two enables the writer to put forward an improved specification.

The new record/playback and erase heads were investigated and it was found that for the same minimum distortion level the bias volts across the recording head could be reduced. Referring to page 460, this means that R53 should now be increased to 300 ohms. Many queries have been received on how to measure the bias and erase volts, so that it will be a good thing to say here that with the equipment to be found in the average constructor's workshop it will not be possible to get an accurate measurement; what is possible, provided that the meter used has a sufficiently high impedance, is a comparative reading. As a guide—and it must be reiterated that it is a guide only—the reading given on a Pullin 10,000 ohms per volt meter was 20 volts measured from R53 to chassis. Since the original specification was published, two of the components used in the bias and erase oscillator are no longer on the market, and the opportunity is taken to replace these with components that are freely available. No change in the general design was found necessary, the requirements of good waveform, stability and ample output for erase being already there, so that the only changes required are the replacement of the original centre-tapped oscillator coil by the Osmor type QT8, and the replacement of the original H.F. choke by either the Wright and Weaire type 666, or two Osmor type QC1 connected in series. As shown in the drawing, if using the Wright and Weaire type 666 a 500 pF condenser should be connected in parallel. On technical grounds the W. & W. coil is to be preferred as it can be tuned to give rejection of the oscillator volts on the H.T. line, but where no test equipment exists it is better to use the two Osmor type QC1.

Frequency Response

A consideration of the first frequency response characteristic suggests that not only should the higher frequencies be extended and maintained, but that to keep a proper balance the bass response should be extended and maintained too, so that the new specification now runs ±3/DB30-9,000 cycles/sec., with

RECORDING AMPLIFIER

Layout identical with original.

Parts List Changes:

C4 = 0.05 μF.
C7 = 0.05 μF.
R8 = 2.2 KΩ.
VC1 = 100 KΩ.
C41 = 50 μF 12-volt wkg. } **optional (see text).**
R29 = 100K. }

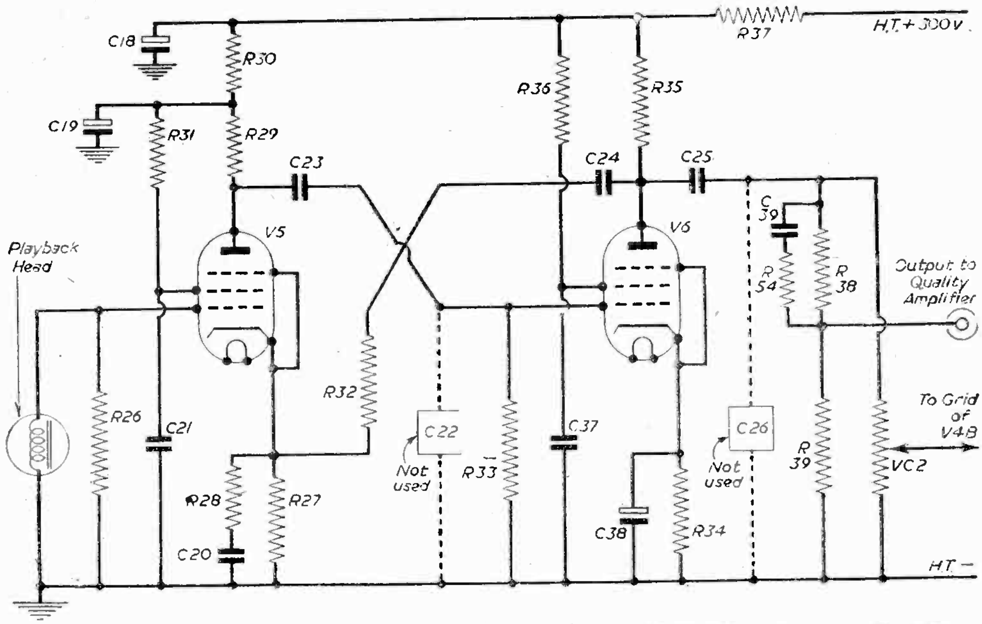
a drop of not less than 12DB at 12 kc/s. Two further modifications were included, in that it was found that there was a 4db loss at 9 kc/s at the output terminal marked "Output to quality amplifier" when used with approximately 5ft. of coaxial, and there was a variation of frequency response of H.F. during recording depending on the position of VC1 amounting to ± 3db. Checking on the recording amplifier it will be seen that VC1 is a 500,000-ohm potentiometer. Using so high a resistance as this will keep the gain of the stage at maximum, but will result in a loss at high frequencies when the arm is otherwise than at maximum. The simplest way out of the difficulty is to allow for the slightly reduced gain and use a potentiometer of approximately one-fifth the original value, making it 100,000 ohms. Now that the top response is to be extended, the small changes in the equalisation that are needed can be incorporated in such a way that the small loss of gain occasioned by the use of a 100 K potentiometer for VC1 can be made up. These changes are tabulated on page 458.

Modifications

Coming now to the playback amplifier, the first modification is the correction of the fixed potentiometer "Output to quality amplifier." The correction consists of "bridging" the feed resistance R38 by a condenser C39, and a series resistance R54 whose values are 30 pF and 660 K. This will compensate for up to 8ft. of coaxial cable. This, of course, does not correct for changes caused by the variation of VC2 when using the integral amplifier, but generally these can be neglected. C22 and C26 are now disconnected and removed, and altering the value of R28 to 500 ohms completes the changes as far as the H.F. response is concerned, excepting that the feedback is also to be increased which will make the changes more effective. In order to maintain the bass response and extend it to 30 cycles per second, it will be necessary to increase the gain of the playback amplifier V5 and V6. This is done by changing R35 to 220 KΩ, R36 to 1.2 MΩ, fitting a decoupling condenser C37 0.25 μF and decoupling condenser C38 50 μF and increasing the H.T. line volts to 300.

Though some critics will doubt whether the cost of increasing the bandwidth of a reproducing system from the 60-8 kc/s to the new one of 30 cps-12 kc/s is worth while, to those who have heard the modified amplifiers there is no possible doubt. As some indication of the subjective tests that the new equipment has come through with 100 per cent. marks is that of re-recording the special Audiophile records which on playback are indistinguishable from the original.

The final frequency response characteristic is

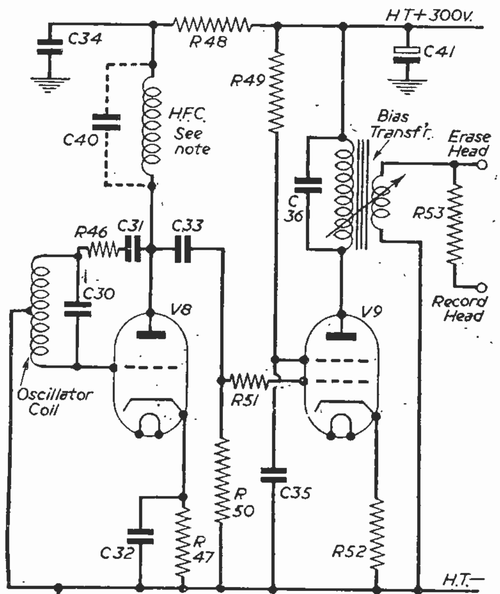


PLAYBACK AMPLIFIER

R26 1.5MΩ.	R34 1.5 KΩ.	VC2 500 KΩ.	C24 0.001 μF.
R27 2.2 KΩ.	*R35 220 KΩ.	V5 EF40.	C25 0.25 μF.
*R28 500Ω.	*R36 1.2 MΩ.	C18 16 μF elect.	*C26 Not Used.
R29 220 KΩ.	R37 50 KΩ.	C19 16 μF ,,	V6 EF40 or EF37.
R30 27 KΩ.	R38 470 KΩ.	C20 0.01 μF.	*C37 0.25 μF.
R31 1.2 MΩ.	R39 47 KΩ.	C21 0.25 μF.	*C38 50 μF elect (6v.) wkg.
R32 120 KΩ.	*R54 660 KΩ.	*C22 Not Used.	*C39 30 pF.
R33 1 MΩ.		C23 0.25 μF.	

* Indicates components where a change has taken place.

tabulated below. It will be found a very close fit to the specification.



Note: If Wright and Weaire Choke Type 666 is used C40 must be connected as shown

SUPERSONIC BIAS SUPPLY

*Oscillator Coil, Osmor Type QT8.	R46 = 1.0 K Ω.
*H.F. Choke, either 2 Osmor type QC1 or	R47 = 4.7 K Ω.
*1 Wright and Weaire type 666.	R48 = 25 K Ω.
	R49 = 4.7 K Ω.
	R50 = 250 K Ω.
	R51 = 1.0 K Ω.
	R52 = 270 Ω.
C30 = 0.005 μF.	*R53 = 300 Ω.
C31 = 0.001 μF.	1 Wright and Weaire Bias Transformer type 579.
C32 = 0.1 μF.	
C33 = 0.001 μF.	
C34 = 0.1 μF.	
C35 = 0.1 μF.	* Indicates components where a change has taken place.
C36 = 0.005 μF.	
*C40 = 0.0005 μF.	

30 cps	=	17.0 db.
40 cps	=	18.0 db.
60 cps	=	19.0 db.
100 cps	=	19.0 db.
250 cps	=	19.0 db.
1,000 cps	=	19.0 db.
4,500 cps	=	21.0 db.
7,000 cps	=	20.0 db.
8,000 cps	=	18.0 db.
9,000 cps	=	15.0 db.
10,000 cps	=	11.0 db.
11,500 cps	=	8.0 db.

There is one further modification, which can be considered as optional, in that it is only required when insensitive microphones are used. It is that the gain of the recording amplifier may be increased by changing the value of R2 to 100 KΩ and connecting a decoupling condenser C41 (50 μF) from the cathode of V1 to earth.

International Sound Recording Congress

THE Société des Radioélectriciens, in conjunction with important French broadcasting, cinema, acoustical and television groups, recently organised a conference at which all sound recording processes could be discussed, as well as the use of these same techniques for the recording and storage of " information " in comparatively new fields, such as magnetic recording of images, memory devices, electronic calculators, computing and statistical machines, automatic telephony devices, and so on.

The Congress, which lasted a week, was held at the Maison de la Chimie, in the rue Saint-Dominique, Paris, and over 600 delegates from 22 countries, including the U.S.S.R. and Czechoslovakia, attended, with, of course, the largest contingent from France herself. The British delegates included Dr. O. K. Kolb (British Acoustic Films), A. J. Forty (British Post Office), M. M. Freeland (Radio Malaya, Singapore), C. M. Phillips and J. A. Clark, of S.R.D.E. and the Acoustics Group, Hants, D. W. Aldous (British Sound Recording Association), Dr P. E. Axon and H. J. Houlgate (BBC), A. Tutchings, R.R.E., Malvern, D. G. Jaquess (Decca), H. A. Thomson (Kelvin & Hughes, Glasgow), and Prof. D. Gabor (Imperial College of Science).

An exhibition of the latest sound recording and reproducing equipment was a popular feature of the proceedings, to which the public were admitted for 150 francs (about 3s.) and given the opportunity of making personal voice recordings and hearing the playback.

About 50 exhibitors and distributors took space, but only two British firms were represented—Grampian Reproducers, Ltd., Feltham, Middlesex, and Truvox, Ltd., of Harrow, Middlesex, with Mr. Robert Bradford, of the former company, in attendance. The display on his stand of the modified BBC pattern negative feedback disc cutter-head, developed with the Reeves Equipment Corporation of New York, and the associated 40VA and 60VA output feedback amplifiers, attracted much interest, as did the Truvox Mark III Tape Deck.

Five Sections

The Conference proper was divided into five sections: (a) history, communication and methods of measurement; (b) magnetic recording; (c) photographic recording; (d) mechanical recording; and (e) applications and their extension into the realm of information storage.

As over 60 papers were given in four days, meetings were running simultaneously and the British visitors split up to cover these diverse sessions and subjects, ranging from studies of " wow " and flutter to an artificial variable delay line using magnetic tape designed as an analogue correlator to a survey of the fascinating *musique concrete*, in which an analysis of the form of music and the examination of its transient and spectral constitution leading to its application in objective music was discussed.

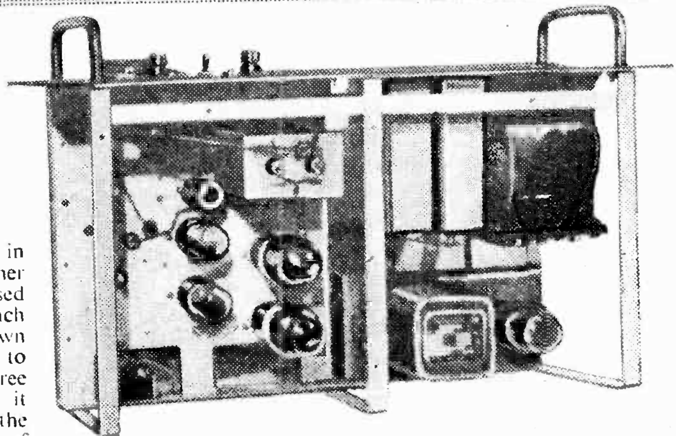
In the exhibition all forms of magnetic tape and wire recorders were displayed and demonstrated, with some good examples of American design (notably the Ampex models).

D. W. ALDOUS.

Stabilised Power Supplies

SOME THEORETICAL NOTES AND CONSTRUCTIONAL DETAILS

By E. N. J. Marguerit



THERE is always a controversy in the amateur world as to whether one should have a stabilised power unit in the "den" or have each piece of equipment fitted with its own power supply. The answer seems to be that a highly stable and ripple-free source of power is desirable, as it enables one to use it for supplying the necessary power to a new piece of circuitry while it is being tried and experimented upon. When the design, possibly suitably modified, has been found satisfactory, it can be fitted into the equipment it was designed for and its own unstabilised supply built for it. It does, therefore, seem that a stabilised power supply is a necessity for any serious experiments in the field of electronics.

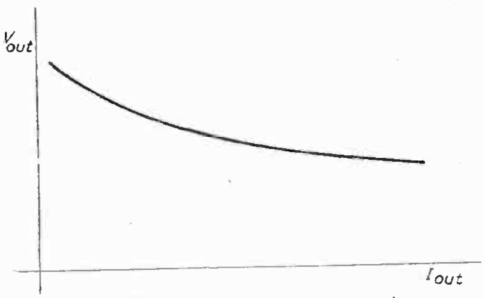


Fig. 1.—Plotting current against voltage.

Power Supplies

In this article this heading embraces any device that will convert an alternating potential into a direct potential. The main component for this purpose is the rectifier. Rectifiers can take the following forms:

1. Metal rectifiers.
2. Cold cathode rectifiers.
3. Thermionic rectifiers:
   (a) Hard vacuum;
   (b) Gas filled.

All these can be used in half-wave or full-wave circuits. Half-wave rectifier circuits are perhaps cheaper to build, but have the disadvantage of requiring large values of smoothing capacitors.

Whichever system is used in a simple power unit there is an inherent disadvantage in both, that they have poor regulation. That means that the output current is a function of the output voltage. If we plot output current against output voltage we obtain a curve as shown in Fig. 1.

As the current taken from the power supply increases its voltage drops. Another consideration, of course, is that if the mains voltage feeding the system fluctuates, the output follows these fluctuations fairly faithfully.

Methods of Improving the Regulation

1. A choke-input filter can be used after the rectifier to obtain a better regulation. However, the output voltage in this case will not be as high as with a capacitor input filter. This means that if a high output voltage is required, using a choke-input filter circuit, a fairly large mains transformer will be needed. Fig. 2 shows the two types of circuit with some typical figures to illustrate the above.

2. Another method of improving the regulation is to use a voltage regulator tube across the smoothed output of the rectifier.

Those gas-filled tubes such as the VR75, VR105, VR150, 90C1, 85A2 and many others have the

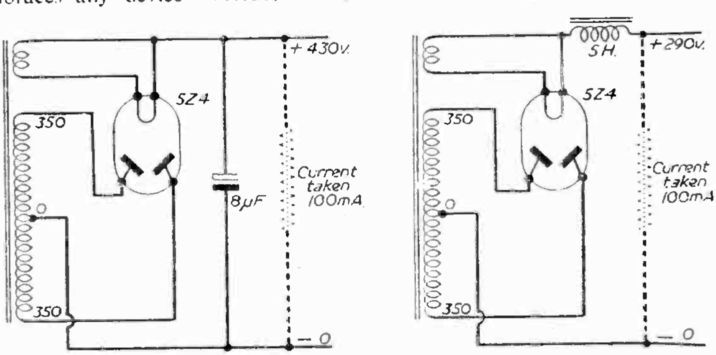


Fig. 2.—Capacitor and choke-filter circuits.

property of maintaining, within limits, a constant voltage across them.

In Fig. 3 a potential E1 is connected in series with R1 and the regulator tube. The potential E2, which is the burning voltage of the tube, is also the output of the system. E1 must be large compared to E2 for good regulation.

To calculate the value of R1 in Fig. 3 one must remember that two currents flow through it: one is the current through the tube needed in order to maintain the ionisation of the gas, the other is the current taken by the outside source fed by the neon.

Let I1 be the current required to maintain ionisation. This current varies from 1 to 5 milliamperes according to types, and let I2 be the current required by the outside load, then if E1 and E2 have the meaning of Fig. 3,

$$R1 = \frac{E1 - E2}{I1 + I2}$$

The output current obtainable from these tubes is in the region of 10 to 40 milliamperes.

If we plot the burning potential (E2) against output current we get a graph as shown in Fig. 4.

For example, the regulation of a VR150 from minimum to maximum current is 5.5 volts.

3. The third method is to use an electronic circuit to compensate for variations in the output due either to fluctuations in the mains supply or to varying loads.

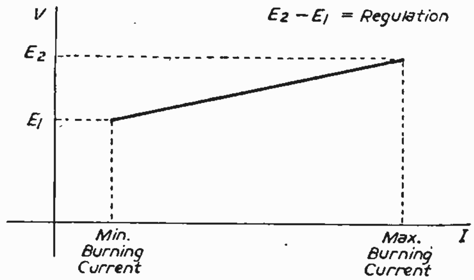


Fig. 4.—Plotting burning potential against output current.

Electronically Stabilised Power Supplies

Theoretical Considerations

If the output voltage is to vary, due to the causes mentioned earlier, use is made of the control characteristic of a triode to compensate for that variation.

Consider the circuit of Fig. 5 where the tube T1 is connected in series with a potential E in, obtained from a suitable rectifier-smoothing arrangement. The output voltage appears between the cathode of T1 and the negative line. The grid of this tube, known as the series valve, is connected via R to a source of negative voltage with respect to the cathode. Consider also a load resistor RL connected across the output. Now, if the grid of T1 is very negative with respect to the cathode, so much so that T1 is cut off and, therefore, passes no current, no current will flow through RL. But as the bias is gradually

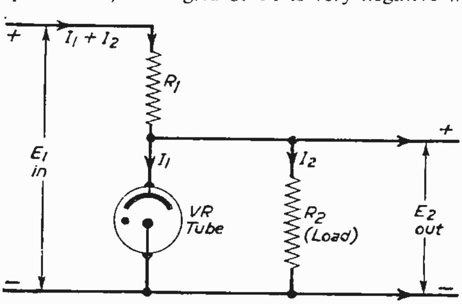


Fig. 3.—A voltage regulator tube and associated circuit.

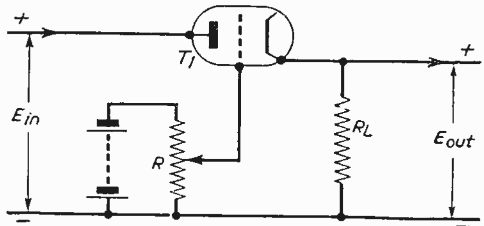


Fig. 5.—Using a triode to control output.

decreased (i.e., the grid becoming more positive with respect to the cathode) the valve will pass more and more current and this current must flow through RL. In other words T1 is used as an electronic resistance.

Consider now Fig. 6, similar to Fig. 5, but RL is now variable. Suppose that R is at some position which determines a certain value of bias for T1. We have seen above that this value of bias will allow a certain current to flow through T1 and RL. Keeping R fixed, we now vary the value of RL. Let us decrease RL in an effort to increase the current through it, but as T1 has a fixed bias it cannot pass that higher current, hence to obey Ohm's Law E2 must necessarily fall. Therefore, if we wish to pass the higher current through RL we must decrease the bias on T1 by altering the setting of R. It now seems obvious that if we had an electronic means of altering the bias on T1 for varying load currents we would have solved our problem.

This is conveniently achieved by using a D.C. amplifier. The type of D.C. amplifier used for this purpose is known as a difference amplifier.

In the above discussion we have assumed that E1 is always constant, but we know that in practice this is not so as it depends primarily on the mains voltage. It is proposed now to consider the action of the regulator as E1 varies.

Referring to Fig. 6, suppose that a fixed potential E2 is required, and that a current $\frac{E2}{RL}$ should flow through RL. To do this R must be adjusted so that T1 has the required bias to pass that current. Imagine now that E1 increases due to an increase in the mains voltage; E2 will also rise, but as E2 increases the bias on T1 will also increase, therefore allowing T1 to pass less current, but RL is fixed, therefore the increased potential E1 will bring E2 down to almost its original value. Hence the regulator will automatically compensate for mains voltage fluctuations.

Difference Amplifiers

By definition a difference amplifier is a two input device which will amplify the voltage difference existing across its inputs.

Consider the circuit of Fig. 7 where T is a triode having an anode load RL. If the cathode is held at a steady potential E2, from a low-impedance source, and the grid connected to a potential E1 varying within small limits, then the circuit will amplify the difference of voltage (E2—E1). This output will be developed across RL.

Another form of D.C. amplifier is shown in Fig. 8. Here two triodes or a double triode are used with their two cathodes connected to a common resistor

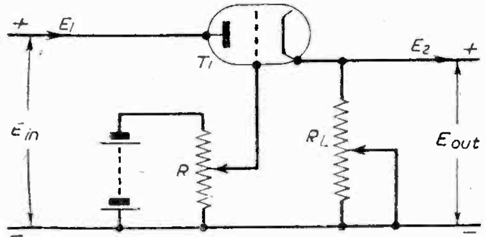


Fig. 6.—In this modification of Fig. 5, RL is made variable.

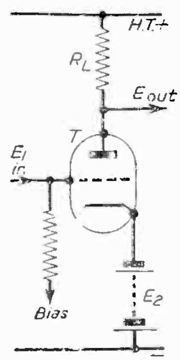


Fig. 7.—A simple triode circuit.

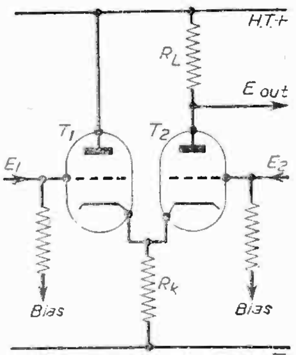


Fig. 8.—An alternative triode circuit using a double triode.

Rk. The inputs E1 and E2 are applied to the grids. Suppose that E2 is fixed and E1 varies, then the amplified difference will appear across RL of T2. It is essential that the D.C. amplifier used to regulate a power supply has a high gain, and as the gain of a triode amplifying stage depends on the amplification factor of the triode and on the value of the anode load, it is necessary that a high μ triode be used and that RL be large.

We shall now see how a D.C. amplifier can be used to regulate or stabilise a power supply.

Consider the circuit of Fig. 9 where T1 is the series valve and T2 the simple form of difference amplifier shown in Fig. 7. T3 is a voltage regulator, i.e., a low-impedance source, fed from the H.T. line through R3. This maintains the cathode of T2 at a steady potential E1. R1 and R2 are connected in series across the output in such a way that the potential at the junction of the two resistors with respect to the negative line is smaller than E1 by an amount which determines the bias of T2. Let this potential be E2.

The expression for E2 is

$$E2 = E\ out \times \frac{R2}{R1 + R2}$$

The anode of T2 is fed from E out via a resistor RL across which is developed the bias for T1. The grid of T1 is returned to the anode of T2.

It is clear from this diagram that T2 is connected as a difference amplifier, its inputs being E1, which is fixed and known as the reference voltage, and E2.

To explain the behaviour of the circuit let us assume that E out rises. This increase in output voltage will increase E2, thereby decreasing the bias of T2, because the value of E2 approaches that of E1. This will make T2 more conductive and the anode voltage will fall. Consequently the voltage across RL increases. But this voltage is the bias of T1, and if its bias increases so does its resistance. This fall compensates for the tendency of E out to rise.

Mathematical analysis of this type of circuit shows that to obtain satisfactory results it is essential that T1 has a high amplification factor and T2 a high value of mutual conductance.

Practical application of this circuit would make use of a beam tetrode for T1 such as a 6V6, 6L6, 6Y6, 12E1, etc., and a high gm pentode for T2 such as a 6SJ7, 6SH7, etc.

A circuit utilising the second type of D.C. amplifier is shown in Fig. 10. The behaviour is the same as that explained for the circuit of Fig. 9.

The type of double triodes normally used with this circuit are 6SL7 and 12AX7.

(To be continued.)

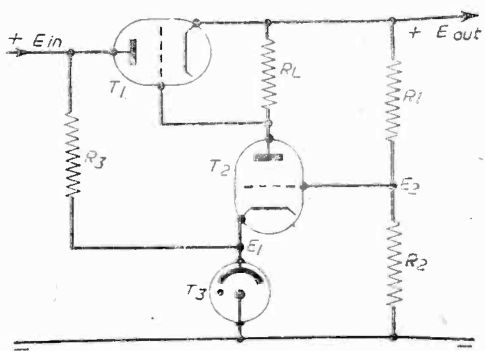


Fig. 9.—Simple difference amplifier.

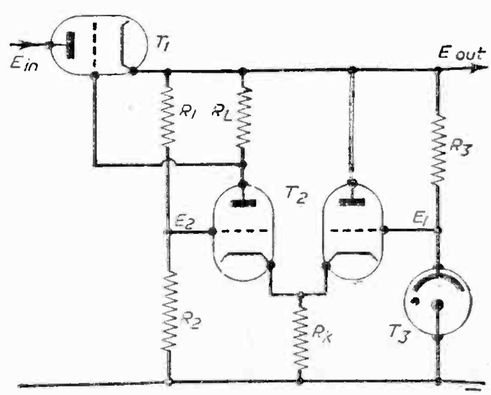


Fig. 10.—A D.C. amplifier circuit.

Mains Supplies for Battery Valves

By David Boswell, B.Sc.

THE 1.4 volt range of miniature battery valves were not primarily designed for use on rectified 50 cycle mains. The valve manufacturers state, however, that they can be operated satisfactorily from such sources, but recommend slightly different supply voltages. Exhaustive tests are continually carried out by the manufacturers on random batches from the production line, and these are designed to simulate the conditions experienced in receivers of the combined battery/mains type. The tests pre-suppose a certain standard of treatment which can best be described as " reasonable," but it is contended that even this standard is not always achieved by set-makers, amateur and otherwise. Since the " life " of these valves can be seriously shortened when incorrectly powered, some detailed investigation is desirable.

Emission

This range of valves, on the B7G base, is of proven ruggedness and reliability. During the recent war their use in such things as mine-detectors and " walkie-talkie " sets demonstrated an unquestionable value in service, but they were then powered, with one exception, by batteries. From a fundamental standpoint the disadvantage of a mains unit is its relatively poor regulation. Whereas a commercial 90-volt dry battery, when new, will not have a potential exceeding 97 volts between terminals, a mains derived voltage of this magnitude may momentarily deliver more than twice the operating figure. Many transformerless circuits normally considered acceptable for this class of receiver are here found wanting.

Compared to their mains types, the valves have filaments which are long and slender. Small ripple voltages can cause microphony, distortion and other inaudible vibrations which do not occur when batteries are used. Being directly-heated their emissive coating of barium oxide is sprayed directly on to the heater wire, and this is usually a very thin strip of nickel-aluminium alloy, whose surface area is relatively small. Anode and screen currents are thus limited to values well below those encountered in comparable indirectly-heated types.

It is obviously essential to cushion the valves from the peaks and surges that an over-zealous mains unit is apt to deliver and to guard the filament and its coating with more care than is usual. In this respect the amateur is willing to do far more than the set manufacturer ; he has often to pay astronomic prices ! It is firmly held that the accepted standard of treatment administered to this class of valve in battery/mains receivers is generally far too harsh, and that some means must be found of improving their lot if a good " life " is required.

L.T. Supplies

There are two common methods of supplying the heaters from the mains ; a transformer-fed parallel circuit is shown in Fig. 1 and the straightforward series arrangement in Fig. 2. Both of these are satisfactory if the set is running correctly and all filaments are alight. It is instructive, however, to compare the behaviour of both types of feed when one or more of the filaments burns out—a common fault in sets of this type. The parallel circuit utilises an L.T. smoothing choke (in some cases, alas ! a resistor), whose D.C. resistance will usually be 15-20 ohms. For a given value of inductance, the lower the resistance the better, and in this example we will assume a value of 15 ohms. When one filament fails there will be a tendency for several things to happen. First, due to transformer regulation and a smaller voltage drop across the choke, the applied voltage will attempt to rise. This must cause an increased current to flow in the remainder of the valves, which in turn raises the resistance of their filaments. It is clear that the final voltage and current can only be ascertained by experiment or by plotting

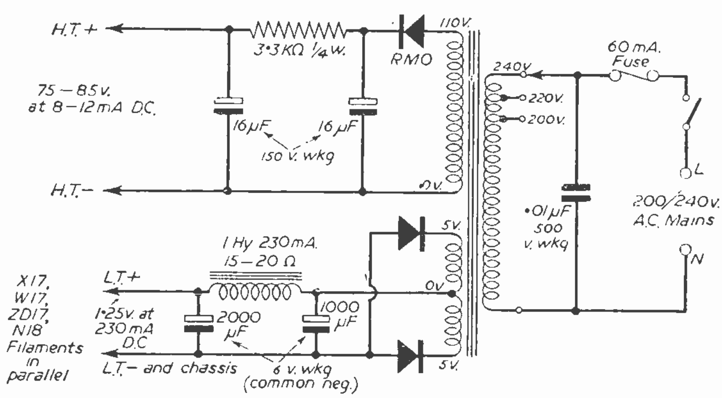


Fig. 1.—The parallel-fed filament method.

the curves of (a) the unit's output voltage against current, and (b) the variation of valve filament current with applied voltage. Where these graphs intersect, will give the operating condition for any selected number of valves. The form in which they appear is shown in Fig. 3.

The following figures were not taken from any particular unit. They represent an average case, but it should be stated that in many miniature battery-eliminators where the transformer core is small and therefore nearer saturation, conditions may be even worse. Let the five valve filaments be operating at, say, 1.25 volts and drawing .23 amps. from the power supply. When one fails, the current drain falls to .21 amps; there will be a decreased voltage drop across the smoothing choke and a rise in output volts due to transformer regulation. In fact, the filaments have now to run with an L.T. potential of 1.7 volts. This is dangerously high. With the 20 ohm choke, matters are worse, the voltage rising from 1.25 to 1.8 volts in similar circumstances. If the set is not switched off immediately, such an increase may cause the next weakest filament to go and the remaining valves are receiving over two volts. It has been known for an unattended parallel fed receiver, operating from a standard commercial mains unit, to burn out all four valves in ten minutes of silent destruction.

In a pure series arrangement, if one filament fails, the rest are open circuited and immune from damage. A more usual practice is to shunt some, or all of them, with resistors, so that filaments low in the chain shall not have to carry the anode and screen currents of those higher up. In such cases the effect of a burn-out will depend on the position of the valve and the values of the associated shunts. As it is readily possible, using the series circuit, to give adequate protection to the remaining valves after a filament failure, this method is preferable.

H.T. Supplies

Another hazard which these valves are expected to endure is that of having heater and anode voltages applied simultaneously. It is assumed that the fine, directly-heated element will warm up and be

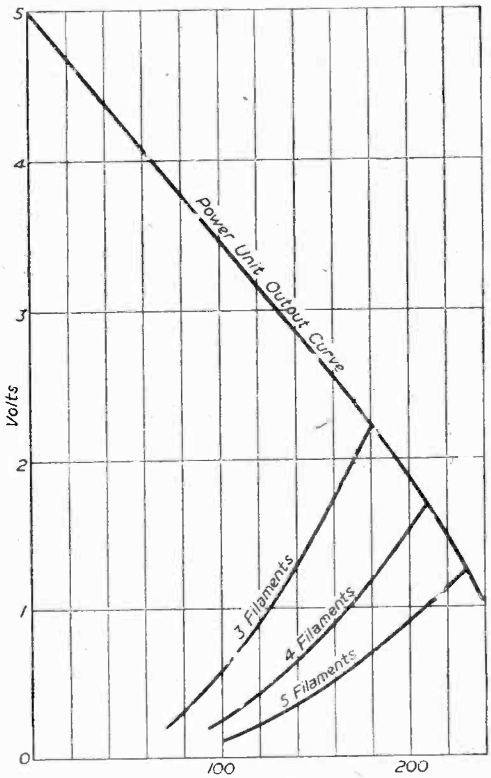


Fig. 3.—Setting out a graph plotting volts and current for various valve combinations.

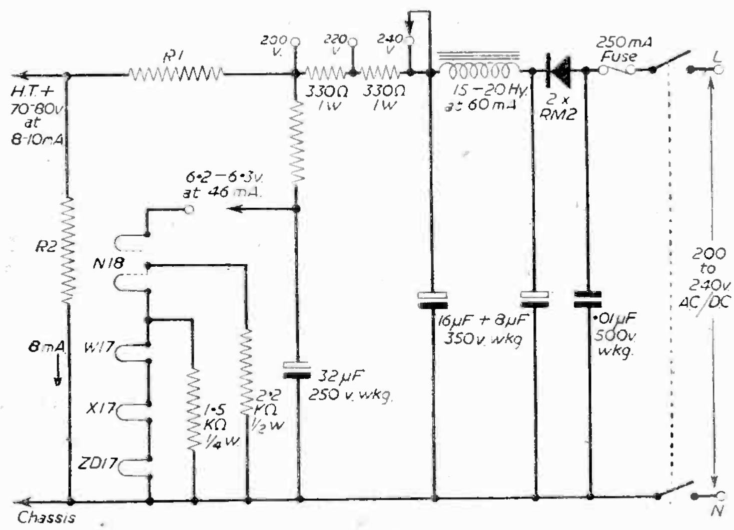


Fig. 2.—The series-fed filament arrangement.

ready to emit instantaneously, but this, of course, is not the case. A time interval of between one-fifth and one-third of a second may be involved.

When batteries are used, due to their relatively good regulation, no serious harm is done, but with a mains unit incorporating metal rectifiers, the valves may have to warm up in the presence of an H.T. voltage greatly in excess of their rated maximum (90 volts). This is particularly true of the series-fed arrangement in Fig. 2. Unless the divider network (R1 and R2) allows a drain at least as great as the total valve H.T. current, then a voltage of 150 volts or more will appear when switching on, or after a filament casualty.

It is emphasised that the

variations in H.T. voltage which occur under the conditions mentioned are unlikely in themselves to cause immediate failure. They are merely recurring instances of misuse and their elimination can add materially to the emissive life of the valves.

Surges

Heater current surges are common in receivers with series arrangements, and these are due entirely to the resistance/temperature characteristic of the wire elements. In the case of tungsten, the ratio of resistance hot to resistance cold is of the order five to one. This represents a serious problem where the greater part of the chain consists of valve heaters as opposed to voltage dropping resistors. The nickel-aluminium alloy used in these particular battery valves has a ratio of about four to one. This is still in itself sufficient to invite a sustantial surge, though the valve heaters normally represent only a small fraction of the chain.

A convenient method of overcoming the problem is to insert a surge limiter, known commercially as a Brimistor or Thermistor, in series with the heaters. These devices have an inverse resistance/temperature characteristic and are quite suitable where the H.T. rectifier is a valve and forms part of the chain. To use this type of rectifier in a small, portable receiver, would inevitably add to the heat and size problems; for this reason the metal rectifier is preferred, and surge limiters are omitted.

Also, when switching on series heater chains in A.C./D.C. mains sets, it is often noticeable that one of the valves invariably warms up first. Its filament may glow very brightly in one spot for a brief period before the chain settles down, though normally its robust nature makes it capable of standing the strain. Such a phenomenon can be caused by close coiling in a spirally-wound heater, or by local thinning of material where the wire is welded to its connecting strip inside the valve. This may also occur in battery valves, but will not be readily visible and, in view of the relatively delicate nature of the heater strip, prevention is a wise move.

The battery/mains set designer is thus presented with a difficult situation. A "Brimistor" may protect the heaters from sudden mechanical expansion due to the heating effect of current surges, but it will also prolong the period during which the barium oxide coating may be forced to emit before it is up to an even temperature. In addition, the H.T. voltage may temporarily reach a very high level.

Undoubtedly, the ideal solution is to hold off the H.T. supply while the heaters warm up slowly, but to do this involves extra expense which often cannot be tolerated.

Other switching surges involving the charging and discharging of condensers are more likely to damage the rectifiers and condensers themselves than harm the valves.

(To be continued.)

New Wireless Transmitting Licence Regulations

THE Wireless Telegraph (General Licence charges) Regulations 1954—Statutory Instrument 1954 No. 439, published by the Stationery Office, price 6d.—have now been laid before Parliament and give the charges for the main licences other than those for broadcast sound and television receivers.

These regulations, which came into operation on the 1st June, 1954, describe the fees and the scope of all the major licences. The fees of these licences have now been assessed so that the revenue obtained from each type of licence will cover the costs incurred in connection with that licence.

The following are the most important changes involved:

(a) The Amateur (Sound) Licence allows amateurs to work their stations anywhere in the United Kingdom. Originally they required special Alternative Address or Portable Licences for this purpose. Hitherto the power at which newly licensed amateurs could operate was lower than that allowed to established amateurs; this distinction has now been abolished, as has the different charges varying with the power used. An Amateur (Sound) Licence will cost £2 a year.

(b) A new licence, the Amateur (Sound Mobile) Licence, has been introduced which, for the first time, allows amateurs to operate from a moving vehicle. This licence will be available only to holders of an Amateur (Sound) Licence and will cost £1 a year.

(c) The annual royalty of the Amateur (Television) Licence has been reduced from £3 to £2.

(d) Radio controlled models become subject to licensing for the first time. The licence fee of £1 will cover a period of 5 years.

(e) The annual royalty for the Business Radio Licence, originally £5 per licence plus £5 for each station covered by the licence, is now reduced to £3 for each station. The name of the licence is changed to the Private Mobile Radio Licence.

(f) All Radio Beacon Licences now cost £1 for five years. This is a reduction for Aeronautical Beacon Licences which at present cost £1 a year.

(g) Firms who require licences for testing and developing radio equipment will no longer be issued with Experimental Licences but will be given a Testing and Development Licence. If their tests are conducted exclusively under suppressed radiation conditions they will be given a licence costing £1 for five years; if it is necessary for them to radiate, the licence fee will be £2 a year.

(h) Wireless schools and technical institutes paid 10s. a year for their licences and an additional 10s. a year if they used radar. Under the new Training Establishment Licence they will pay £2 for five years; this licence will include the use of radar for training purposes.

(i) The annual fee for ship licences is now £2 whether the ship is compulsorily fitted with radio or voluntarily fitted. This fee includes a charge for receiving broadcast (but not television) programmes, but does not include the cost of inspecting the equipment. The inspection charge, hitherto included in the licence fee for a ship voluntarily fitted with wireless, will be separately chargeable.

(j) The fee for aircraft licences is increased from 5s. to £1 a year. The new licence covers the reception of broadcast programmes.

The Beginner's Guide to RADIO

The Sixteenth Article of a Series Explaining the Fundamentals of Radio Transmission and Reception. This Month the Transformer, the Output Valve, and Speaker are Dealt With, With Notes on How to Read a Circuit Diagram

By F. J. CAMM

I HAVE already dealt briefly in earlier articles with the transformer explaining why it is used and what is meant by transformation ratio. An explanation of how it is made will help the reader to understand its function. The action of a transformer differs from that of a resistance. The simplest transformer consists of two coils of insulated wire wound round an iron rod and the coils may be wound either side by side or one over the other. When a fluctuating current is passed through one of the coils (the primary) a difference of pressure (voltage or potential) arises between one and the other. Also, the current passing through one coil *induces* a current in the other coil.

Now, if each coil has the same number of turns, then the difference in voltage between the ends of the second coil will be the same as that between the ends of the first. Similarly, if the second coil has more turns than the first, then the voltage produced will be greater than that across the first coil.

This is where the usefulness of a transformer becomes apparent. It enables the voltage to be stepped up any desired amount (I am, of course, referring to alternating current; it is impossible to step up direct current). Thus, if the second coil has twice the number of turns as the first, then the voltage across the second will be twice as much as the first, and if the second coil has three times as many turns the voltage will be three times as great as the first. A transformer can be wound to give any desired transformation ratio. This ratio is selected according to the characteristics of the valve it is to "feed." If the transformation ratio is too high, distortion will occur. Generally, a low-frequency transformer coupled to the output valve has a ratio varying between 3½ to 1 and 6 to 1. The output valve selected must, of course, be "matched" to the loudspeaker. It would, for example, be wrong to use a transformer and output valve giving an output of, say, 3 watts undistorted, in connection with a loudspeaker which would overload at less than this.

Transformers used in wireless sets are not made on the simple lines just described for purposes of illustration. It would indeed be very inefficient. Wireless transformers have soft iron cores, not in the form of a rod, but in the form of thin plates. These plates interleave as will be seen in Fig. 71 so that they provide a rectangle with a bar connecting two of the sides. A well-known material for these cores is Stalloy, and it is available already stamped in various sizes. It will be seen that this extends right round the outside of the coils as well as passing through the middle of them. The coils are, of course, very carefully insulated from one another, and are nearly always wound on the same bobbin. First, the primary winding is wound on then a layer of wax paper or insulating material such as Empire tape and, finally, the secondary winding is put on.

The power valve acts in exactly the same way as the previous valve, small variations of current at the grid giving large variations in the plate current.

The amplifying property of the valve itself added to the step-up effect of the transformer causes the total amplification to be considerable.

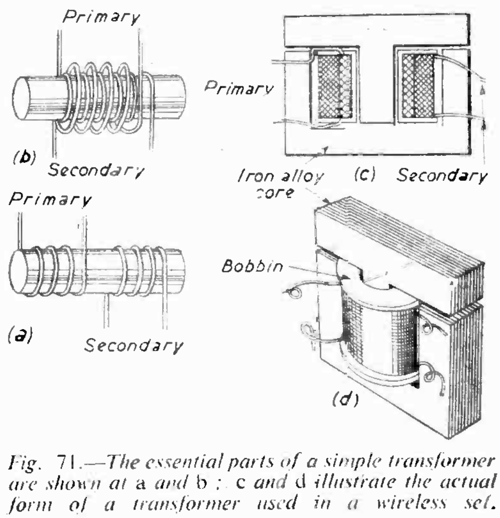


Fig. 71.—The essential parts of a simple transformer are shown at a *and* b; c *and* d *illustrate the actual form of a transformer used in a wireless set.*

At this stage we may connect up the loudspeaker. It is connected in the plate circuit of the output or power valve. That is to say, between the plate and the positive end of the high-tension supply.

In order to understand the working of the loudspeaker I will deal with the very simplest type, one consisting of a vibrating reed, not used nowadays. It consists of a permanent magnet, a strip of flexible iron known as the reed, a coil of fine insulated wire and a cone attached to the reed by a small metal rod. The coil is wound on a small bobbin which fits over one end of the magnet, while the reed, which is of a springy nature, is screwed to the other end of the magnet. Its action is as follows: the current from the plate of the power valve passes through the coil; this tends to increase the power of the magnet, for it is a well-known fact that if an electric current is passed through a coil of wire wound round a piece of iron the iron will become magnetised—in other words an electro-magnet or solenoid. In the case of the speaker, however, the iron is already magnetised. In other words, it is a *permanent* magnet. The current passing through the coil, therefore, increases the magnetism. We have already seen that when music or speech or any other sound is being received this current fluctuates in harmony or *syntony* with the sound vibrations of the instruments being played and this means that the magnetism produced by the current will also fluctuate, thus causing the reed to vibrate and communicate the sounds to the cone.

Whatever type of speaker is used (and there are several types) this principle applies.

Reading a Circuit

In the early part of this series, I illustrated a very simple circuit with diagrams showing the theoretical circuit and the wiring diagram, numbering the parts to correspond. As the circuit made use of very simple components, such as a home-made coil and a triode detector valve, which is scarcely ever used to-day, I think it advisable, now that the reader has become accustomed to more modern components, to illustrate a modern three-valve circuit in theoretical and practical form, with each component numbered to correspond. This circuit does not make use of triodes but employs two pentodes and a tetrode valve. The pentode valve, of course, gives much greater amplification.

(*To be continued*)

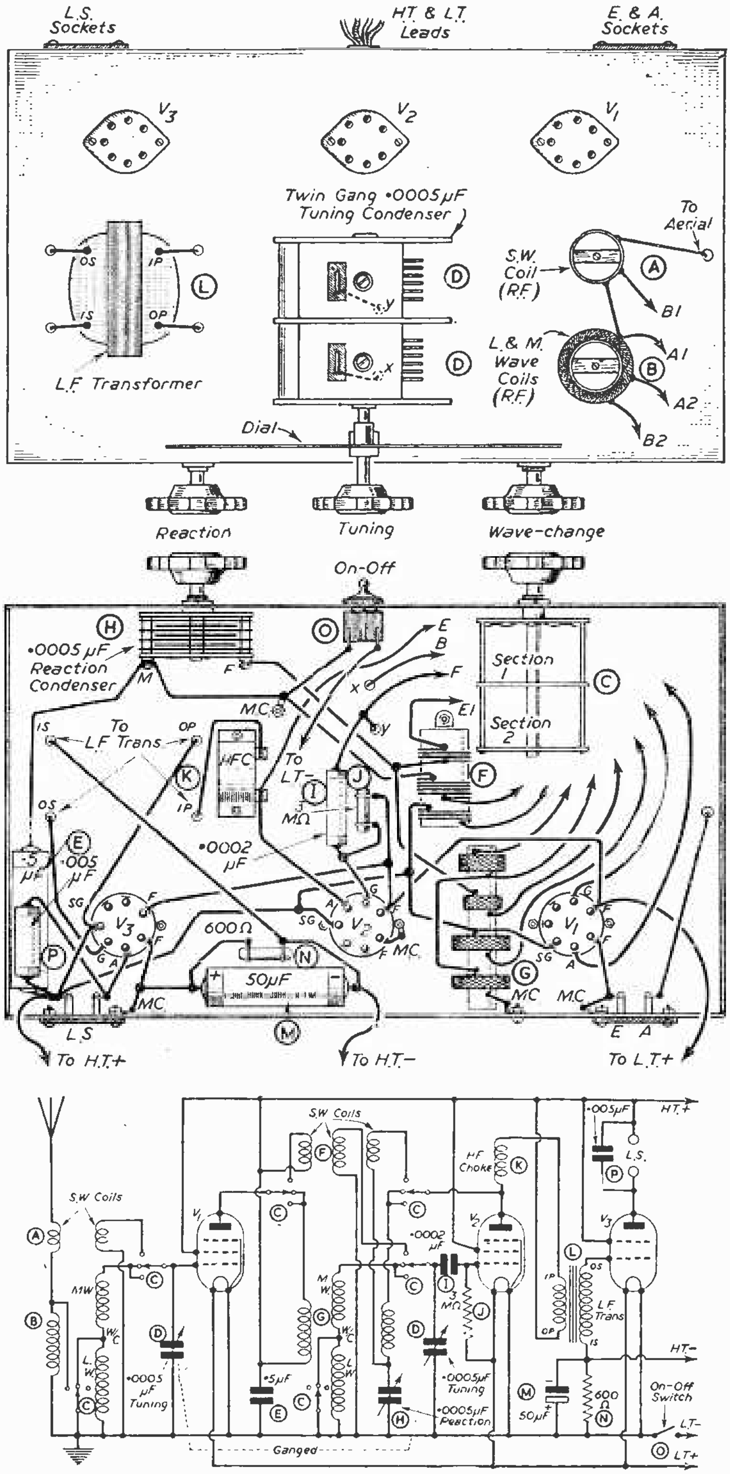


Fig. 72.—(Bottom right) Theoretical circuit of a modern three-valve receiver. (Above) Top and underneath views of a receiver built to the circuit showing position of wires. The numbers on the circuit correspondent to the numbers on the wiring diagrams.

On Your Wavelength

BY THERMION

Ionospheric Conditions

ONE of the major studies at the Radio Research Station, Slough, continues to be into ionospheric "weather" and its effect on long-distance radio communication. Data on local ionospheric conditions are supplied to the station from its own observatories in various parts of the world and from those maintained by other countries. This information is used in the preparation of forecasts six months ahead of transmission conditions for the users of high-frequency radio communications.

A recent development has been the construction of special "British Zone" charts which forecast conditions for circuits terminating in the British Isles. It is hoped that these local charts will give more accurate forecasts than the general charts previously used.

The station is also using a method of investigating ionospheric conditions by studying long-distance back-scatter (that is, "echoes") from the earth's surface of high power pulses transmitted from the observation point. Sharply beamed aerial systems directed along fixed azimuths and capable of operating over a wide frequency band are used for this purpose. A rotating beamed aerial system of restricted frequency coverage has also been developed for use with a Plan Position Indicator display. Propagation conditions within a circular area of 5,000 km. radius from the observation point are shown on the P.P.I. as the aerial rotates. In addition a camera is arranged to take one photograph at each revolution of the aerial. By projecting the developed film at a greatly increased speed a vivid picture is obtained of ionospheric changes within 5,000 km. of Slough.

Radio Navigational Aids

THE study of phase changes in low-frequency ground waves, as they pass over geological boundaries or from a path over land to a path over water, is important for those types of radio aids for marine and air navigation which are based on the reception of low-frequency signals from fixed transmitters. The new system of phase measurements which employs an ultra-high frequency radio link to convey a phase-reference signal has been completed and proved satisfactory in use.

Germanium Diodes

THE work of the station on germanium diodes includes the examination of the current voltage temperature characteristics and noise spectra of point-contact and junction diodes together with related theoretical studies.

The Guitar Again

I HAVE received a number of letters concerning my paragraph on the guitar, in answer to a comment in an obscure little pamphlet which masquerades as an official journal. I was invited to comment by the editor of this precious publication, but he does not like my comments. He labelled all electrified instruments as tin pan alley trash. Sorry I cannot accept him as an authority on music. Having studied my Groves, I have a better understanding of what comprises a musical instrument than he does. I have no doubt that members of the Classic Guitar Association are a little peeved at the competition from these modern instruments, not having yet realised the revolution in public taste especially in music and musical instruments which has taken place in the past 30 years.

Another letter on the topic comes from the editor of *B.M.G.*, the oldest established journal dealing with fretted instruments. He is in full agreement with my comments. He points out that there are three kinds of guitars—spanish guitar (strung with gut or nylon and played with the fingers); plectrum guitar (strung with wire and played with a plectrum) and Hawaiian guitar (strung with wire and played with finger picks). He comments: "The Editor of the journal you have mentioned considers neither of the latter should be called a 'guitar.' If his instrument were the violin, I suppose the hill-billy player of this instrument would be told to find another name for the stringed instrument he 'debases.'"

Another correspondent, R. L. Williams, of Craven Arms, Salop, congratulates me on the "obscure paragraph" I wrote on the subject, and having so labelled it by the rest of his letter shows that he completely understood it. He acknowledges the "far-reaching influence" of my page, not a bad admission from one who admits that he cannot understand what I write. However, I am sorry to have caused this rift in the guitar.

Important Work of the Clubs

THERE are some radio clubs with very full memberships which operate as little friendly gatherings of keen amateurs, meeting once a week in a private room at the local or in a school room loaned by a friendly schoolmaster. Some of the latter encourage their scholars to join, and in such cases the handicraft room and its equipment are placed at the disposal of members. There are much larger clubs run on advanced lines which perform valuable experimental work, and one of these is the Leicester Radio Society, which between the night of the 4th of May and the morning of the 5th assisted G3CCA to make the first all-transistor contact without the aid of any thermionic valves whatsoever. That station made contact with G6PO in Buckingham, a distance of 45 miles.

Noisy Reception

DETAILS OF THE VARIOUS CAUSES OF NOISE AND HOW TO MEASURE SIGNAL/NOISE RATIO

By F. E. Apps

IN this article I am dealing with the noise actually created in the receiver and not with noise received by it. All radio receivers generate a certain amount of noise and this noise will increase as the amplification of the receiver is increased. Now as weak signals require high amplification, it necessarily follows that reduction of this noise becomes more difficult as the sensitivity of the receiver is increased.

All of the probable causes of noise in a radio receiver can be minimised if not entirely eliminated. The types of noise can be stated to be as follows:

(i) Shot effect.
(ii) Thermal agitation.
(iii) Microphonics.
(iv) Hum.
(v) Imperfect contacts, dry joints, etc.

Shot Effect

This noise is generated entirely by the valves in a receiver. It is due to the fact that the stream of electrons from cathode to anode is not absolutely steady (ignoring, of course, the effect of the other electrodes). The electrons do not leave the cathode at the same velocity and consequently the electron current is spasmodic. This causes a minute current of irregular value to be superimposed on the main anode current of the valve, thus setting up in the anode circuit a superimposed minute voltage. This is then amplified throughout the receiver to the output stage. This noise from shot effect will appear on the whole of the frequency bands of the receiver.

It will be found that in a valve that has very little space charge the shot effect is very pronounced, so that to keep this effect as low as possible various valves should be tried. If not successful in reducing it this way reduction of the voltages on the electrodes and the reduction of cathode temperature will often effect it. The reduction of cathode temperature can, of course, be effected by reducing the heater voltage slightly.

Thermal Agitation

As can be seen by its title, this noise is caused mainly by temperature changes. The reason for this is as follows: when a current flows through a conductor it consists of a flow of free electrons. Now these free electrons are in random motion with velocities that depend upon the temperature of the conductor. These random motions of the free electrons cause minute variations of current that produce a fluctuating voltage between the ends of the conductor. If this noise is developed across a resistor in the input stage of the receiver it will, of course, be amplified with the signal and passed with it to the output stage. It will be seen, therefore, that to keep this noise within limits, and keep a reasonable signal/noise ratio, it is necessary to see that resistors are of good make and of correct wattage and to see that good joints are made at soldered points. Components should also be as far apart as space will allow so as to keep temperature down. The effect upon thermal noise will be seen in the formula

$$E = \sqrt{4KTR\Delta f}$$

where E = RMS noise voltage.
K = Boltzmans constant.
T = Absolute temperature.
R = Resistance in ohms.
f = Frequency.

$K = 1.37 \times 10^{-28}$ joules per degree absolute T in degrees Kelvin.

Microphonics

This type of noise is caused by the mechanical vibration of the elements in the valve or valves. It may be due to vibration of the chassis, the valve-holder or the valve itself, and is caused by sound waves from the speaker. It can also be caused by long leads (especially in the oscillator circuit) vibrating. Some types of valve are more subject to this fault than others, those most liable being the second detector, usually a double diode triode, and the frequency changer. Apart from using other valves, precautions should be taken either to mount the chassis, or gang, or valve holders on rubber. Long leads in frequency changer circuits should be avoided, and care taken to ensure valves are protected from acoustical vibrations from the speaker by enclosing them in cans.

Bad Contacts, Dry Joints, etc.

The noise that these faults can produce is obvious. Amongst bad contacts the following are very necessary to check. Bad contact in valve sockets; bad welding inside valves; bad tracks or poor contact in gain controls; loose laminations of mains transformer or chokes; loose filaments in dial lamps; weak springs in mains switch causing intermittent contact; poor aerial and earth contacts; dirt in vanes of gang condenser.

Signal/Noise Ratio

Reference has been made in this article to signal/noise ratio. A brief description of how this is taken follows.

The receiver to be checked should be in a place where little outside electrical interference is likely to affect it. A screened box in which the receiver could be placed would be ideal. The receiver should be tuned to the highest frequency on the scale (i.e., minimum gang) and all controls at maximum. Using a reliable signal generator which will give a modulated and an unmodulated signal, tune to the frequency of the receiver. Now reduce the output of generator until the output from the receiver shows 1 milliwatt on output meter. Now replace milliwatt output meter with a microwatt output meter and switch off modulation from generator. The reading on the microwatt meter will now show residual noise. From this reading the noise level in db can be calculated.

TRANSMITTING TOPICS

WIDE-BAND COUPLERS IN THEORY AND PRACTICE

By Wm. A. Hope

THE modern trend in transmitter design is to eliminate the use of unwieldy components, especially in the intermediate stages, by using W.B.C. techniques. The purpose of this article is to explain, basically, the theory and practice of W.B.C. circuitry based on the author's experiments. For those of us who are mathematically minded, the derivation of certain formulæ will be given in the Appendices.

Basic Theory

Two circuits are said to be inductively coupled when mutual inductance exists between them. This, in turn, enables energy to be transferred from one circuit to the other by transformer action. Although the overall behaviour of coupled circuits is rather complex, we can enunciate certain conditions which will satisfy our needs, no matter what type of coupling is used.

Law A.—The effect of the secondary circuit is equivalent to an impedance of $\frac{(\omega M)^2}{Zs}$ ohms, added in series with the primary. Zs being the vector value of the series secondary impedance alone, M is the mutual inductance between the coils Lp and Ls and ω is the angular velocity in radians/sec. Reference should be made to Appendix A.

Law B.—The induced secondary voltage, produced by a primary current of Ip, is equal to ω.M.Ip volts, and is 90 deg. out of phase with Ip.

Law C.—One question which has previously cropped up in the discussion of W.B.C. principles is: "If the secondary is considered as reflecting an impedance into the primary circuit, why cannot we consider the primary as reflecting an impedance into the secondary?" The reason for this is that the impedance reflected into the primary circuit takes into account the back E.M.F. induced in the primary by the secondary current Is. Reference to Appendix A will clarify this. We can now enunciate Law C.

The secondary current, Is, can be considered equal to a current that would flow if the induced voltage was applied directly in series with the secondary and the primary circuit eliminated. These three simple laws will hold good for all types of coupled circuits connected with the design of the couplers, and are essential in determining the circuit conditions, as detailed later.

Circuit Calculations

A. Determine the primary current, Ip, by means of Law A.

B. Knowing Ip, calculate the induced secondary voltage by means of Law B.

C. Once the induced secondary voltage has been found, calculate the secondary current, Is, using Law C. The formulæ given below are used in direct calculation of the circuit constants and are valuable in assessing the limits of the W.B.C.

Reflected secondary impedance to primary circuit

$$= \frac{(\omega M)^2}{Zs} \quad \text{.........Eqn. 1}$$

$$\text{Equivalent primary impedance} = Zp + \frac{(\omega M)^2}{Zs} \quad \text{Eqn. 2}$$

$$\text{Primary current, } Ip = \frac{E}{Zp + \frac{(\omega M)^2}{Zs}} \quad \text{.........Eqn. 3}$$

$$\text{Secondary current, } Is = \frac{\omega M Ip}{Zs} = \frac{\omega ME}{Zp.Zs + (\omega M)^2} \quad \text{Eqn. 4}$$

In connection with Eqn. 3, it must be remembered that there will be either a lead or lag of 90 deg., dependent on the effect of M. Zp and Zs are the respective vectorial values of the primary and secondary impedances. The reflected impedance to the primary circuit, $\frac{(\omega M)^2}{Zs}$, is a vector quantity having both resistive and reactive components, as given in Eqns. 5 and 6.

Resistive component of reflected impedance =

$$\frac{Rs(\omega M)^2}{Rs^2 + Xs^2} \quad \text{.........Eqn. 5}$$

Reactive component of reflected impedance =

$$\frac{-Xs\,(\omega M)^2}{Rs^2 + Xs^2} \quad \text{.........Eqn. 6}$$

Rs and Xs being the two components of the secondary impedance, a positive reactance being inductive. If the value of M is small, or the value of Zs large, the reflected impedance to the primary is small. Thus the primary circuitry is only slightly influenced by the presence of the coupled secondary circuitry. Conversely, if M is large and Zs small, the reflected impedance to the primary circuit will be great, thus determining the behaviour of the primary to a very great extent.

Coefficient of Coupling (k) Factor

It is not intended to review the various types of coupled circuits here, as the author considers that these are already well known, and to go into their respective merits would be futile. We will now proceed to examine the effect of the k factor between two coupled circuits. If the coefficient of coupling, k, between two coupled circuits is low then it follows that the secondary current, Is, is small and the resultant response curve is peaked. As k is increased, the magnitude of Is increases and the response curve begins to "flatten out." This will continue until the reflected resistance from secondary to primary, at resonance, is equal to that of the primary. At this stage the value of k to produce this result is critical and is termed the "critical coupling"—an important factor in W.B.C. design—and determines the maximum possible secondary current that is obtainable. If we increase the k factor beyond this value the current, at resonance, will become less than that at the critical coupling value, while new peaks of secondary current will appear equidistant from the point of symmetry, i.e., the resonant frequency point—the spacing between the peaks varying directly as k. Fig. 1 shows this phenomenon which results from the nature of the reflected impedance, produced by the resonant secondary circuit. When k is small, it follows that the secondary voltage and current will also be small, bearing in mind that the shape of the secondary current curve will be much sharper than the resonant response of the secondary circuit since the induced voltage is directly proportional to primary current and must, therefore, be greater in the resonant condition. If, on the other hand, k is large, the reflected impedance, at resonance, will be large also, thus causing a reduction in primary current, ultimately resulting in a low induced voltage, as well as secondary current. The double humps are due to the fact that, with a tuned secondary circuit, the reflected reactance into the primary circuit is inductive at frequencies less than that of resonance, while it is capacitive at frequencies above resonance.

Since the algebraic sum of the reflected reactance and the primary reactance must always be zero at any one given frequency, the effect of the secondary circuit will reduce the impedance that the primary offers to the applied voltage from the generator. This results in an increase in Ip and thus will increase the induced voltage at points just off the point of resonance. It will therefore be apparent that two new resonant frequencies are introduced at such values of k. Thus the critical coefficient of coupling is reached when the reflected reactance, at resonance, is equal to the resistance of the primary circuit, i.e.,

$$\frac{(\omega M)^2}{Rs} = Rp.$$

Therefore : $(\omega M)^2 = Rp.Rs$

and, for critical coupling, $\omega M = \sqrt{Rp.Rs}$......Eqn. 7

Since the "Q" factor of the circuit is numerically equal to the ratio of reactance to resistance, we get : $Qp = \frac{\omega Lp}{Rp}$ and $Qs = \frac{\omega Ls}{Rs}$, where Rp and Rs are the respective resistances of the primary and secondary ; and Lp and Ls are the respective primary and secondary inductances.

Hence : $\omega M = \sqrt{\frac{\omega Lp}{Qp} \times \frac{\omega Ls}{Qs}}$

Substituting $k = \frac{M}{\sqrt{Lp.Ls}}$, see Appendix B.

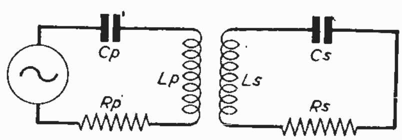
Critical coupling factor, $k_c = \frac{1}{\sqrt{Qp.Qs}}$ ....Eqn. 8

Since the critical coupling factor is usually small, a typical value of 0.01 will result if the Q's are each equal to 100.

Estimation of W.B.C. Bandwidth

We have seen from Fig. 1 that the response is virtually flat over a certain range of frequency, near that of resonance, while the response becomes steep at frequencies farther from the resonance point. This is the correct relative response for any band-pass filter ; and will, we hope, be the ultimate aim of our W.B.C. responses, when the unit is finally complete ; since uniformity, over certain frequency limits, is our theoretical aim. The bandwidth is given by the approx. value of Eqn. 9.

Bandwidth = k (resonant frequency of tuned circuits).. Eqn. 9



The author would like to indicate, at this point, that, for uniform transmission within the limits of the W.B.C., it is advisable to raise the Q factor of the circuits at the critical coupling point by 1.5.

(*Continued on page* 477.)

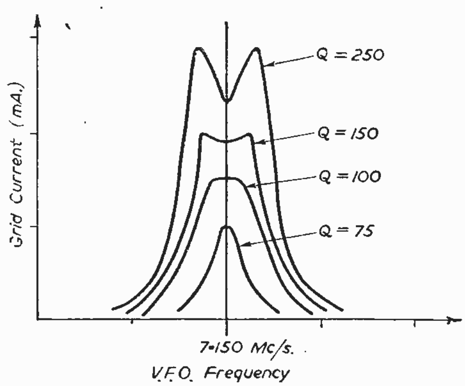


Fig. 1.—Effect of varying Q.

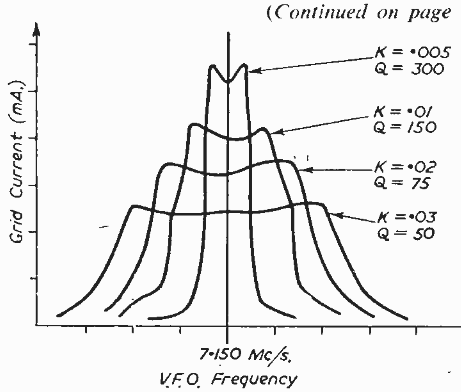


Fig. 2.—Effect of varying K.

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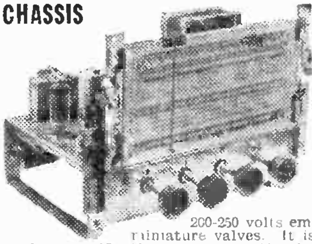

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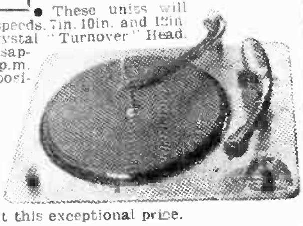

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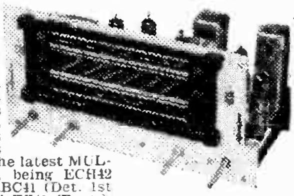

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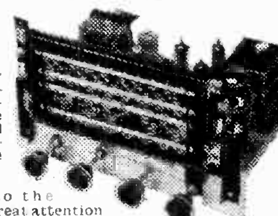

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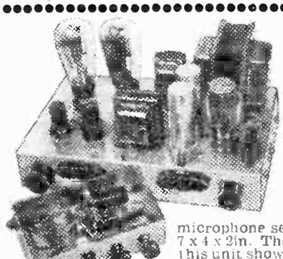
COMPLETE KIT for 12 WATT HIGH FIDELITY "Push-Pull" AMPLIFIER



Designed for A.C. mains 200 to 250 volts, employs 6 valves plus rectifier, with negative feed-back, and comprises a main amplifier chassis and a remote controlled Pre-amplifier and Tone Control Unit, incorporating four controls—bass, treble, main volume or mixing contol, and a radio, gram, microphone selector switch. This control unit measures only 7 x 4 x 2in. The measured frequency range of the amplifier with this unit shows an excellent response from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore, that ample correction is provided to suit any type of pick-up with any type of recording. Input voltage for maximum output is 70 mV. 6.3 volts at 2 amps. and 30 mA. H.T. is provided for tuning unit, etc. Price of complete kit, Amplifier and Control Unit, including drilled chassis and valves, £14. Complete specification and layout 2/-. We can also supply completely assembled and ready for use at £17. Hire Purchase Terms (Assembled Chassis only) £5/13/3. Deposit and 12 months of £1/1/4. Please add 7/6 carr. and insurance. THIS AMPLIFIER COMPARES WELL WITH THE WILLIAMSON AND SIMILAR DESIGNS AT A FRACTION OF THE COST.

A 4-VALVE QUALITY "Push-Pull" 6-8 watt AMPLIFIER for A.C. mains

Incorporating Negative Feedback, Filter Input, Circuit and employing 6V6s in Push-Pull. A simple arrangement is provided to enable either a magnetic crystal or lightweight pick-up to be used, and is suitable for use with Standard or Long-playing records. A tone control is incorporated, and the 10-watt output transformer is designed to match 2 to 15 ohm speakers. The overall size of the assembled chassis is 10in. x 8in. x 7½in. high, and full practical diagrams are supplied. Price, including drilled chassis and valves, of complete kit, £6/17/6. Price of assembled chassis, supplied ready for use, £8 12 6. Full descriptive leaflets are available separately for 1/-.

"PERSONAL SET" BATTERY ELIMINATOR

A complete kit of parts to build a Midget "All-dry" Battery Eliminator, giving approx. 69 volts and 1.4 volts. This Eliminator is for use on A.C. mains and is suitable for any 4 valve Superhet receiver requiring H.T. and L.T. voltage as above or approx. to 69 volts. The kit is quite easily and quickly assembled and is housed in a light aluminium case, size 4½in. x 1½in. x 3½in. Price of complete kit with easy-to-follow assembly instructions, 42/6. In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts and 1.4 volts. Size of assembled Unit 7in. x 2½in. x 1½in. Price 47/6 (Plus 1/- carr. and ins.).

STERN RADIO Ltd. 109 & 115, FLEET STREET, E.C.4. TELEPHONE : CENtral 5812/3/4

Hence, $k = \frac{3}{2\sqrt{Qp.Qs}}$ ....Eqn. 8A

In designing the W.B.C. it is advisable to proceed as follows:

(1) Use Eqn. 9 to find a suitable value of k, to give the required bandwidth.

(2) Use Eqn. 8A to determine the best Q values for uniform transmission response, within the frequency limits. From Eqns. 8 and 9, we see that if the bandwidth is large, the value of k must be large and the relative circuit Q values will be low. This results in the secondary voltage and current values being small; thus the smaller the bandwidth, the greater will be the output, for a fixed R.M.S. generator voltage input to the primary circuit. Fig. 2 shows the relationship between k, Q and bandwidth, utilising the equations above. Having decided upon our circuit constants, it is simply a question of constructing our W.B.C.s separately, after having determined the values of L and C, to resonate in the centre of the pass-band of the amateur band under question; i.e., resonating on 7.150 Mc/s for the 40-metre band. These values can be readily determined using the various formulæ given in Appendix C.

Fig. 3.—Pulse width and harmonic relationships.

Harmonic of Fundamental Frequency (f)	Optimum Ia pulse length, at f c/s, expressed in electrical degrees (values are approximate)	Approx. Percentage Output comparable with Class C Amplifier (Class C taken as 100%)
2	80°–120°	65
3	70°–110°	45
4	60°–85°	30
5	50°–70°	25
6	40°–50°	21

Frequency Multipliers

It is common practice to construct the V.F.O. for the lowest frequency band to be covered and multiply up to each separate band, using the W.B.C. stages. It is a well-known fact that, since the pulses of anode current of a Class C amplifier have a high harmonic content, it follows that this type of amplifier is ideal for W.B.C. operation; since it is only necessary to adjust the anode current pulse width for favourable harmonic generation, provided that the bias is increased as the output harmonic is increased. ("Principles of Frequency Multiplication," PRACTICAL WIRELESS, December, 1952.) The shorter the length of the Ia pulse, the higher is the plate efficiency, but more bias and exciting voltage are needed to produce any given harmonic. The plate efficiencies given in Fig. 3 are less than those normally associated with Class C operation standards; but since the output is normally less than Class C, the anode dissipation will, therefore, not be exceeded. Fig. 4 shows the various voltage waveforms to be expected with the average frequency multiplier valve and, although not to scale, suffices to illustrate the point in hand.

Experimental Circuitry

The circuit shown in Fig. 5 was the basis of the experiments conducted on W.B.C. techniques. It is seen that mutual inductance coupling is used to couple the two windings and relevant coil winding data are given in Fig. 6. Details of coil spacing are not given, since the relative positions must, usually, be determined by experiment.

The former used was the Aladdin Type 5937/6, which has an overall diam. of [illegible]in. and has a winding capacity of 1 [illegible]in. Incidentally, the complete coupler can be constructed from Aladdin accessories and is comparable with the dimensions of a midget I.F. transformer. A 6SN7 double-triode was used for all experiments and the response curve, in each case, was drawn by plotting frequency against grid current. The V.F.O. should be set to the H.F. end of the band in question and the primary trimmer of the coupler adjusted for maximum drive; then set the V.F.O. to the L.F. end and adjust the secondary trimmer for maximum grid drive. It may be necessary to move the relative positions of L1 and L2, but the author did not find this necessary in his case. Now swing the V.F.O. over the entire range and note the grid current. If it is not fairly steady, reduce the capacity of the 30 pF trimmer and repeat the process until flat grid drive is obtained. The grid current should drop abruptly just outside the band

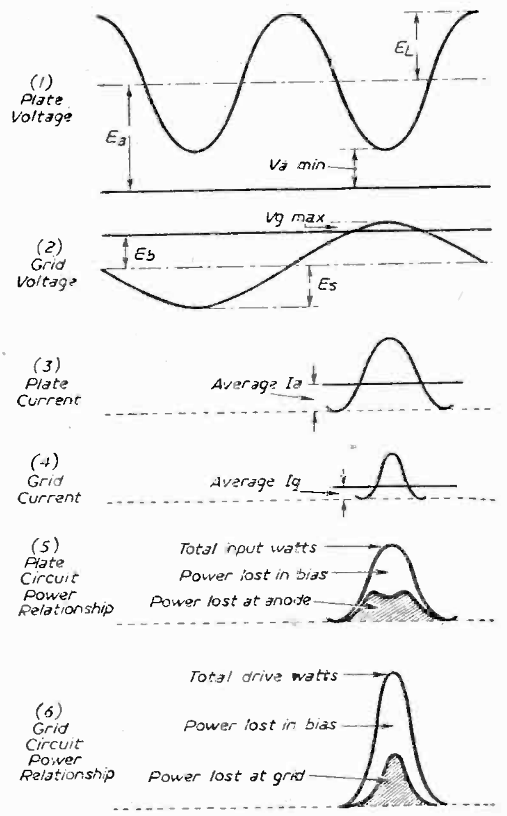


Fig. 4.—Typical Class C harmonic generator waveforms.

Ea = H.T. volts. Eb = Bias volts. Va min. = Minimum anode volts. EL = Volts across anode load. ES = Input drive voltage. Vg max. = Maximum control-grid volts.

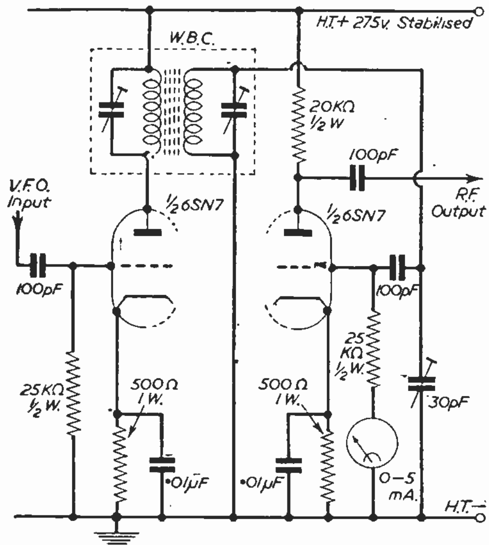


Fig. 5.—An experimental circuit.

COMPONENT LIST

Two 25,000 ohm ½W. Resistors
Two 500 ohm 1W. Resistors
One 20,000 ohm ½W. Resistor
Three 100 pF Mica Capacitors
Two 0.01 µF Capacitors
One 30 pF Trimmer
One F5937/6 Aladdin Former
One PP5939 Aladdin Core
One Top Plate to fit F5937/6
One Solder Tag Ring for F5937/6
One Aluminium Screening Can 2⅜in. x 13/16in. square.

limits; if this is not the case. the coupler is incorrectly adjusted. The response curves obtained, using these couplers, are reproduced in Fig. 7. The output of the V.F.O. on the 160 metre band was in the region of 10 volts R.M.S., while the H.T. voltage was 275. Great care should be exercised in the coupler construction. since it will give endless pleasure and ease of transmitter operation.

APPENDICES :

Appendix A. The secondary voltage is produced by Ip, the primary current. The voltage induced in the secondary is ωMIp and is 90 deg. out of phase with Ip. Hence, the secondary current is $\frac{\omega MIp}{Zs}$. Zs being the secondary impedance. This current produces a back E.M.F. of $\frac{\omega M(\omega MIp)}{Zs}$ or $\frac{Ip(\omega M)^2}{Zs}$

Band	Prim. Turns	Sec. Turns	Wire Gauge	Approx. Parallel Capacity
1.7 Mc/s	70	70	40g. Enam.	20pF.
3.5 Mc/s	35	35	32g. Enam.	9pF.
7.0 Mc/s	28	28	32g. Enam.	5pF.
14.0 Mc/s	22	22	32g. Enam.	2-5pF.
21.0 Mc/s	17	17	32g. Enam.	2-5pF.
28 Mc/s	12	12	32g. Enam.	2-5pF.

Fig. 6.—W.B.C. coil winding data.

volts in the primary circuit. Since this voltage is 90+90 deg., i.e., 180 deg., out of phase with Ip. it is a back E.M.F. The reduction in voltage, due to this back E.M.F., is $\frac{(\omega M)^2}{Zs}$ times the primary current; so that the effect of the secondary circuit, upon the primary circuit, is the same as adding an impedance of $\frac{\omega M^2}{Zs}$ to the primary circuit.

Appendix B. The coefficient of coupling, k, is defined as: "The ratio of mutual impedance component of the two circuits to the square root of the product of the separate primary and secondary impedance components, *of the same kind.*"

Mutual impedance component = ωM.
Primary impedance component = ωLp.
Secondary impedance component = ωLs.

$$\text{Therefore } k = \frac{\omega M}{\sqrt{\omega Lp \cdot \omega Ls}} = \frac{\omega M}{\sqrt{\omega^2}\sqrt{Lp \cdot LS}} = \frac{\omega M}{\omega\sqrt{Lp \cdot Ls}} \quad \text{Thus } k = \frac{M}{\sqrt{Lp \cdot Ls}}$$

(*Concluded on page* 506)

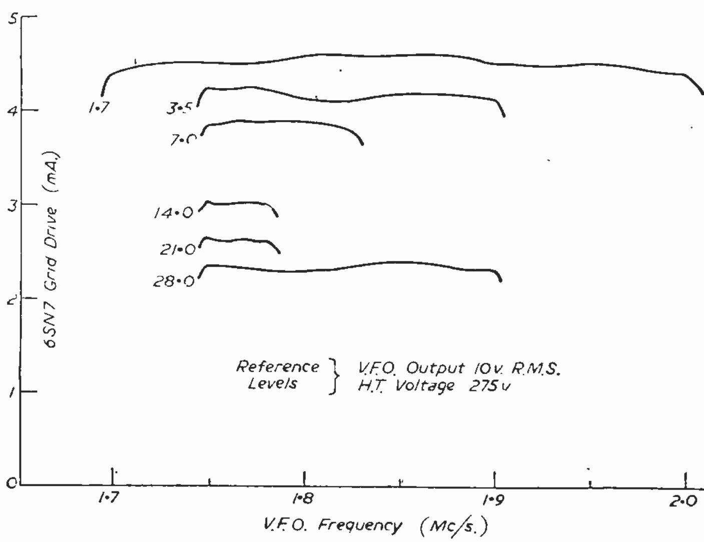
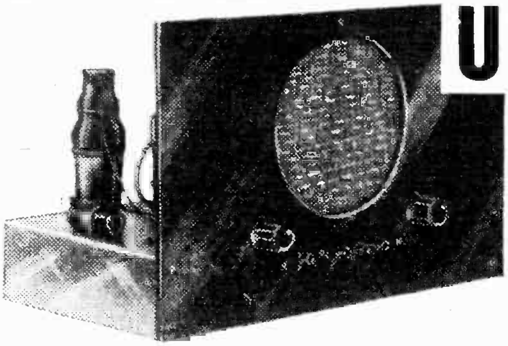


Fig. 7.—W.B.C. frequency response curves.



UNIVERSAL PUSH-BUTTON 4

AN A.C./D.C. RECEIVER WITHOUT MANUAL TUNING. PRE-SELECTED STATIONS ARE CHOSEN BY A PUSH-BUTTON UNIT

THIS circuit was designed with several requirements in view, and it ably fulfils them. A good degree of selectivity and sensitivity was desired, without the complication of a superhet circuit, and this was achieved by using two tuned circuits with loosely-coupled primaries, in conjunction with an anode bend detector, which is comparatively insensitive to weak signals. As a result, the four desired stations were received quite free of interference, with a very short indoor aerial.

Particular attention was given, in the layout and circuit, to avoid hum, which so readily arises in A.C./D.C. receivers. The anode bend detector cannot operate at hum frequencies, since the tuning coil is then of negligible impedance, so no hum is passed on to be amplified by the output stage. (Changing the detector to one of the more usual type, with grid condenser and leak, resulted in a noticeable increase in hum.) The hum level is so low that it is difficult to hear any hum at all, unless the ear is placed near the loudspeaker when no signal is being reproduced.

Further to simplify operation, the on/off switch is separate from the volume control, so that the latter can be left at any previously obtained setting —a small point which is found well worth while in a receiver of this type. A double-pole rotary mains switch is used, so that the set is effectively disconnected from the mains when switched off.

The push-button unit is wired to provide one

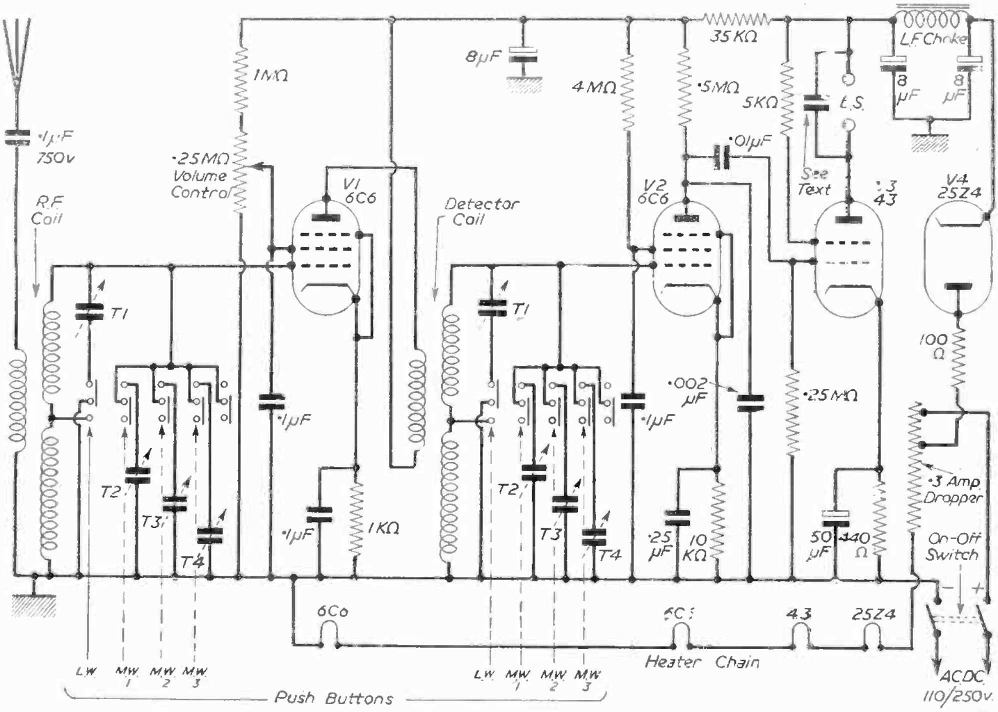
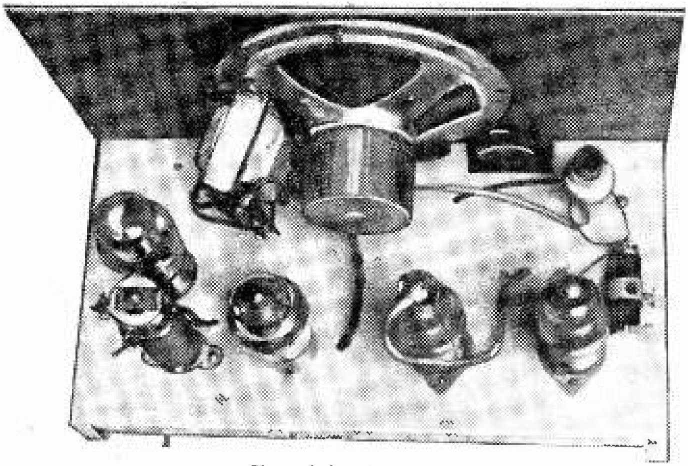


Fig. 1.—Circuit diagram.

long-wave and three medium-wave stations, as shown in Fig. 1. Each button operates a double-pole, double-throw switch combination. When the long-wave button is depressed, both trimmers T1 are brought into circuit. When any of the other buttons are operated, the pairs of trimmers T2, T3 and T4 are switched in, and the coils are switched to medium-waves as the first button springs out. If no long-wave station is required, four or five medium-wave stations could be provided for, and the spare button can, of course, be used for an additional station, or for "gram" reproduction. Tuning is accurately maintained, even with changes in the aerial, because of the loosely-coupled primary winding, and it was for this reason that this type of coil was selected here.



Top of chassis view.

COMPONENT LIST

Resistors :
100 ohm, 440 ohm, and 5,000 ohm (1-watt).
1,000, 10,000, and 35,000 ohm (½-watt).
.25 megohm, .5 megohm, 1 megohm, and 4 megohm (½-watt).
Condensers :
Three .1 μF (350v. w.).
.1 μF (750 v. w.).
.002 μF and .005 μF (350 v. w.).
.01 μF mica.
.25 μF.
50 μF (25-50 v. w.).
Three 8 μF (350 v. w.).
Four twin pre-set condensers.
Pair "Astral" Dual-Range coils.
.3 amp 800 ohm mains dropper with two adjustable clips.
6C6, 6C6, 43, and 25Z4 valves, or equivalents. Holders for same.
Double-pole 5-button push-button unit with knobs.
Double-pole mains rotary on/off switch (Bulgin).
60mA smoothing choke.
Chassis, P.M. speaker with transformer, control knobs, 3-ply for panel, screened brading, etc.

As there is only one stage of L.F. amplification, very little distortion is introduced and quality of reproduction was surprisingly good. If desired, a measure of negative feedback could be introduced over the output stage, by wiring a .25 megohm resistor, with .5 μF condenser in series, from 43 anode to 6C6 anode.

In the event of manual tuning being required, the unused switch contacts should be used to bring into circuit a 2-gang .0005 μF tuning condenser, and the layout should be suitably modified to accommodate this component. If a pilot-lamp is wanted, a .3 amp. 6.3 volt type, shunted by a 40 ohm 1 watt resistor, should be wired between rectifier heater and mains dropper. If these changes are made, care should be exercised to assure that hum is not caused. Twin flex should be used for the pilot bulb connections, and should be well away from grid and anode wiring.

Chassis Layout

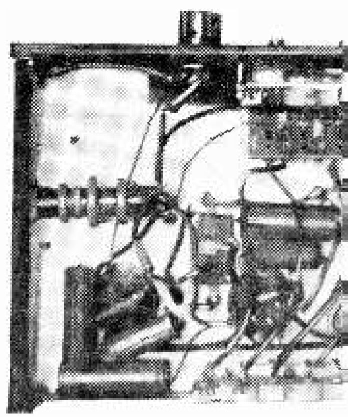
This is shown in the half-tone illustration on this page, and the chassis, approximately 7in. by 13in., was bent up from sheet aluminium. When completed, the whole receiver pushes into the back of a suitable cabinet, the panel coming up behind a cut-out approximately 10in. by 6in. As a result, there are no live bolt heads or similar exposed metal parts, and the receiver is safe.

The aerial condenser is to keep mains voltages out of the aerial, and should be of good quality. If the aerial is long, a small condenser may be introduced in series with it, to sharpen aerial tuning. A 50 pF pre-set condenser is admirable for this position. The aerial coil and associated wiring is above the chassis, and not screened.

Tag A on the mains dropper is the bottom fixed clip, and goes to the switch. Tag B is the central adjustable clip, and goes to the 100 ohm resistor. Tag C is the upper adjustable clip, and goes to the rectifier heater.

The condenser wired in parallel with the speaker transformer is connected directly to the transformer tags, and a capacity of .005 μF is suggested. A larger capacity will result in a more "mellow" tone.

The front of the chassis is cut to accommodate the on/off switch and



Below chassi.

volume control. These are secured to the plywood panel, and are not in contact with the chassis. As a result, fixing bushes and spindles are "dead" as regards possible mains voltages.

Sub-chassis Wiring

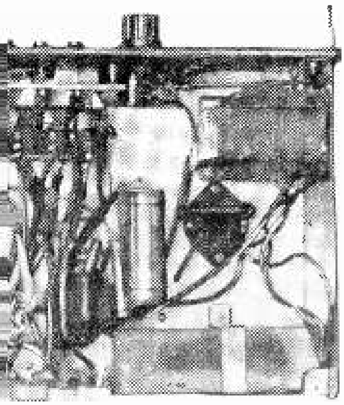
Wiring below the chassis will become clear from the illustration at the foot of this page, but a few points require special note. The heater wiring should be put on first, and should be right against the chassis. Other wiring is kept clear of these leads. The two leads to the on/off switch pass directly through the side runner, between choke and panel, and these are kept away from the aerial, externally, to avoid possible modulation hum.

The 43 valve grid lead is screened, as is the lead from the detector grid cap, to avoid hum and instability. The side of the switch near the chassis is used for R.F. stage switching, and the leads from the tags on this, to the pre-sets, are screened. All the screening brading should be bonded to the chassis. This can be done by forming loops of connecting wire round the screened leads, and soldering.

The other side of the push-button switch deals with the detector circuit. Only the leads to the long-wave pre-set need be screened here. Wiring for the other side of the switch is exactly the same, the leads being added before the switch is secured in place.

Best alignment between push-buttons and panel holes was obtained when the switch was securely bolted to the panel. The frame of the switch should be connected to chassis, to preserve stability, so the 6 B.A. bolts used were insulated from the switch by means of ebonite bushes. This is desirable since the heads are flush with the panel.

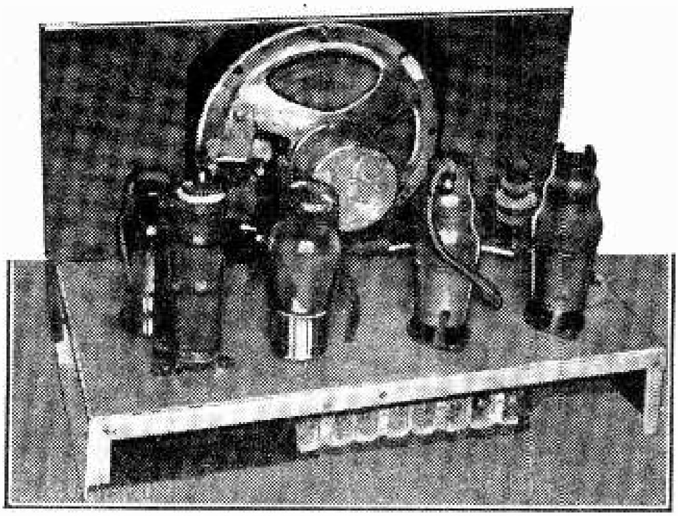
Each of the trimmers T1 to T4 is a *double* trimmer, one section tuning the R.F. stage, and one the detector stage. The various leads should go directly to the tags, or stray coupling may result in instability if the volume control is turned to maximum. It is also desirable that all other connections be short. Leads from the aerial coil pass down through the chassis to the switch.



wiring view

The trimmers are bolted along the rear runner of the chassis, this position being chosen so that easy adjustment is possible when receiver is in its cabinet.

Connections for the detector coil are shown on the right. This coil is mounted by its earthing tag, as is the aerial coil. No reaction is used, but a coil with reaction winding can be utilised by leaving the reaction winding disconnected.



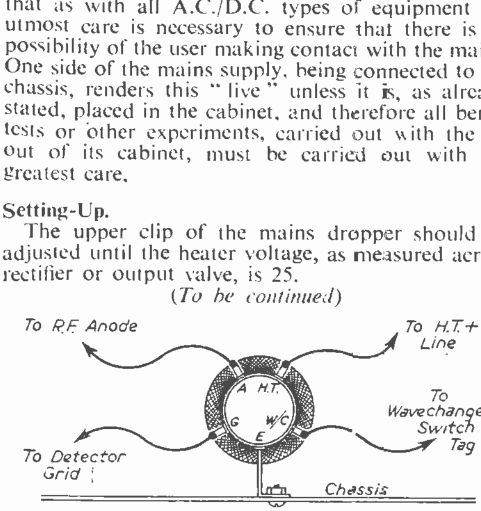
Rear view showing pre-sets

Full details of the chassis and wiring diagrams will be given next month, along with further details of the actual construction. In the meantime, for those who are able to build from a theoretical circuit some notes may be appropriate concerning the setting up of the receiver. It should be emphasised, however, that as with all A.C./D.C. types of equipment the utmost care is necessary to ensure that there is no possibility of the user making contact with the mains. One side of the mains supply, being connected to the chassis, renders this "live" unless it is, as already stated, placed in the cabinet, and therefore all bench tests or other experiments, carried out with the set out of its cabinet, must be carried out with the greatest care.

Setting-Up.

The upper clip of the mains dropper should be adjusted until the heater voltage, as measured across rectifier or output valve, is 25.

(*To be continued*)

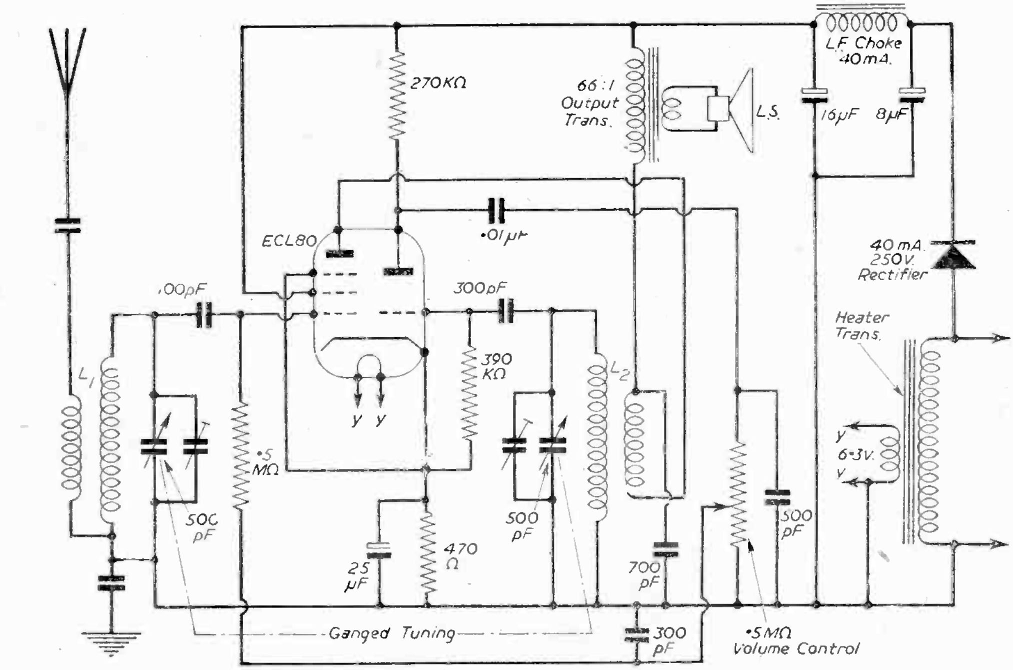


Coil data.

A Modern Reflex Receiver

A NUMBER of queries have been raised concerning the circuit published under this title in last month's issue. First, no practical layout diagram is available, and the only information we can supply is that in the issue in question. Secondly, there is no battery version of this particular type of valve and, therefore, it is not possible to make a battery version of this circuit. Thirdly, the coils may be any standard screened or unscreened modern types, although if unscreened it is preferable to mount them one above and the other below the chassis or otherwise screen them from one another.

The circuit showed the mains input connected both to earth and aerial, and it should be stated that this can be dangerous. The coil on the right, therefore, should be the secondary of a mains transformer in order to isolate the receiver from the mains, or, if expense is to be saved by using only a heater transformer, then the aerial and earth leads should be isolated by means of fixed condensers rated for at least 600 volts working. That on the earth side should be .1 μF and that in the aerial lead some value between .0001 and .0005 μF. A revised diagram is given below.



The modern reflex receiver.

News from the Clubs

CLIFTON AMATEUR RADIO SOCIETY

Hon. Sec.: C. H. Bullivant, G3DIC, 25, St. Fillans Road, London, S.E.6.

THE membership of this society is continually on the increase and each week sees one or two new members. The Clifton caters for all aspects of amateur radio from the constructor to the short-wave listener and licensed operator. Programmes are arranged to suit all tastes. For instance, on May 7th club member D. Veasey gave a talk on "Hi-Fi" and demonstrated his home-built amplifier with standard and L.P. recordings, whilst on May 21st another popular Junk Sale was held. On this occasion there was a record attendance of 48 and many pieces of equipment changed hands, including, for the first time, a complete television set.

Constructional evenings were held on May 14th and 28th, when members busily engaged themselves on building up new equipment or repairing faulty equipment.

During July it is proposed that the following meetings and events take place:

July 9th, Constructional evening; July 16th, Any Questions?; July 18th, Second D.F. contest; July 23rd, Constructional evening; July 24th/25th, Transmitting and receiving contest.

Meetings are held every Friday at 7.30 p.m., at the clubrooms, 225, New Cross Road, London, S.E.14. A warm and cordial welcome awaits visitors and new members.

SOUTHEND AND DISTRICT RADIO SOCIETY

Hon. Sec.: J. H. Barrance, M.B.E., 49, Swanage Road, Southend-on-Sea, Essex.

THE Southend group of radio amateurs took part in the National Field Day organised by the Radio Society of Great Britain recently in a 24-hour continuous watch. Two portable stations were manned: one at Thundersley Glen, working on 80 and 160 metres, and one at Pulpitts Hockley, working on 20 and 40 metres. Contacts were made with some 200 similar portable stations in the British Isles and about a dozen foreign countries, in spite of the rain, thunder and lightning. At one period during the night, the rain was electrostatically charged, as was also the tent and the whole area. The conditions were the worst ever experienced at this annual event; proving that in an emergency communications could be maintained without mains or wire in extremely adverse circumstances.

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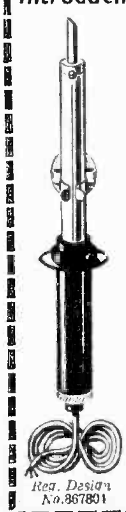

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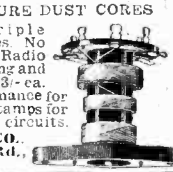

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AMPLIFIER DESIGN

5.—UNTUNED AMPLIFIERS—CONTINUED

By R. Hindle

(*Continued from page 396 July 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.

As a matter of fact, a number of such curves are given on the same graph; each curve is for a different grid voltage, but along any particular curve the grid voltage is constant. If the valves were perfect these lines would be perfectly straight and the "curves" for different grid voltages in equal steps (say each curve is for a grid voltage of 1 volt different from its neighbour) would be parallel and equally spaced. Such idealised curves for a fictitious perfect valve are shown in Fig. 20, for Eg=0 volts to Eg=−9 volts in steps of one volt. Supposing the anode load is 50 KΩ and the H.T. applied is 250 volts. Now if 250 volts appeared actually at the anode of the valve (Fig. 20b) there must be no current flowing because there is no voltage drop in the anode load, so the first point of the resistance graph, which is being superimposed on the anode volts/anode current graph, is for Ea=250 volts and Ia=0 mA. At the other extreme, if the whole 250 volts appeared across the load, so that, in effect, the valve was a short circuit, there would be 0 volts at the anode and the current flowing would be, by Ohm's Law, $\frac{E}{R}=5$ mA. The second point to plot on the graph is, therefore, for Ea=0 and Ia=5 mA. These two points are A and B respectively on Fig. 20a, and the line joining them is called the load line for 50 KΩ. The valve, working with such a load, must always operate according to a point resting along this line. When a signal is applied to the grid the operation of the valve will carry it along the load line between the extremes represented by the voltage of the signal. The requirement for distortionless amplification is that for a certain slight change in grid voltage there must always be the same change in anode current, and this is clearly the case with this imaginary valve because the various curves are parallel and at equal distances and anywhere along the load line the distance between two adjacent "curves" along the load line extends over an equal part of the Ea volts scale. Load lines for different anode loads will all start from the same point on the baseline (assuming that the H.T. voltage remains constant), i.e., at the point representing the H.T. supply, 250 volts in our example, but they will run to different points on the Ia scale because the maximum current for the condition of zero volts at the valve anode will vary. For instance, a load of 25 KΩ permits a maximum current of 10 mA and so the load line is AC; for 100 KΩ the maximum current is 2½ mA and the load line is AD. The greater the load the less steep the load line. On all these lines distortionless amplification is possible and so the obvious inference is to use the bigger load if the maximum amplification is required.

But, to leave the world of imagination and to get down to the practical facts, the real valve curves are not at all like Fig. 20; they are curved and they are somewhat irregularly spaced and hence the distortion to which valves are prone. Fig. 21 gives the actual curves of a triode. They would be curved over also at the upper end if they were extended so far, but the makers set a limit to the amount of power that may be dissipated at the anode. In this case it is 1.5 watts, which means that the H.T. power (volts multiplied by mA) consumed must not be more than this figure. The dotted curve on the characteristic curves indicates this maximum and there is little point in drawing the curve farther into the realms that may not be used. On this set of curves is superimposed the load lines for the three load resistance values considered for the idealised valve, i.e., 25 KΩ, 50 KΩ and 100 KΩ. Now the load lines do not cross the curves at exactly regular intervals. The 25 KΩ load is not too bad, however, over part of its length, though at its extremes the spacing becomes erratic. The region between −2 volts and −6 volts gives reasonably constant spacing between the curves and the 4 volts grid swing gives an anode voltage swing of from about 135 volts to 205 volts (read from the base scale corresponding with the two extreme points along the load line over which the valve is worked). Input 4 volts, output 70 volts, amplification $\frac{70}{4}=17\frac{1}{2}$ times. That is easy!

The 50 KΩ load line will allow an equal input signal, but the anode now swings from 110 volts to 190 volts; now input 4 volts, output 80 volts amplification 20 times—better than the smaller load. How about a larger load still, then? According to the 100 KΩ load line the same input swing takes the

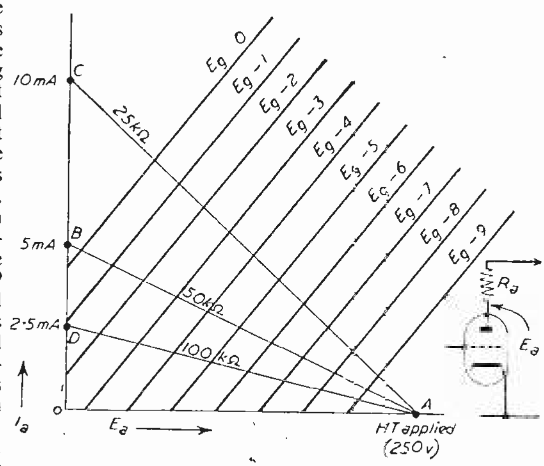

Fig. 20.—Load lines of an imaginary perfect triode.

anode volts over the range 85 volts to 180 volts, a signal peak-to-peak of 95 volts, making the gain $\frac{95}{4}$ = nearly 24 times. This is better still, but notice that the load line is getting near to the curved ends of the characteristic, where the spacing is less regular, indicating that the proportion of distortion is on the increase, and the load line for 250 KΩ also shown is even worse so far as distortion is concerned. If, however, the input signal is less than that already considered the distortion caused by the curvature will be proportionally less. The rule is, then, that the load can be made larger, and consequently a greater amplification obtained, for a given degree of distortion for a smaller input signal.

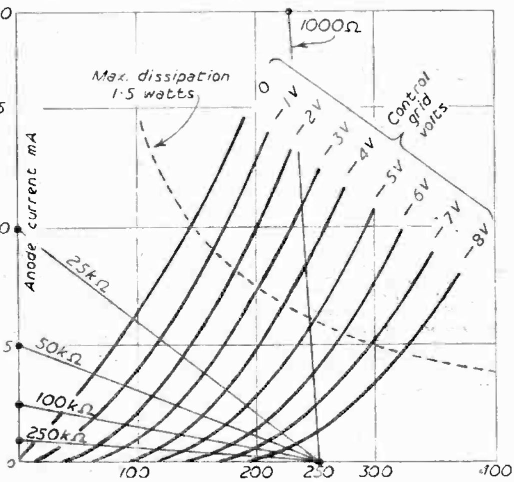

Fig. 21.—Load lines of a triode.

Grid Current

In considering the permissible grid voltage swing the risk of grid current has to be borne in mind. Electrons that are attracted to the grid of the valve have to pass through the grid resistor, in which process they will produce a voltage that will upset the working point of the valve and so cause distortion. That is quite generally known, but what is not always realised is that grid current can flow before the grid goes positive. For instance, in the case of an ordinary triode such as is now being considered grid current begins to flow when the grid is -1 volt, and consequently the input signal must not be allowed to drive the grid more positive than this point.

Small Load

Now consider the other extreme—the reduction of the load to a smaller value. It will be seen that as the load is decreased the load line takes on a steeper and steeper angle, cutting the grid volt curves more and more obliquely. Now if the spacing of the curves is varying, and we know that such is the case, by cutting the curves more obliquely the variation in spacing is more and more accentuated and so distortion becomes worse and worse. Another effect is that, to keep below the maximum permitted dissipation line the range of grid voltage permissible becomes more restricted for the H.T. voltage assumed. For a load of 1,000 ohms, as will be seen from Fig. 21, the grid voltage has to be kept more negative than -5 volts with 250 volts H.T. to avoid the maximum dissipation line and the erratic spacing of intersections with the grid voltage curves indicates a high degree of distortion.

To sum up the triode case, therefore, the optimum load is the load represented by a load line drawn from the applied H.T. voltage and at an incline such as to cut the curves as near as possible at right angles. The value of the load is calculated by observing the current indicated on the Ia axis where the load line cuts the Ia axis. Then by Ohm's Law R=E.I., i.e., H.T. voltage multiplied by Ia (multiplied by 1,000 because Ia is measured in mA). The load can be made somewhat larger than this optimum with an increase in gain, but if made much larger the input signal must be kept small or else the H.T. supply must be increased to avoid undue distortion. On the other hand, if the load is made less than optimum the gain will be reduced and if much smaller the degree of distortion will be seriously increased. Generally, the anode load of a triode should not be less than three times ra as specified by the valve makers.

Pentode

Now consider similarly a pentode, for which the equivalent curves are given in Fig. 22. The same considerations apply, i.e., to avoid distortion the load line must cut the curves for the range over which the grid is to swing so that they are as near as possible equidistant. We already know that the pentode will not accept so great a grid signal as the triode without serious distortion, and these curves bear out this fact. The optimum load will be represented by the load line that crosses the curve for the lowest grid voltage reached by the signal input just above the curved foot. For instance, an anode load of 100 KΩ will allow the grid to swing to about -2.5 volts without a great deal of distortion. Increasing the load increases the distortion and requires a reduction in input signal for equally tolerable results: on the other hand, decreasing the load actually decreases the distortion at the expense of gain. In fact, because the curves are nearly horizontal the load line has to be practically vertical, indicating a zero load, to cut the curves at right angles and so to give the minimum distortion. At best, however, a pentode can accept only a small input unless considerable distortion can be tolerated.

Practical Design Considerations

It will be remembered from the earlier discussion that the shunt capacitance across the load resistance is the stray capacitance from anode to cathode (Cak) of the amplifying valve plus the input capacitance of the following valve (Cgk: this is the "cold" input capacitance, i.e., that before power is supplied to the valve) plus the capacitance fed back from anode to grid of the following valve by virtue of the Miller Effect, and this fed back component amounts to $(\mu+1)$. Cag: these are the inter-electrode capacitances, the electrodes involved being indicated by the little letters, g being grid, a being anode and k being cathode.

In Table 1 are given the values of inter-electrode capacitances of some valves likely to be used for resistance coupled amplification. The total shunt capacitances are given also, assuming a gain of 12

(*Continued on page 489.*)

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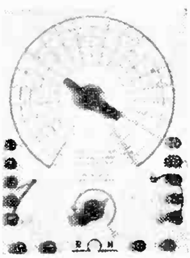

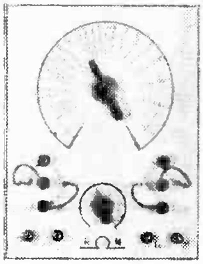

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times in the case of a triode and 80 times in the case of a pentode, the following valve in each case being assumed to be a similar valve (or in the case of the 12AU7 the second half of the same valve; the two figures given for Cak for this valve are for the two halves of one valve. In all other respects the two halves are identical).

Wiring and component strays, apart from the valve itself, of 15 pF, a likely figure, are taken in assessing the total shunt capacitance. The superiority of the pentode over the triode in this respect is clearly indicated, and also the improvement made in new miniature valves compared with the octal variety; obviously, the small modern valve is preferable and should be used wherever possible. Using the figures in this table, the maximum permissible resistive load for a given upper frequency range can be worked out.

TABLE 1

Table showing magnitude of stray capacitances in a R.C. amplifier.

	6J5	12AU7	6BR7		6SJ7
			B9A		
	Octal Triode	B9A Double Triode	Triode Connected	Pentode Connected	Octal Pentode
Cgk	3.4 pF	1.6 pF	3.2 pF	4.25 pF	6 pF
Cak	3.6	.5 .35	6.7	4	7
Cga	3.4	1.5	1.1	.01	.005
Cga x valve gain	40.8	18	13.2	.8	.04
Total Valve Shunt C (Cgk Cak Miller Effect)	47.8	20.1	23.1	9.05	13.04
Add strays external to valve, say, about 15 pF.					
Total shunt C	63 pF	35 pF	38 pF	24 pF	28 pF
Reactance of Strays at 20 Kc/s	120 KΩ	230 KΩ	200 KΩ	330 KΩ	270 KΩ

Miller fed back capacitance assumes gain for triodes to be 12 and for pentodes to be 80.

Consider now the design of an audio amplifier of which, let it be assumed, the load may be allowed to drop to .9 of the mid-frequency value at 10 Kc/s. As shown previously the load drops to .7 of maximum at the frequency at which the reactance of the total stray capacitances equals the resistance of the load Req (the anode load resistance RL in parallel with the grid resistance in the circuit of the following valve Rg) and it drops to .9 of maximum at half the frequency of equality. In the present case, therefore, the maximum resistance for Req is equal to the reactance of the strays at twice the stipulated upper frequency limit, i.e., 20 Kc/s. The reactance of the capacitance can be calculated by the standard formula

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

but to ease matters, because it is one thing to know how to work out these things, but quite a different matter to make the calculations frequently, Table 2 has been prepared and the values required for the case now being considered are also presented in Table 1. The maximum permissible load Req for the stipulated frequency response is, then, a half of the reactance figure given in Table 1. These indicate permissible load resistors higher than those decided upon previously from the point of view of load lines and so in practical design the value indicated by the load lines would be accepted, knowing that the frequency characteristic will actually be better than that stipulated.

It is not always desirable, of course, to extend the frequency characteristic beyond that which can be usefully employed. A case in point is the design of a feedback amplifier such as will be coming up for consideration later. Often such an amplifier can be unstable at a frequency above audibility and this can cause havoc with the fidelity of the amplifier. The cure is to reduce the gain at those high and unwanted frequencies. If the stray capacitances are found to be too small to give the necessary restriction in range with the chosen size of load extra capacitance can be added across the load to give the required compensation.

Let there be given, however, one further reminder that Req, as determined above, is not only the anode load resistor, but that resistor in parallel with the grid resistor of the following valve. The grid resistor will very likely be about 1 MΩ if the following valve is an amplifier and not a power valve. So, having decided from a load line analysis what size of load the valve would prefer and having checked from a consideration of strays, in relation to the maximum frequency required, the highest value of resistive load permissible, the choice will be for the smaller of the values indicated by these two methods. For instance, an effective load of 100 KΩ was found practicable for the triode, but any increase was seen from the load line to introduce distortion. Now it is found that an anode load up to 230 KΩ is permissible from the stray capacitance point of view, but the smaller figure 100 KΩ is chosen. The 1 MΩ

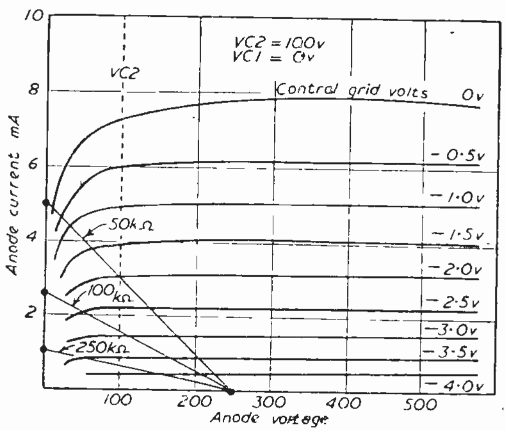


Fig. 22.—Load lines of a pentode.

grid resistor will have comparatively little effect in this case, and a 100 KΩ resistor will be used as anode load. This, in parallel with the 1 MΩ grid resistor, will give an actual load Req of 91 KΩ. In view of the normal tolerance in components of 20 per cent., we are not likely to lose any sleep over the difference between a load of 100 KΩ and 91 KΩ.

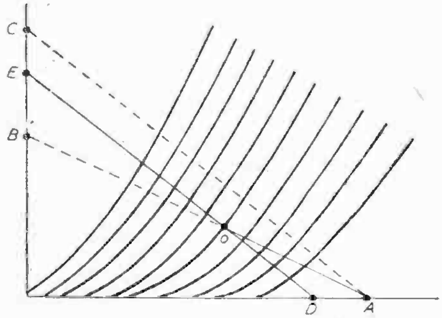


Fig. 23.—Triode load line allowing for differing D.C. and A.C. load.

There is a complication in the drawing of a load line that should, perhaps, be mentioned due to the fact that the coupling capacitance Cc, which has been conveniently forgotten at middle and upper frequencies so that Req has become RL and Rg in parallel, does, in fact, isolate Rg from the H.T. supply point of view. This means that RL alone must be considered when determining the initial working point of the valve before signal is applied. The correct procedure is first to draw the load line for the actual anode load resistor alone. The working point will be along this line. Fig. 23 shows this for the triode case and Fig. 24 for the pentode case, the load line being AB. Now the working point is so chosen that the grid can swing in each direction to follow the amplitude of signal fed to the valve, seeing that the requirements of linear amplification, i.e., that the load cuts the curves with reasonably equal spacing, are met. This working point is O. Now the load line for Req (RL in parallel with Rg) is drawn, AC in the illustrations. Now through O is drawn a line parallel to AC, shown as DE, and this is the true working load line when the signal is applied. In actual fact, where Rg is large compared with RL, this is not likely to be much different to the simpler method in result.

Practical Application of Valve Data

The reader may well be thinking how he can possibly work through this maze of design work when he wishes to build an amplifier. The truth of the matter is that in most cases he will not have to. Most amplifier requirements are more or less stereotyped, and standard design data can be used to provide short cuts. It is necessary, of course, to understand the foregoing theory so that the standard data can be correctly used in appropriate cases and so that, in the cases where a divergence from standard is necessary, the correct steps to allow for the exceptional circumstances will be known.

Dynamic Curves

The method adopted by the valve makers is to determine the most suitable load resistances in normal circumstances and to redraw the curves allowing for these load resistors. The effect is, of course, to reduce the steepness of the Ia/Eg curve. These are known as the dynamic curves. In addition to the Ia/Eg curve the values of ra, μ and gm are plotted on these diagrams. There is nothing very magical about these curves, and the foregoing discussion will have made clear to the reader what problems have been faced in preparing them. In fact, the main curve is merely the plotting of the points of interception of the load line on the static curves with the curves for the various grid voltages.

Suitable Design

Perhaps the best way to bring out some further theoretical and practical points concerning resistance coupled amplifiers is to tackle the actual design and construction of an amplifier, starting with none too rigid a specification, but rather aiming at a unit of utility and versatility such as one would like to have about in the workshop to press into use whenever occasion arises and which might well form part of a more specialised piece of equipment, even a complete receiver, at a later date.

TABLE 2

Table giving reactance of capacitances at higher frequency limit.

	3 Mc/s	2 Mc/s	1 Mc/s	40 Kc/s	20 Kc/s	10 Kc/s	5 Kc/s
1 pF	53 KΩ	80 KΩ	160 KΩ	4 MΩ	8 MΩ	16 MΩ	32 MΩ
5	10.6 KΩ	16 KΩ	32 KΩ	800 KΩ	1.6 MΩ	3.2 MΩ	6.4 MΩ
10	5.3 KΩ	8 KΩ	16 KΩ	400 KΩ	800 KΩ	1.6 MΩ	3.2 MΩ
20	2.7 KΩ	4 KΩ	8 KΩ	200 KΩ	400 KΩ	800 KΩ	1.6 MΩ
30	1.8 KΩ	2.7 KΩ	5.3 KΩ	135 KΩ	270 KΩ	530 KΩ	1.1 MΩ
40	1.3 KΩ	2 KΩ	4 KΩ	100 KΩ	200 KΩ	400 KΩ	800 KΩ
50	1,060 Ω	1.6 KΩ	3.2 KΩ	80 KΩ	160 KΩ	320 KΩ	640 KΩ
60	880 Ω	1,350 Ω	2,650 Ω	67 KΩ	135 KΩ	265 KΩ	533 KΩ
70	750 Ω	1,150 Ω	2,300 Ω	57 KΩ	115 KΩ	230 KΩ	460 KΩ
100	530 Ω	800 Ω	1,600 Ω	40 KΩ	80 KΩ	160 KΩ	320 KΩ

Supposing that a gain of about 150 times is aimed at. This is rather more than is likely to be obtained from a single pentode in a reasonably stable wideband audio circuit and, in any case, it sets a nice problem in design for triode working.

(To be continued)

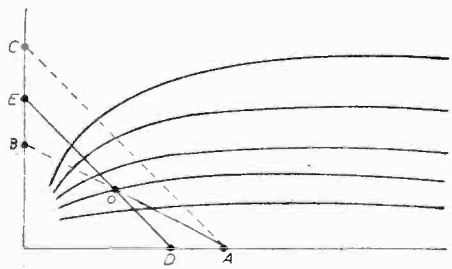
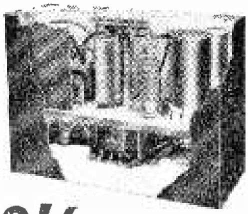


Fig. 24.—Pentode load line allowing for differing D.C. and A.C. load.



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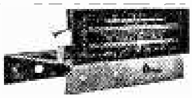

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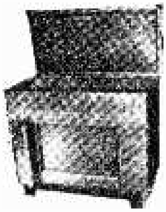

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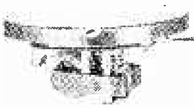

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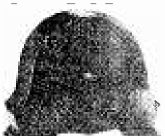

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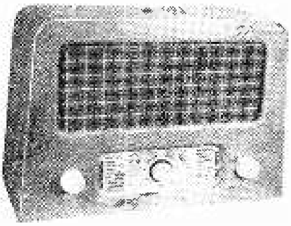

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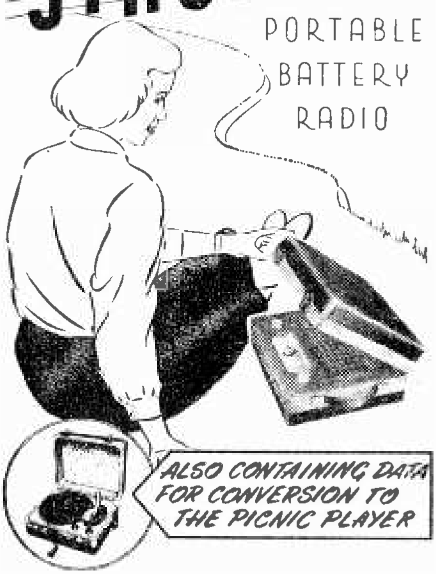

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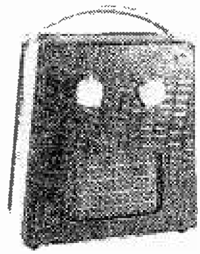

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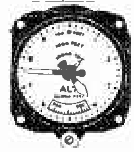

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(Continued from page 398, July issue.)

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Matters, however, are not as simple as this, as it is not possible to get the amplification and the bandwidth. Again, the amplification of low frequencies can be a problem; special amplifier circuits have been designed, and will be described later in this series.

The normal amplifier circuit differs from the normal audio amplifier circuit in that it must be capable of a high output at very low distortion, and also phase shift must be kept at a minimum. The high frequencies must also be reproduced in full, and this is not always possible. It has been stated by one authority (Dr. F. E. Terman) that for a saw-tooth or square-wave to be reproduced correctly all frequencies from the fundamental to the 27th harmonic must be produced in correct phase and amplitude. However, the writer has found that quite good results can be obtained with circuits that do not reproduce more than the first six or eight harmonics. It is interesting to see just how a wave becomes if all above the fifth harmonics are removed.

An Example

The operating condition of a triode for the minimum distortion is the same as for the maximum output in the case where it is terminated with a resistance equal to its impedance. The gain of the stage under these conditions is equal to a half of the amplification factor. For example, a 6C5G will, with a 7 KΩ anode load and a supply voltage of 300, give a gain of 10, and an output swing of about 200 peak-to-peak at very low distortion. Increasing the H.T. will give a greater output for the same amount of distortion. The bandwidth that can be obtained from such a simple circuit runs up in the megacycle range, but will depend on the stray capacity of the circuits. If, however, it is desired that a greater gain, say, 100, is required, the two sections of a 6SN7 can be used, one feeding the other. Decoupling will have to be used, and the circuit of Fig. 5 is quite useful.

Phase Shift

Single-ended output amplifiers allow the shift voltage to be fed to one plate, but there are circuits where the output can be fed direct from the plates of the amplifiers in such a manner that electronic shift can be used. These circuits have several advantages—they reduce the output capacity of the circuit, reduce the number of the components, and also operate in such a manner that the centre of the screen is at all times the point of no distortion. That is, the shift can be applied to a wave in such a manner that the amplifier can be heavily overloaded, and yet the portion of the wave at the centre of the screen is being amplified in a distortionless manner. The

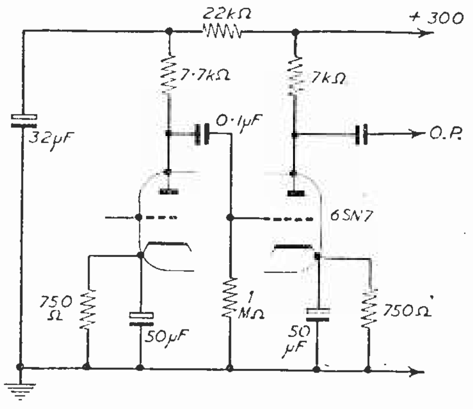

Fig. 5.—Using a 6SN7 with the two sections in cascade.

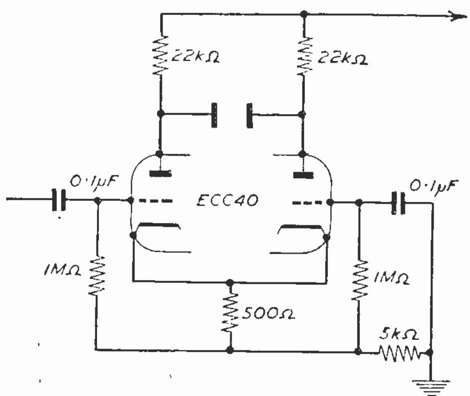

Fig. 6.—This circuit is known as the Schmidt.

circuit is the Schmidt, and it consists of two valves with the cathodes joined and operating with a common cathode resistance. The basic circuit is shown in Fig. 6. The circuit values in this circuit are "calculated," but in practice, of course, the 500Ω could be 470Ω or 510Ω and the 5,000Ω either 4,700Ω or 5,100Ω. If the reader studies the valve data for the Mullard ECC40 he will see that

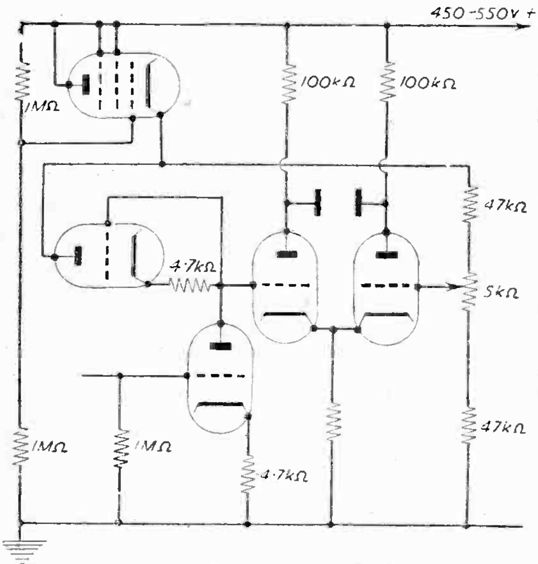

Fig. 7.—An elaborate circuit which has very high gain and minimum phase shift.

in the data the impedance of the valve is given as 11 KΩ whereas in the circuit the values of the load resistors are 22 KΩ. The reason for this is that the feedback in the cathode coupling circuit has the effect of doubling the impedance of the valve. The calculations for the circuit are quite simple. The cathode resistor is calculated in the normal manner by dividing the bias voltage by the anode current, and the cathode coupling resistor is made ten times this value. A coupling resistor of lower value can be used, but the balance will not be as good. An increase in resistance over ten times will only decrease the output for a given distortion.

If, with this circuit, the grid of the second half is fed with a D.C. potential, and not earthed via a condenser, it is possible to vary the bias on one half of the valve. This will upset the ratios of the anode currents in the two valves, so that the voltages developed in the two anode load resistors will be quite different. With the anodes of the valves coupled direct to the deflector plates this can be used as shift control. The values of the resistors in series with the potentiometer will have to be calculated, as if the control were placed between H.T. line and chassis only a portion of the track would be used. The change of only a few volts is usually quite sufficient.

Practical Circuit

An amplifier circuit described several years ago by the writer gave a gain of some 3,000 with a zero phase shift down to zero frequency. The circuit (Fig. 7) is quite simple, but a little unusual. The first valve is a conventional 6SL7 used with one section as an anode load for the other. This is not new, but it reduces the distortion to the lowest possible value, and was first used in the 1920s. The bias of both sections is obtained with the aid of the normal cathode bias resistor—in this case 4.7 KΩ. The H.T. supply to this valve is stabilised by the use of a voltage halving circuit. Here an EF50 was used in the original circuit, but later experience has shown that the EL84 is far more efficient, as it has a larger slope and higher current-carrying capacity. The second 6SL7 is in a conventional Schmidt circuit. The value of the cathode coupling resistor of the second valve will have to be found by trial and error. The top frequency that one can expect to reproduce with this type of circuit is in the region of 20 Kc/s, but there is no zero. If, however, it is required to use the circuit for frequencies below 1 c/s, then the H.T. supply must be stabilised. The output voltage for sweep purposes in about 150 volts.

(To be continued)

Complete Installation for Small Craft

A NEW complete three-in-one radio installation, designed with a particular view to meeting the requirements of near- and middle-water fishing vessels, is now in production by the Marconi International Marine Communication Co., Ltd. Known as the "Guillemot/Renown/Seapilot" installation, it provides full facilities for radio-telephony transmission and reception as well as for direction-finding.

The transmitter, designed only for radio-telephony working, is crystal-controlled and operates in the frequency band of 1.6 to 2.85 Mc/s. This coverage is subdivided into six sections selected by a switch and six preselected spot frequencies can be provided for. Power is obtained from 24-volt accumulators, and the power output to the aerial, unmodulated, is 14 watts.

Operational controls have been kept to a minimum and apart from the "On/Off" switch, consist only of the aerial tuning circuit control and the frequency selector switch. Both the frequency controls are fitted with dials large enough to be operated while wearing gloves.

The "Renown" section of the installation is a seven-valve superheterodyne receiver specially designed for use with a rotating loop aerial to provide both reception and direction-finding facilities. It is fitted with a built-in loudspeaker and covers three frequency ranges of 131 to 45 kc/s, 375 to 1,250 kc/s and 1,154 to 3,400 kc/s, thus giving full coverage of all the necessary marine frequencies, including those used for the transmissions of the "Consol" position-fixing system and the BBC weather reports, forecasts and warnings, as well as those on which the coastal radio-beacon stations transmit.

As in the case of the "Guillemot," controls have been kept to a minimum and made as simple to operate as possible. The frequency band selection switch, tuning and volume controls have all been provided with easily-handled knobs, and the "Renown" and "Guillemot" being of approximately the same dimensions may be fitted one above the other to make a neat and compact installation ideal for the small wheelhouse.

Volume Controls

Midget Ediswan type. Long spindles. Guaranteed 1 year.
No. Sw. 3/- S.P. Sw. 4/-
D.P. Sw. 4/9
ALL VALUES.—10,000 ohms to 10 Megohms.

80 ohm CABLE COAX

STANDARD ¼in. diam. Polythene insulated. GRADE "A" ONLY Not Ex-Govt.
8d. yd.
COAX PLUGS, 1/- each. SOCKETS, 1/- each. LINE CONNECTOR, 1/2. OUTLET BOXES, 4/6.

BALANCED TWIN FEEDER per yd. 6d. } 80
TWIN SCREENED FEEDER per yd. 1/- } ohms

50 OHM COAX CABLES, 8d. per yd. ¼in. dia.

TRIMMERS, Ceramic, 30, 70 pf. **9d.** 100 pf. 150 pf. **1/3** ; 250 pf., **1 6** ; 600 pf., **1/9.**

RESISTORS.—All values : 10 ohms to 10 meg., ¼ w. **4d.** ; ½ w. **6d.** ; 1 w. **8d.** ; 2 w. **1/-** ; High Stability, ½ w. 1%, **2/-.**

WIRE-WOUND RESISTORS.—Best Makes Miniature Ceramic Type 5 w., 15 ohm to 4 K., **1 9** ; 10 w., 20 ohm to 6 K., **2 3** ; 15 w., 30 ohm to 10 K., **2 9** ; 5 w. Vitreous, 12 K. to 25 K., **3 -.**

WIRE-WOUND POTS. 3 WATT. FAMOUS MAKE
Pre-Set Min. TV. Type. Knurled Slotted Knob. All values 25 ohms to 30 K., **3/-** ea. 50 K., **4 -.** Ditto Carbon Track 50K to 2 Meg., **3/-.**
Standard Size Pots, 2¼in. Spindle. High Grade. All Values. 100 ohms to 50 K., **5/6** ; 100 K., **6 6.**
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O/P TRANSFORMERS. Small Tapped pentode, **3/9.** Heavy duty 70 ma., **4/6.** Ditto, tapped. **4/9.**
L.F.CHOKES 10 h. 65 ma., **5/-.** 20 25 h. 100/150 ma., **12/6.** 5 h. 250 ma., **15 -.** 15 h. 100 ma., **10/6.** **LYNX,** 3h. 250 ma., **13 6.** **SIMPLEX,** 10h. 150 ma., **10/6.** **MAINS TRANS.** Made in our own workshops to high grade specification. Fully inter-leaved and impregnated. Tapped prim. 200 v. 250 v. Heater Trans. 6.3 v. 1½ amp., **7/6** ; ditto 6.3 v. 3 amp., **10/6** ; ditto, 12 v., .75 amp., **7/6.** 350-0-350, 80 ma., 6.3 v. 4 a., 5 v. 2 a., ditto 300-0-300, ditto 250-0-250, **21/-.** **AMPLIFIER TRANS.** 250 v. 50 ma. ½ wave. 6.3 v. 2 a. Fully Shrouded. **17 6.** Viewmaster, Auto Type, **35/-.** Teleking, **30 -.** Lynx, **30/-.** Coronet, **30/-.** Simplex, **35/-.** Rewinds and Specials to requirements.

SOUNDMASTER SPECIALS.—Mains Trans., **35/-.** L.F. Choke, **10 6.** O P Trans., **5 6.** Envelope, **6 6.** Specified Wafer Switches, **22 6** per set of 3.

GOODMANS.—Latest Wide Angle Duomag type, Focus Unit. Vernier Focus and adjustable Picture Shift, **35/-.** **ELAC.** C.R.T. Ion Traps, **2/6.**

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LIGHTWEIGHT XTAL HAND MIKES. Chrome finish—Quality and sensitivity for only **25/-.**
ELECTRODYNAMIC MIKE INSERT.—U.S.A. make, precision engineered. Size only 1in. diam. by ½in. Bargain Price **3/9.** Matching Trans. **3/9.**

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TAG STRIPS.—2- or 3-way, **2d.** ; 4- or 5-way, **3d.** ; 6-way, **4d.** ; 9- or 10-way, **6d.,** etc.

T/V. PRE-AMP.—Channel 1. Easily modified for other Channels or Converter use. Midget Chassis, 4¼ x 2¼ x 1¾. Complete with EF42 valve, coax. lead and plug. Ready for use. Brand New Mfrs. Surplus. Listed £3 15s. Special Clearance Price, **27/6** ; p. & p., 1 6.

TOGGLE SWITCHES EX-GOVT.—"On-Off," **9d.** Ersin M'core solder 60/40, 16 g. or 18 g., **5/6** ½ lb. ; T.C. wire, 18 to 22 s.w.g., per yd., **2d.** PVC Connecting wire, 10 colours, Single or Stranded, **2d.** yd. 2 K. 5 w. H.D. w w Pots, **4/6.** 10 K., 25 K., Colvern w w Pot, 1in. spindle, **3/6.** **SCREENED GRID CAPS** I.Oct., or Mazda, **6d.** ea. **BULGIN HIGH VOLTAGE VALVE CAPS,** I.Oct., **1/-.**

FUSES.—1¼in. all values 60 ma. to 10 a., **6d.**

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SLOW MOTION DRIVES.—Epicyclic ratio 4 : 1, **2/3.**

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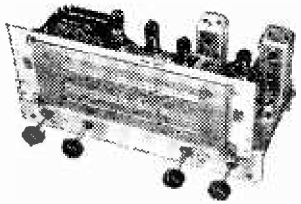
MAINS LEAD.—3 yds. Twin Twisted Maroon Flex. Top Quality 23/0076 Core, **1/-.**



ALL WAVE RADIOGRAM CHASSIS
THREE WAVEBANDS — **FIVE VALVES**
S.W. 16 m.—50 m. — LATEST MULLARD
M.W. 200 m.—550 m. — ECH42, EF41.
L.W. 800 m.—2,000 m. — EBC41, EL41, EZ40.

Brand New and Guaranteed, with 10in. P.M Speaker. A.C. 200/250 v. Four position Wave-change Switch. Short-Medium-Long-Gram. Slow Motion Tuning. Speaker and Pick-up connections. High Q iron-dust cored coils, 465 kc/s I.F. Latest circuit technique delayed. A.V.C. and Negative feedback. Output 4.2 watts. 3 ohms output transformer on chassis. Chassis size 13½ x 5½ x 2¼in. Glass Dial 10in. x 4½in., horizontal or vertical type available, lit by 2 Pilot Lamps. Colour Black Station names, L.W. Green, M.W. Red, S.W. White. Four Knobs supplied. Walnut or Ivory to choice. aligned and calibrated. Chassis isolated from mains. **PRICE, £10/15 0.** Carriage and Insurance, 4/6. (Without 10in. Speaker, **£9 15 0.** Carr. & Ins., 4/6.)

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RECOMMENDED FOR ABOVE CHASSIS GREAT REDUCTIONS
Brand new Plessey 3-speed Autochanger Mixer Unit for 7, 10 and 12in. Records. Twin Hi-Fi Xtal Head with Duopoint sapphire stylus. Plays 4,000 records. Sprung mounting. Superb Quality. Bargain Price, 9½ gns. post free.

Radio-gram. Cabinets, superb Walnut finish. Size 30in. x 29in. x 15in. Lift-up lid. Int. Record Storage space. Facia cut out for above Radio Chassis. Soundly constructed. Complete with Back, Speaker Baffle and Fret. Bargain £9 19s. 6d. Callers only, please.

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NEW BOXED — ALL GUARANTEED

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1R5	8	6J7	8/6	12BA6	8/6		5/6
1S5	8	6K6	7/6	12Q7	10 6	British	7/6
1S4	8	6K7	6/6	12SH7	5 6	Sylvania	
		6K8	9/			Red	10/6
1R5	8	VT127		35L6	10 6	EF91	8
3S4	9	Pen46	9/-	35Z4	10 6	EF92	9 6
3V4	8/-	EF80	10 6	OZ4	8 6	EL32	9/6
3D6	2/6	6L6	10/6	50L6	9 6	7C6	9/6
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5Z4	9/-	6Q7	9/6	6Z32	15	EY91	8/6
6X4	7/6	6SA7	8 6	CV6	3 6	HVR2a	7/6
6AG5	7 6	6SH7	6 6	DK91	8	MS PEN	6/6
6AM6	9	6SL7	9/	DF91	8	PY80	11/6
6AT6	10 6	6SN7	11/-	DAF91	8	PY81	11/6
6B8	7/6	6U5(Y63)	8/-	DL92	9	PY82	10 6
6BA6	8 6	6V6	8/	DL94	8	PEN25	8 6
6BE6	10 6	6X5	9/-	E1148	4 6	SP61	8/6
6BW6	10 6	6AK5	10/6	EA50	2	C22	9/6
6C4	7/6	7S7	9 6	6AL5	7 6	VP23	7/6
6C6	7 6	9D2	5/6	EB34	3 6	VR116	6/6
6D6	7 6	12A6	7 6	EB91	7 6	MU14	9/6
6F6	9/6	12AX7	10/6	EBC33	9 6	ECL80	12/6
6F12	9	12AT7	10/6	EC91	7 6	25L6	10 6
6G6	6/6	12K7	10/6	EF36	7 6	25Z6	10 6
6H6M	3/6	12K8	10/6	EF39	9	25Z4	10 6

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SPECIAL PRICE PER SET
1R5, 1T4, 1S5 and 3S4 or 3V4 ... ... 30/-
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SUB MINIATURE VALVES WIRE ENDS

★ R.F. Pent. .625 v. Fil.
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★ DF66 ★ XFW10
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H.R. PHONES.—(Hi-grade Amer.), **15/6** pr. **S. G. BROWN'S,** 4,000 ohms, **15/6** pr.

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. Micamould Tub., **9d.** ; Hunts Moldseal 500 v. .005, .01 mfd., **9d.** ; .05 mfd. and .1 mfd., **1/-** ; .25 mfd., **1/6** ; 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.**

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1.5 pf. to 500 pf., **1/9.** 515 pf. to 1,000 pf., **2/-.**

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Tubular Wire ends		50/50 v. Plessey	2/-
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4/350 v. Dub.	1/6	32/350 v. B.E.C.	4/-
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10/500 v. Dubilier	2/6	16+16/450 v. B.E.C.	5/6
16/500 v. Dubilier	4/-	16+16 500 v. Dub.	6/-
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16/350 v. B.E.C.	3/-	32+32 350 v. +25/25 v.	
32/350 v. Dubilier	4/-	in same can B.E.C.	6/6
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25/25 v. Dubilier	1/9		
50/25 v. Plessey	1/9		12/6

SPECIALS.—Can Types. 500 mfd. 12 v., **3/-** ; 1,000 mfd. 12 v., **5/-** ; 1,000 v. mfd. 6 v., **4 6** ; 16 mfd. 700 v. Hunts, **6/6** ; .1 mfd. 2 kv., **4/6** ; .5 mfd. 3.5 kv., **5/6.**

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/-.**

KNOBS, GOLD ENGRAVED.—Walnut or Ivory, 1½ in. diam., **1/6** each. "Focus," "Contrast," "Brilliant," "Brilliance On-Off," "On-Off," "Volume" "Vol.—On-Off," "Tone," "Tuning," "Treble," "Bass," "Wavechange," "Radio-Gram," "S., M., L., Gram.," "Record-Play," "Brightness." Ditto not engraved, **1/-** each.

POINTER KNOBS.—Brown with white marking line, small, **9d.,** large, **1/-.**

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REACTION COND.—.0001, .0003, .0005 mfd., **3 6** ea.

E.H.T. TRANSF.—4 Kv. A.C., 2 v. 2 a., **45/-.**

VIBRATOR TRANS.—6 v. input, 250 v. 50 ma. output, **9/6.** **P. & P., 1/-.**

VIBRATORS.—4-pin 12 v. Mallory, etc., **7/6.**

VCR97 £2
TESTED FULL PICTURE
P. & P. 2/-

CHARGER TRANS. PRIM.—0-200/250 v., Sec. 0-9 v.-15 v. 1 a., **13/6** ; 2 a., **16/-** ; 3 a., **18/6** & 4 a., **21/-** 6 a., **26/-.**

FULL WAVE BRIDGE SELENIUM RECTIFIERS.—6 or 12 v. 1½ amp., **8/9** ; 3 a., **12/6** ; 4 a., **15/-** ; 6 a. **23/6.** Ditto F.W. only 6 v., 1 a. (9 v.-0-9 v. A.C.). **5/6.**

ACID HYDROMETER.—New ex-Govt. Unbreakable. Packed in metal case, 7in. x 1½in. dia., **4/6.**

H.F. MIDGET CHOKES.—14 M.H., **2/6** each.

BRIMISTORS.—CZ1 for 3 a. heater chains, **3/6.** CZ2 for .15 a., or .2 a., **2/6.** CZ3 (Pilot Lamp), **1/6.**

COPPER ENAMEL WIRE.—½ 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.

5in. RADIO SCREWDRIVERS.—Sheffield made blade, 2½in. x ⅛in. Ins. handle, 5,000 v., **4½d.** each.

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 v. L.T. Complete, **25/-** ; p. & p., **2/6.** Suitable Battery Portable Sets.

LOUDSPEAKERS P.M., 3 OHM.
3in. Plessey, **12 6.** 5in Goodmans, **13/6.** 6½in. Elac. **14/6.** 8in. R. & A., **17/6.** 10in. Plessey, **25/-.** 12in. Truvox, **55/-.**

I.F. TRANSFORMERS

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

T.R.S. RADIO COMPONENT SPECIALISTS

THO 1665. Buses 133 or 68 pass door.
307, WHITEHORSE ROAD, WEST CROYDON

P. and P., 6d. £1 orders post free. Lists 3d. ALL MAINS TRANS.—1/- extra postage.

Surplus R.F. Pentodes

DETAILS OF EX-SERVICE VALVES, WITH BASE CONNECTIONS

By E. G. Bulley

THE valves that are today available upon the surplus market are shown in table 1, and comprise two specific types, namely one that is termed the " variable mu," and the other having a sharp cut-off characteristic. The former derives its name from the fact that the pitch of the grid helix is varied along its active length, resulting in the mu of the valve being varied as and when the bias voltage is altered. That is to say, as the bias voltage is taken more negative so the mu of the valve will decrease. This characteristic, therefore, allows the valve to handle much larger signal inputs without distortion in the circuit in which it is being used.

In the case of the sharp cut-off type, the grid pitch is uniform along its entire length and therefore one can say that the mu characteristic is more or less constant, and is not therefore affected by the bias on the valve.

The amount of amplification effected by the valve in question can therefore be controlled by the variation of the signal input to the grid, or in some cases by variation of the screen voltage. The latter affects the slope of the valve. By varying the slope characteristic, it in turn affects the amplification factor.

TABLE 1—SURPLUS VALVE TYPES

	E.F.	I.F.	Max. E.A. Voltage	Max. Screen Voltage	Max. Wa	Max. Screen Dis.	Slope Ma/V	Max. Op. Freq. (Mc/s)
VR65	6.3	.63	250	250	4.5	1.25	8.5	100
CV136	6.3	.2	300	275	4.75	0.8	2.6	100
CV138	6.3	.3	300	300	3.0	0.9	7.5	—
6C6	6.3	.3	250	100	—	—	1.25	—
VT193	6.3	.3	250	100	2.0	—	2.85	—
NR64	6.3	.3	250	100	2.0	—	2.85	—
VR106	13.0	.2	250	125	—	—	1.65	—
VR108	13.0	.2	250	125	—	—	1.25	—
NR79	6.3	.45	300	150	3.0	0.5	7.5	—
ARP21	6.3	.45	300	150	3.0	0.5	7.5	—
ARP24	2.0	.21	150	60	—	—	1.0	—
ARP20	4.0	.95	200	200	4.0	—	8.5	—
ARP38	4.0	.25	250	100	1.25	—	2.2	—
VT149	4.0	.25	250	100	1.25	—	2.2	—
VR91A	6.3	.3	300	300	3.0	1.7	6.5	125
VR100	6.3	.3	250	100	2.0	—	2.85	—

Cross-modulation

The adoption of the variable-mu valve does prevent what is known as cross-modulation, that is to say,

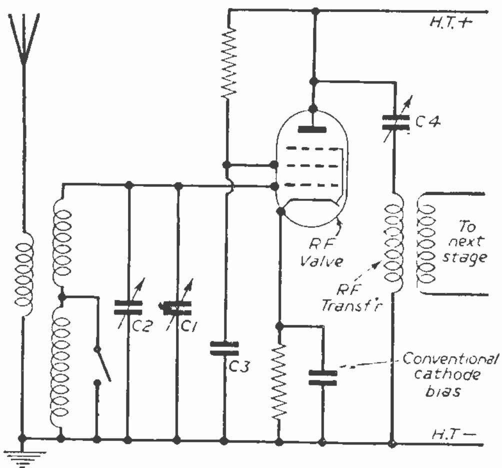

Fig. 1.—A conventional H.F. stage in a modern receiver.

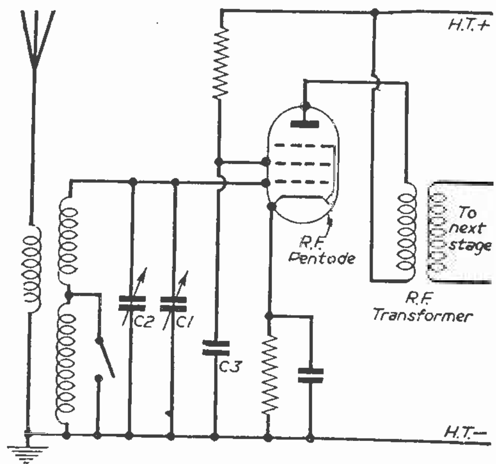

Fig. 2.—An alternative to the circuit shown in Fig. 1. Here the R.F. transformer primary carries the anode current of the valve.

the use of such a valve prevents the interference which can be set up by the modulation of two or more signals.

A typical R.F. stage is shown in Fig. 1, and in such a circuit, screening is an essential requirement. This can be appreciated when one realises that any stray reaction effects will create instability. However, upon examination of the circuit, it will be seen that the aerial is inductively coupled to the grid coil, the latter being tuned by a suitable condenser C1 to the frequency required; C2 is the trimming condenser. The screen grid is suitably by-passed by a condenser C3, and the output from the R.F. pentode appears across the primary of the R.F. transformer. This, in turn, is transferred to the secondary of the transformer and hence passed on to the next stage. In this arrangement, condenser C4 is used to adjust the coupling between the valve and the R.F. transformer primary.

An Alternative

However, an alternative arrangement which is more commonly used is shown in Fig. 2.

Furthermore, such valves can also be used as frequency changers so long as there is a separate oscillator valve. This practice, however, is not recommended for U.H.F. work, the reason being that there is always the possibility of interference from the output of the local oscillator. A typical circuit in which the valve is used as a frequency changer is shown in Fig. 3, and is included so that the reader will appreciate the application of such valves. Fig. 3 shows the method by which the output from the local oscillator is injected into the grid of the R.F. valve which is being used as a frequency changer.

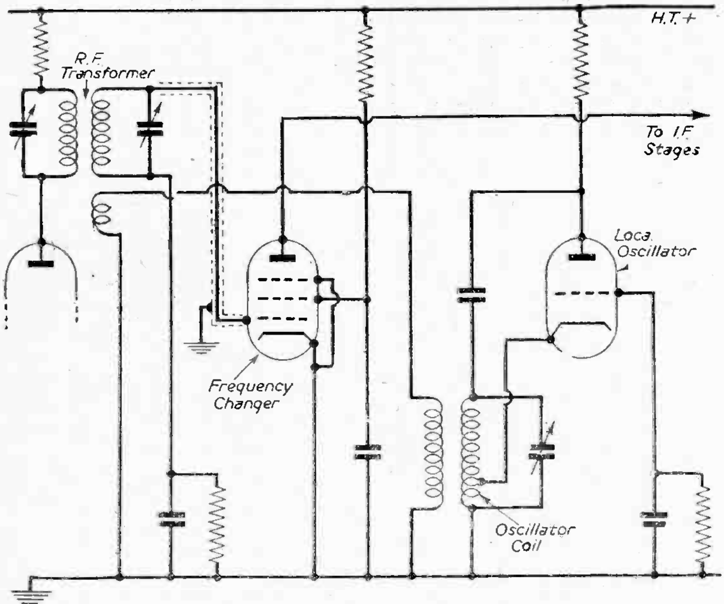

Fig. 3.—Circuit of a superhet frequency changer stage in which an R.F. pentode acts as frequency changer.

An advantage of an R.F. stage, however, is that it provides greater gain with improved signal/noise ratio.

A.V.C.

A further advantage of the variable-mu type of R.F. pentode is, of course, the ability to use the variation in gain afforded by the variable-mu characteristic in an attempt to overcome the drawbacks of fading when receiving long-distance signals. Variation in the bias voltage over quite a wide range varies the gain of the valve, and therefore it is usual in the superhet type of receiver to use this type of valve in both the R.F. and I.F. stages. After the I.F. stages the signal is rectified and applied not only to the A.F. amplifiers, but also back to the R.F. and I.F. stages. The voltage produced by the rectified signal is used for the bias of the controlled stages (through suitable filters to avoid instability) and thus as the signal becomes stronger more bias is applied to the valves and the gain thus reduced. This type of valve is available in both "short grid base" and "long grid base" and therefore alternative types may be used according to the degree of control desired.

TABLE 2—PIN CONNECTIONS

1	2	3	4	5	6	7	8	T.C.	Base
H	K	A	G2	G3	M	—	H	G1	M.O.
G1	K & G3	H	H	A	—	G2	—	—	B7G
G1	K	H	H	A	G3 & I.S.	G2	—	—	B7G
H	A	G2	G3	K	H	—	—	G1	USS6
—	H	A	G2	I.S.	—	H	K	G1	I.O.
—	H	A	G2	I.S.	—	H	K	G1	I.O.
—	A	G3	H	H	K	G2	—	G1	B7
—	A	G3	H	H	K	G2	—	G1	B7
—	H	A	G2	G3	—	H	K	G1	I.O.
—	H	A	G2	G3	—	H	K	G1	I.O.
M	A	G3	H	H	K	G2	—	G1	B7
H	K	A	G2	G3	M	—	H	G1	M.O.
M	H	A	G2	G3	—	H	K	G1	I.O.
M	H	A	G2	G3	—	H	K	G1	I.O.
H	G2	A	G3	I.S.	K	G1	I.S.	(Pin G-H)	B9G
—	H	A	G2	I.S.	—	H	K	G1	I.O.

(I.S. = Internal shield or screen.)

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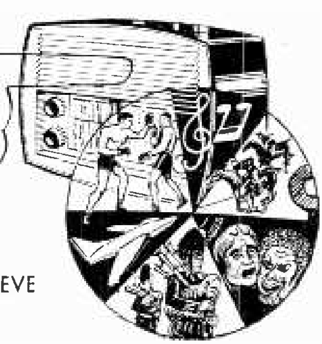

By MAURICE REEVE

Repeated Description

I HAVE often complained of the BBC's insensitivity to repetition in many of its programmes, most notably the weather forecasts, news bulletins and other items of topical interest. Also, to me, the needless reading out of casts and other detail after some of the shortest items and, not infrequently, before as well, when all of it is at our elbow in the *Radio Times*.

A notable instance of this occurred during the past month on the occasion of Her Majesty's visit to the City to take luncheon with the Lord Mayor. Three commentators were posted along the route: Max Robertson at Temple Bar describing the "Ceremony of the Sword," Wynford Vaughan-Thomas outside the Mansion House to tell of the arrival there, and Godfrey Talbot inside to whet our appetites and thirsts for the lunch itself. All three told us that (a) the Queen was wearing a green hat and a fur cape, (b) the Duke of Edinburgh was in the uniform of an Admiral of the Fleet, (c) the sky was of Mediterranean blue and the sun was shining down, (d) it was a great historic occasion and the pageant of our glorious history was rolled out before us in the various rites, etc., that were performed, and so on and so on. As the whole broadcast took less than 30 minutes the total effect was one of boredom and annoyance such as we feel on hearing three consecutive news bulletins with scarcely a word changed in each.

A liaison between commentators should not only be the simplest matter possible, but should be obligatory and part of the routine on such occasions. One commentator only should describe the dresses and uniforms (unless, as with a famous pianist, they are changed between courses, etc.). Another should be deputed to "do" the weather, crowds and related events, whilst the third should explain the historical origins and significance of the ceremonies enacted. We should then have a continuous picture of what is taking place unfolded for us instead of, as it were, constant references back to what has already gone by and dips into an index to see what is coming. So simple yet so rarely met with.

"Between the Wars"

Mr. Wickham Steed, late editor of *The Times* gave a talk on the origins of the *Entente Cordiale* and is at present engaged in a series of six programmes of reminiscences styled "Between the Wars." They are very interesting and a forceful radio personality, akin to Bertrand Russell's, is behind them. The talk on the *Entente* might well have had the sub-title "... or how the 1914-18 war came about."

Cobbett's "Rural Rides" is one of the great books on England and those who finish it are well rewarded. Stimulating, racy, forthright, if not always quite accurate, it makes us smell the new mown hay and the freshly turned soil. This is exactly what Ralph Wightman is and did, though I am sure he is more accurate than Cobbett was said to have been. So the three trips that Mr. Wightman took over some of Cobbett's own route were thoroughly enjoyable. I thought the editing and production most agreeable and apposite, and appreciated the reading of passages from Cobbett by John Sharp.

BBC Dictatorship

The new radio play "Defeat," by Graham Sutton, was another disquisition on dictatorship which the BBC seems to be fathering, or mothering, just now. I liked it very much. Dealing with the Athenian expedition to Sicily in 415 B.C. and its utter rout, it has, as all the plays in this recent bunch have had, its pointer to topical events. I was rather tickled at the request of one of the characters to another to "shut the window." I didn't know there were any so long ago.

Dame Myra Hess

Dame Myra Hess played Beethoven's greatest sonata, Op. 111, most beautifully, with all the love and affection of years of association with it and other Beethoven masterpieces, and with sufficient technical mastery to do full justice to the incomparable variation writing, trills, etc.

Mr. Ernest Newman gave an appreciative and interesting talk on Elgar on the occasion of the centenary of the master's birth.

The BBC's "originality" staff worked at full pressure for the 90-minute variety bill which formed part of the programmes celebrating the Queen's return. Items I recognised of truly staggering novelty were some bagpipes, "All Through the Night" and "Home Sweet Home."

Plays

"Odd Boy Out," a school story, savoured up to a point of "The Winslow Boy," inasmuch as one of the boys at a preparatory school was wrongfully accused. But it differed greatly when the headmaster was shown up as a nefarious scoundrel. A good story well acted.

So was "The Little Foxes," Lillian Hellman's story of the aftermath of the American Civil War. But some of the Southern accents were dubious to the point of being untruthful.

"Stop Press Murder" was the usual mixture which cast suspicion on every innocent person without showing up the real culprit too vividly. It had some merits. It was adapted by Rex Rienits from the novel of Guy Ramsey.

News from the Trade

New Mullard Multi-purpose Beam Tetrode

A NEW beam tetrode valve likely to be of great value to designers of compact audio, video or radio frequency equipment has recently been made available by the Communications and Industrial Valve Department of Mullard, Ltd. This is the QVO6-20, which has an anode dissipation of 20 watts. The new valve is intended for operation at full ratings as a power valve at any frequency up to 60 Mc/s, and at reduced ratings to 175 Mc/s. It has been designed to meet the requirements of a very wide variety of applications, from servo amplifiers to video modulators, and it will function equally well in radio transmitters as driver, frequency multiplier, power oscillator, or output valve.

A single QVO6-20 in Class "C" will deliver 69 watts at 60 Mc/s, while at audio frequencies a pair in push-pull, Class AB1 will provide 120 watts output. The mutual conductance of 7mA/V ensures high power sensitivity even at low anode voltages.

As a precaution against internal feedback, the anode is brought out to a top cap and the lower part of the valve is provided with a short metal screen connected to one of the pins. The heater voltage is 6.3 volts and the base is Internation octal. The QVO6-20 is a direct replacement for the American 6146.—Mullard Ltd., Century House, Shaftesbury Avenue, W.C.2.

The "New Radiotime"

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A unique feature of the receiver is that it can be set to switch "on" to a pre-selected radio programme and then, after a short interval, sound a buzzer alarm to wake the extra-heavy sleeper. It can also be set to switch "on" automatically at any time of the day without sounding the alarm buzzer.

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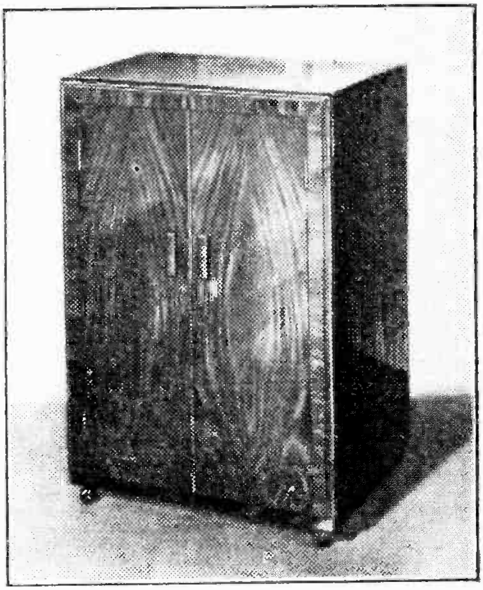
Six-second Soldering Iron

A NOVEL soldering iron of Australian design is being marketed in this country by the well-known traders Arthur's, of Charing Cross Road. This iron, known as the "Scope," is intended for operation from either A.C. or D.C. from 2.5 to 6 volts, and is primarily recommended for use with a 4-volt transformer from A.C. mains. The heating time is then six seconds, and the current drain approximately 30 amps. A switch ring is fitted round the handle which is slid forward to bring the element into circuit. As soon as the required heat is obtained the switch is drawn back and thus the load is applied intermittently. It must not be left switched on for too long a period or the bit will be burnt. In such a case the tip will have to be cleaned up. Each iron is guaranteed for three months, and the price is £1 19s., and the transformer, if required, costs £1 17s. 6d.—Arthur's, 150-152, Charing Cross Road, W.C.2.

Whiteley Electrical Record Cabinets

TWO new storage cabinets are announced by the makers of the well-known W/B speakers. Known as the "Melody" and "Symphony" these cost £9 17s. 6d., and the following are general descriptions. The "Melody" accommodates TV or radio receiver on top; room inside for 150 10in. or 12in. records. Highly polished French walnut veneer finish, interior in lacquered birch. Fitted with easy-running castors and has removable record index cards clipped inside doors. Rubber buffers at back of cabinet.

The "Symphony" has a capacity of 250/300 10in. and 12in. records. Top is large enough to take record player or medium-size TV or radio set. Highly polished French walnut veneer finish, interior in lacquered birch. Easy-running castors, removable record index cards inside doors, rubber buffers at back of cabinet.—Whiteley Electrical Radio Co., Ltd., Mansfield Works, Victoria Street, Mansfield, Notts.



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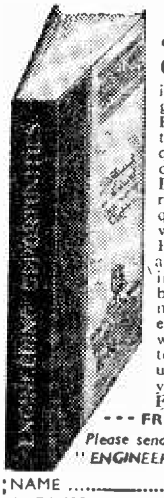

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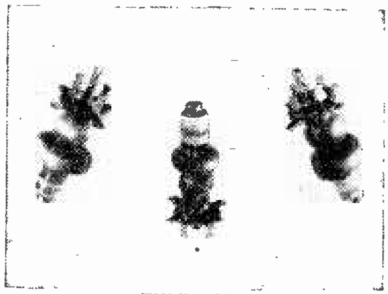

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The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

Interference Suppression

SIR,—I have read A. E. Lofting's article on "Radio Interference Suppression" (May issue, and also the petty comments on it by A. Hale, June issue). May I now add my comments to Mr. Lofting's well-written article, trusting they will be accepted as constructive, not destructive.

Dealing with the question of C.T. to earth capacitor arrangements, providing a source of danger, a low rating fuse in all short connected arms affords excellent protection. Some really good units are available on the market, these incorporate cartridge type fuses from 60 mA. upwards.

The question arises of certain motors requiring inductors in the filter units. Before going to the trouble of winding these it would be well worth while investigating the field arrangements of such machines. In many cases the field coils of a two-pole universal series motor are not arranged symmetrically about the armature, but to one side. This results in virtually no inductance in the line which is connected directly to the commutator. If no external inductors are used with this arrangement some of the H.F. interference voltage escapes the reactance path of the capacitor and travels along the conductor to be radiated. In some cases this can be overcome by arranging the two field coils symmetrically about the armature. The result would be an arrangement like Fig. 1 of Mr. Lofting's article, where L1 and L1 would be the series field and where the motor would be the armature. It can be readily seen that by this arrangement the fields tend to act as inductors in a low-pass filter unit. The method is by no means foolproof; self-capacitance of the field coils, together with inductive effects from the H.F. voltage in the armature, all take their toll of its efficiency. However, it is worth a trial. A third capacitor connected directly across the commutator is often desirable to provide a path for the symmetrical H.F. component.

As the oscillatory nature of the brush spark is the main source of interference in this type of motor, attention should always be paid to the brush gear. The spring tension of the bushes should be about 2 lb. per sq. in., and the brush should always be perfectly free in its holder.

Mica should be undercut unless a class "C" brush or its equivalent is used.

Finally, for Mr. Hale's information the majority of washing machines are for use on A.C. mains and have induction motors that require no suppression. —K. R. WALPOLE (Electrical Engineering Instructor) (Exeter).

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.

Amateur Transmitting

SIR,—Can anyone wonder why there is so much red tape attached to radio transmitting when we get this reaction as exemplified by the correspondent in the July issue.

All because Mr. Bradley wanted to work a walkie-talkie without having to have the same qualifications and conditions of a chap on 100 watts. (Would one have to have a master mariner's certificate to set sail in a 12-footer?) Incidentally, we all know that when the war was on all sorts of chaps—Home Guard and the rest—were playing about with walkie-talkies. How many of them had heard of the morse code? How many could read a circuit? But, of course, there are no essential stations during war time!

Ham radio, over the years, has built up a tradition to which its adherents are fanatical. By their standards it is a crime that there should be an easy way to transmitting. There must, it seems, be some test, some ordeal, by which only the brave and the strong shall survive. Thus, this mutual admiration society can, by licking the hand of authority, perpetrate its philosophy over all.

Can they get away with it for ever?

The influence of change in other countries might open things out. Or we might get a modern William Wilberforce (if only some V.I.P. could be interested). By the way—how many saw the TV film, "Back of Beyond"? The farmer's wife calling her neighbour on the trans-receiver—the chap with the portable relaying the message for a doctor. Wonder if they would be interested in Atlantic conventions or compulsory morse tests?

Finally, I'd like to point out that if a novice band were created it must be isolated from "Ham" radio—a thing apart. It must have its own code and frequency and not be just an unwanted appendix. —HECTOR COLE (Workington).

Mathematics and the Service Engineer

SIR,—Mr. Apps, in his brief reply to the comments of Mr. W. F. Ritchie, jumps with surprising verbal agility from the mathematical frying-pan to its associated fire.

Such sweeping statements which imply that the mathematical ability of a successful candidate in the General Certificate of Education does not go beyond simple arithmetic cannot be left unchallenged. It is extremely questionable whether a candidate at "O" level would succeed on arithmetical ability alone; I am sure the examiners never intended this. If

Mr. Apps' remarks are applied to the papers at Advanced and Scholarship levels, then his comments are patently false. Please, Mr. Apps, be more specific and less misleading.—G. W. F. ASHFORD (King's Lynn).

SIR,—Your contributor, Mr. Apps, in his reply to the letter of Mr. W. F. Ritchie, does not save himself by the assertion that people who have attained the level (he does not say which level) of the General Certificate of Education can tackle only simple arithmetical problems.

A glance at the syllabuses of the Northern Universities Joint Matriculation Board reveals that, for the "Ordinary" level, there are three papers of two, two, and two and a half hours each, dealing with Arithmetic and Trigonometry, Algebra and Geometry respectively.

The syllabuses for the "Advanced" and "Scholarship" levels of the G.C.E. in "Mathematics" and in "Mathematics and Theoretical Mechanics" make it clear that these levels are well beyond the standard required for the Ordinary National Certificate.

Whichever level Mr. Apps was referring to, it is quite clear that he is wrong, and I would suggest that he makes sure of his facts before galloping into print in future.—J. W. WHITEHEAD (Headmaster, Central High School, Leeds).

Dabbler

SIR,—In your June issue of PRACTICAL WIRELESS—which, by the way, I have had from the first number, and *Amateur Wireless* before that—Thermion asks: what is a dabbler? He goes on to expose some of the so-called radio engineers and good luck to him.

I suppose I would now qualify as a "dabbler" but for many years past I was a professional radio engineer and I can vouch for Thermion's statement as to sharp practitioners—I worked for some. But only this week an old customer of mine 'phoned to ask if I would repair his set (I have many of these). The set was one I built 12½ years ago and this was the first time it had gone wrong—worn out switch contacts.

I put in a new switch and my friend has asked me to build him a "gram." He has no faith in shop-made stuff, he says.

So thank you, Thermion, for your straight-from-the-shoulder speech on our behalf. I shall keep on "dabbling" which helps me and helps the people who like a square deal at a right price.

The gentleman I made the set for is only one of many, I am proud to say, who will not allow anyone else to touch their sets.—PERCY IMHOF (Walthamstow).

Battery Sets

SIR,—I was very interested in H. Whetter's letter, in May issue, on "Battery Receivers." I do certainly agree that a set that is badly needed is the one for the over 60s (mains and battery) as stated (also at the right price). I do not, however, agree altogether with regard to the reason many people prefer a battery set to a mains set (because it is much quieter in operation), but go for a mains set because the majority of battery sets give such poor reproduction. It is, however, true to say that battery sets generally do not render such a good performance as they are so much more sensitive than a mains set, in that they are more easily rendered inefficient in their operation by high resistance connections to their operating supplies, and also corrosion set up by fumes, etc., from accumulators and spent batteries within the set itself. I would like also to say that many people are not able to use a mains set for lack of mains supply. I do, however, think that most people prefer a "mains set" because of the following reasons:

1. Cheaper by far to operate.
2. No worry with the changing of accumulators, etc.
3. No 13s. 9d. or so for H.T. batteries every three or four months.
4. More efficient in operation.—J. H. ROBINSON (Fife).

TRANSMITTING TOPICS

(*Continued from page 478*)

Appendix C. Additional calculation formulae:

Resonant Frequency: $f = \frac{10^6}{2\pi\sqrt{LC}}$ Kc/s.

L is in micro-henrys; C is in pico-farads and π is 3.142.

"Q" Factor of Circuit: $Q = \frac{2\pi fL}{R} = \frac{\omega L}{R}$

f is in cycles/sec., L is in Henrys and R is in ohms.

COIL INDUCTANCE:

1st Adaptation of Wheeler's Formula:

$$L = \frac{N^2 \cdot r^2}{10l + 9r}$$

L is in micro-henrys, r is outside radius of the coil in inches, l is the winding length in inches and N is the number of coil turns.

2nd Adaptation of Wheeler's Formula:

$$N = LX\left(1 + \sqrt{1 + \frac{9}{aLX^2}}\right)$$

N is the number of turns, L is the inductance in micro-henrys, a is the outside radius of the coil in inches, X equals $\frac{20}{nd^2}$ where n is the number of turns per inch and d is the coil diameter in inches.

40 gauge enamelled wire has 188.7 t.p.i.
32 gauge enamelled wire has 85.47 t.p.i.

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"Practical Wireless," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. 'Phone: Temple Bar 4363.
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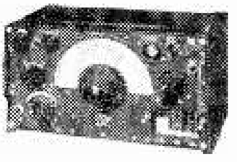
EX-A.M. RECEIVER TYPE R1155



Brand new and unused 5 Frequency ranges: 18.5-7.5 Mc's; 7.5-3.0 Mc's; 1,500-600 Kc's; 500-200 Kc's; 200-75 Kc's. Supplied in maker's original wood transit case. LASKY'S PRICE, £11 19 6. Complete. R.1155 Receivers. Secondhand aerial tested, £7 19 6. Carriage and packing 12/6 per unit extra, including 10/-, which will be refunded on return of packing case.

ASSEMBLED POWER PACK OUTPUT STAGE FOR R.1155 RECEIVER

For use on 200-250 v. A.C. mains. Complete with 2 valves. In metal case size: 12 x 7 x 5½ins. LASKY'S PRICE, 79/6. Carr. 5/- extra.

Power Pack as above. Fitted with 6½in. p.m. speaker. LASKY'S PRICE, £5/5/-. Carriage 5/- extra.

PLASTIC ESCUTCHEON MASKS

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12in.	12/6
16in.	25/-

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Output 7-9 kV. E.H.T. with heater winding for EY51. 19/6.

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SPECIAL OFFER, 4 Valves: 1 each 1R5, 1T4, 1S5 and 3S4.
LASKY'S PRICE 30/-
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1S4 ...	7/6	1A5 ...	9/-	6J7 ...	6/6	EF39 ...	7/6
3S4 ...	9/-	12K8 ...	8/6	OZ4 ...	6/-	12K7 ...	10/6
1T4 ...	7/6	12Q7 ...	8/6	KT2 ...	3/6	6L6 ...	10/6
1R5 ...	7/6	CAL5 ...	9/-	6K8 ...	8/6	EA50 ...	2/6
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1C5 ...	7/6	1D5 ...	8/6	ECH35	13/6	35L6 ...	10/-

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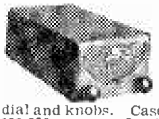

Small size case, 12 x 4 x 6in. Will fit most cars. For either 6 or 12 volts depending on vibrator. Chassis supplied with 5 octal valve holders, medium wave aerial and oscillator coils, output transformer, volume control, sundry resistances and condensers, dial and knobs. Case finished in brown crackle. Dial calibrated 150-550 metres. 5 valves to suit. One each, either GT or metal: 6SA7, 6R7, 6V6, 6K7, OZ4. **LASKY'S PRICE £5/5/-.** Carriage 5/- extra. Or less valves, 69/6. Carriage 5/- extra. Other chassis in various conditions of completion are available for personal callers only. **CIRCUIT** for 5 valve car radio, using above chassis. **PRICE 1/6.**

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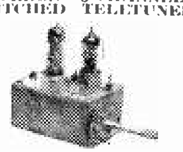

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4 mfd. 500 v., 2/9; 4 mfd. 750 v., 3/9; 4 mfd. 1,500 v., 4/9; 4 mfd. 2,000 v., 7/9; 6-6 mfd. 400 v., 5/11; 11-7 mfd. 500 v., 7/9; 4 mfd. 400 v., plus 2 mfd. 250 v., 1/11; 8 mfd. 500 v., 4/9; 15 mfd. 500 v., 5/9.

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	Each		Each		Each
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1R5	7/9	6SJ7Met	7/9	35Z4GT	10/6
1S5	7/9	6Q7G	9/11	35L6GT	9/11
3V4	7/11	6SN7GT	11/9	AC5PenDD	9/9
5Y3G	8/9	6V6G	8/9	UL41	10/9
5U4G	10/6	6V6GT	7/9	EF36	5/9
5Z4G	9/6	6X5GT	8/9	EB91	8/9
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6AM6	6/9	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	12Q7GT	10/6	SP61	2/9
6K8G	9/9	15D2	4/9	VU120	2/11

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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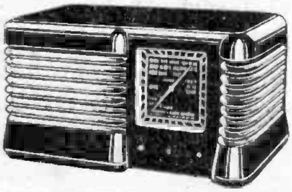

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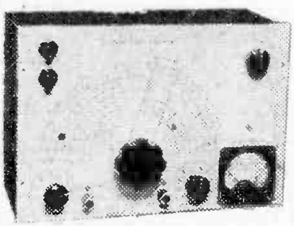


High impedance plastic recording tape by famous manufacturer. 1,200 feet complete on spool, 17/6. P. & P. 1/6. 600 feet 8/-. P. & P. 1/-.

Pr. 200/250 v., secondary 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volt at 2 amps. 13/-.

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

Heater Transformer. Pri. 200-250 v. 6 v. 1½ amp., 6/-; 2 v. 2½ amp., 5/-.

R.I. MAINS TRANSFORMERS, chassis mounting, feet and voltage panel. Primaries 200/250.

350-0-350 75 mA. 6.3 v. 3 a. tap 4 v. 6.3 v. 1 a., 13/6.

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

500-0-500 120 mA. 4 v. C.T. 4 a. 4 v. C.T. 4 a. 4 v. C.T. 2.5 a., 27/6.

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
8 mfd., 350 v. wkg., tag ends	1/6
50 mfd., 25 v. wkg., wire ends	1/9
100 mfd., 350 wkg.	4/-
100+200 mfd., 350 wkg.	9/6
16+16 mfd., 350 wkg.	3/3
Ex Govt. 8 mfd. 500 v. wkg., size 3½ x 1½. 2 for	2/6
60+100 mfd., 280 v. wkg.	7/-
16+32 mfd., 350 wkg.	6/-
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
50 mfd., 12 wkg.	11d.
32+32 mfd., min., 275 wkg.	4/-
50 mfd., 50 wkg. 8 mfd., wkg., wire ends	1/9
Miniature wire ends moulded 100 pf., 500 pf., and .001 ea	7d.

CONSTRUCTOR'S PARCEL, comprising chassis 12½ x 8 x 2in., cad. plated 18 gauge, v/h., IF and trans. cut-outs, backplate, 2 supporting brackets, 3 waveband scale, new wavelength station names. Size of scale 11½ x 4½in., drive spindle, drum, 2 pulleys, pointer, 2 bulb holders, 5 paxolin international octal valve holders, 4 knobs, and pair of 465 IFs, 16/6. P. & P. 1/9.

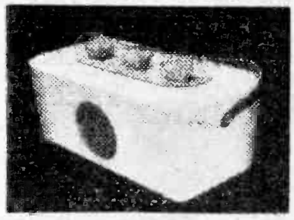
AS ABOVE, but complete with 16+16 mfd. 350 wkg. and semi-shrouded drop thro' 250-0-250 60 m.a., 6 v. 3 amp. Pri. 200-250, and twin-gang, 31/6. P. & P. 3/-.

Trimmers, 5-40 pf., 5d.; 10-100, 10-250, 10-450 pf., 10d.

Germanium crystal diode, 1/6, post paid.

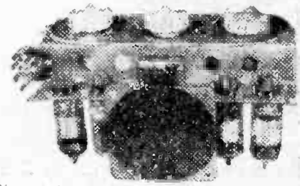
PATTERN GENERATOR 40-70 Mc/s. direct calibration, checks frame and line time base, frequency and linearity, vision channel alignment, sound channel and sound rejection circuits, and vision channel band width. Silver plated coils, black crackle finished case, 10 x 6¾ x 4½in. and white front panel. A.C. mains 200/250 volts. This instrument will align any TV. receiver. Cash prize, **£3.19.6** or **£1.9.0** deposit and 3 monthly payments of £1. Post and packing 4/- extra.

TV. CONVERTER for the new commercial stations, complete with 2 valves. Frequency :—can be set to any channel within the 186-196 Mc/s. band. I.F. :—will work into any existing TV. receiver, designed to work between 42-68 Mc/s. Sensitivity 10 Mu v. with any normal TV. set. Input :—arranged for 300 ohm feeder. 80 ohm feeder can be used with slight reduction in R.F. gain. Circuit EF80 as local oscillator, ECC81 as R.F. amplifier and mixer. The gain of the first stage, grounded grid R.F. amplifier, 10 db. Requires power supply of 200 v. D.C. at 25 mA., 6.3 v. A.C. at 0.6 amp. Input filter ensuring complete freedom from unwanted signals. 2 simple adjustments only, **£2.10.0** Post and packing 2/6.



PERSONAL PORTABLE CABINET in cream-coloured plastic, size 7 x 4½ x 3in. Complete 4-valve chassis. Scale and 3 knobs. Takes miniature 90 v. and 7½ v. batteries. 10/-. P. & P. 2/-.

3in. P.M. SPEAKER to fit above, 10/-. Miniature output transformer, 5/-. Miniature wave-change switch, 2/-. Miniature 1-pole 4-way used as Volume and Off, 2/-. 4 B7G valveholders, 2/4. Midget twin gang ⅞in. dia., ⅞in. long and pair medium and long-wave T.R.F. coils ⅞in. long x ⅞in. wide; complete with 4-valve all-dry mains and battery circuit, 9/6. Condenser Kit, comprising 11 miniature condensers, 8/6. Resistor Kit, comprising 15 miniature resistors, 4/6. 25 x 25 mfd., 1/6. P. & P. 2/6. Valves to suit above 10/- ea. Point to Point Wiring Diagram 1/-.



View of chassis as it would look when assembled with valves inserted.

Extension speaker cabinet, in contrasting walnut veneers, size 15 x 10½in. Will take 6½ or 8in. speaker, 17/6. P. & P. 2/-.

Volume Controls. Long spindle less switch, 50 K., 500 K., 1 meg., 2/6 each. P. & P. 3d. each.

Volume Controls. Long spindle and switch, ¼, ½, 1 and 2 meg., 4/- each; 10 K. and 50 K., 3/6 each. ½ and 1 meg., long spindle, double pole switch, miniature 5/-.

Standard Wave-change Switches, 4-pole 2-way, 1/9; 5-pole 3-way, 1/9. Miniature 2-pole 4-way, 4-pole 3-way, 2/6.

Valveholders. Paxolin octal, 4d. Moulded octal, 7d. EF50, 7d. Moulded B7G, 7d. Loctal amphenol, 7d. Loctal pax., 4d. Mazda Amph., 7d. Mazda pax., 4d. B8A, B9A amphenol, 7d. B7G with screening can, 1/6. Duodecal paxolin, 9d.

Twin-gang .0005 Tuning Condensers, 5/-. With trimmers, 6/6.

Midget .00037 dust cover and trimmers, 8/6.

P.M. SPEAKERS

	with trans.	less trans.
3½in.		13/6
5in.	16/6	12/6
6½in.	16/6	12/6
8in.	18/6	15/-
10in.		19/6

Post and packing on each of the above, 1/6 extra.

RADIOGRAM CHASSIS.—5 valve A.C./D.C. 3-way band superhet. 195/255 volts 19-49, 200-550 and 1,000-2,000 metres, flywheel tuning frequency. 470 K/cs iron-cored coils and IFs. Size of chassis, 13 x 6½ x 2½. Complete with valves and 8in. P.W. speaker, p. & p., 5/-, **£8 17/6.**

Terms of business : Cash with order. Dispatch of goods within three days from receipt of order. Where post and packing charge is not stated, please add 1/6 up to 10/-, 2/- up to £1, and 2/6 up to £2. All enquiries S.A.E. Lists 5d. each.

D. COHEN, RADIO AND TELEVISION COMPONENTS
23, HIGH STREET, ACTON, W.3. (Opposite Granada Cinema)

Hours of Business : Saturdays 9-5 p.m. Wednesdays 9-1 p.m. Other days 9-4.30 p.m.