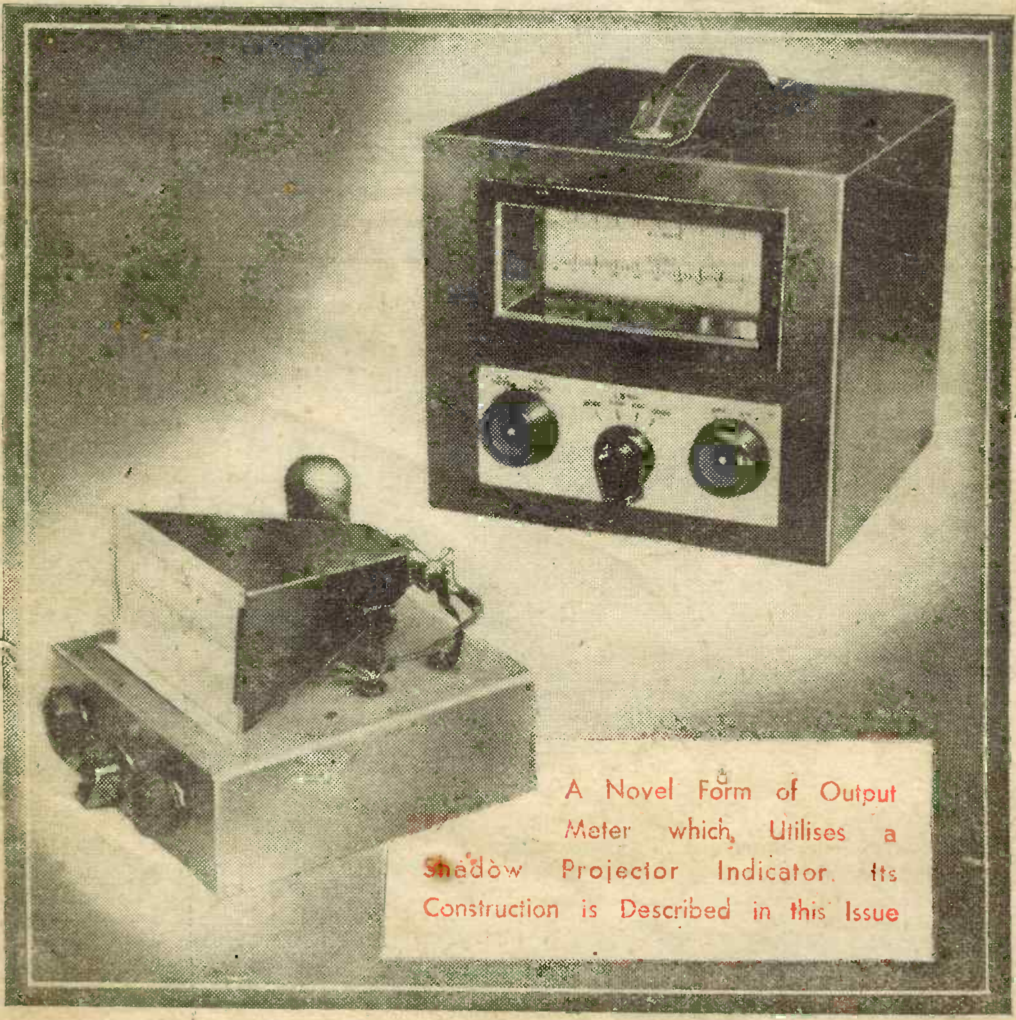
L.F. AMPLIFIER DESIGN

Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

Vol. 19. No. 449 NEW SERIES. NOVEMBER, 1943



A Novel Form of Output Meter which Utilises a Shadow Projector Indicator. Its Construction is Described in this Issue

PREMIER RADIO

NEW PREMIER S.W. COILS

4- and 6-pin types now have octal pin spacing and will fit **International Octal** valve-holders.

4-pin Type			6-pin Type		
Type	Range	Price	Type	Range	Price
04	9.15 m.	2/6	06	9.15 m.	2/6
04A	12.26 m.	2/6	06A	12.26 m.	2/6
04B	22.47 m.	2/6	06B	22.47 m.	2/6
04C	41.94 m.	2/6	06C	41.94 m.	2/6
04D	76.170 m.	2/6	06D	76.170 m.	2/6
04E	150-350 m.	3/-			
04F	255-550 m.	3/-			
04G	490-1,000 m.	4/-			
04H	1,000-2,000 m.	4/-			

Chassis Mounting Octal Holders 10½d. each.

New Premier 3-Band S.W. Coil, 11-25, 25-38, 38-8 m., 4/9.

Rotary Wave Change to suit above, 1/6.

SHORT-WAVE CONDENSERS

Trolitul insulation. Certified superior to ceramic. All brass construction. Easily ganged.

15 m.mfd.	2/11	100 m.mfd.	3/11
25 m.mfd.	3/3	160 m.mfd.	4/8
40 m.mfd.	3/3	250 m.mfd.	5/8

Brass Shaft Couplers, ¼in. bore, 7½d. each.

Flexible Couplers, ¼in. bore, 1/2 each.

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Rola 6½in. P.M. Speaker, 3 ohms Voice Coil, 25/-.
Rola 8in. P.M. Speaker, 3 ohms Voice Coil, 25/-.
Above speakers are less output transformer.

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Lead-coated steel, undrilled. 10in. x 8in. x 2½in., price 7/- each. 20in. x 8in. x 2½in., price 10/6 each.

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

BAKELITE DIELECTRIC REACTION CONDENSERS

.0001 mf. 1/3.
.0003 mf., 2/6.
.0005 mf., 2/9 each.
.0003 mf., Differential, 2/11.

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Standard H.F., 1/-.
Binocular H.F., 1/6.

VOLUME CONTROLS

Carbon type, 20,000, 50,000, ¼ meg., 1 meg., and 2 meg., 3/9 each. Carbon type, 5,000, 10,000 and ½ meg., 4/6 each.
Wire wound type, 5,000 and 10,000 ohms, 5/6 each.

METERS

0-100 ma. Moving Iron, A.C. or D.C., Bakelite Case, flush mounting, 2½in. diameter, price 12/6 each.

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Mains Resistances, 660 ohms .3A. tapped 360 + 180+60+60 ohms, 5/6. 1,000 ohms, .2A. tapped at 900, 800, 700, 600, 500 ohms, 5/6. ½ watt all values, 5d. each. 1 watt all values, 7d. each. 4 watt from 50 to 2,500 ohms, 1/- each. 8 watt from 100 to 2,500 ohms, 1/6 each. 15 watt from 100 to 10,000 ohms, 2/- each. 25 watt from 100 to 20,000 ohms, 2/9 each.

SWITCHES

QMB, panel mounting, split knob type 2-point on/off, 2/- each. DP on/off, 3/6.

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

Resin-cored Solder, 7½d. per coil.

Push-Back Connecting Wire, 2½d. per yard.

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

Screened Braided Cable. Single, 1/3 per yard. Twin, 1/6 per yard.

7-pin Ceramic Chassis Mtg. English Type Valve-holders, 1/6 each.

Amphenol Octal Chassis Mounting Valve-holders, International type, 1/3 each. English type, 1/3 each.

Send for details of our Microphones, Valves and other radio accessories available. All enquiries must be accompanied by a 2½d. stamp.

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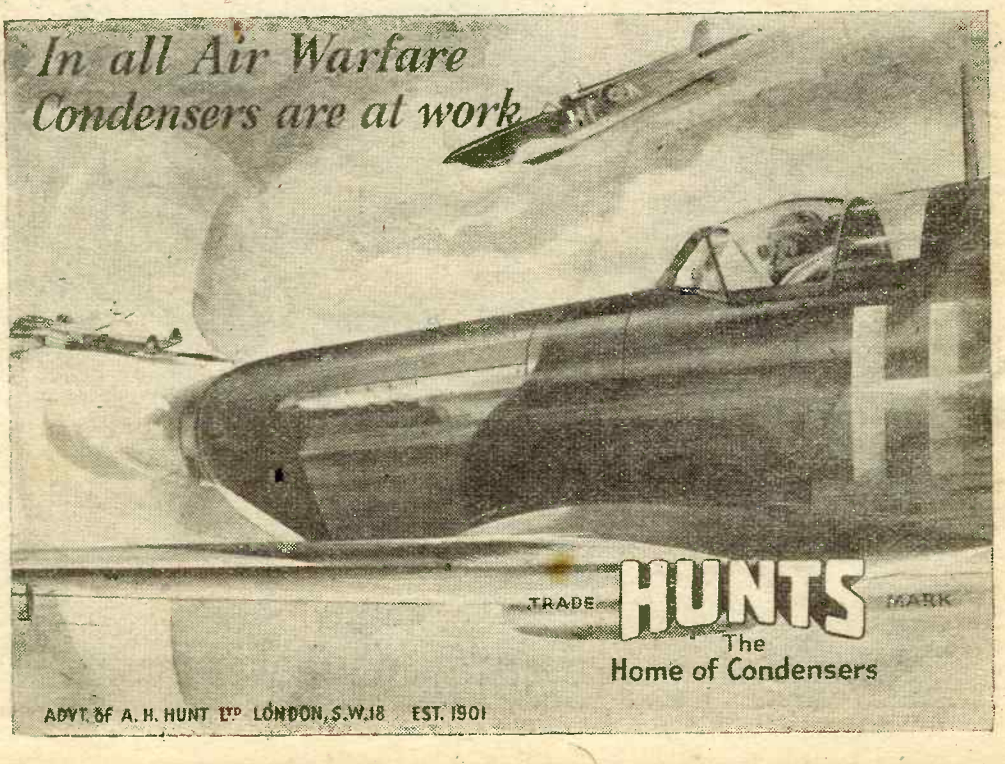


Practical Wireless

11th YEAR OF ISSUE

EVERY MONTH
Vol. XIX. No. 449. NOV., 1943.

and PRACTICAL TELEVISION

Editor F. J. CAMM

COMMENTS OF THE MONTH — BY THE EDITOR

Selling and Servicing

UNLESS a dealer possesses a Board of Trade Licence to sell he may only repair a set. Such licences are only granted after consideration by Local Price Regulation Committees. This has given rise to a large number of anomalies because those already in the radio business in a particular locality oppose the application of any newcomer who wishes to buy and sell wireless parts.

Our attention has been drawn to this matter by a large number of our readers. Here is a typical case. One of our readers discovered that a valve had blown. He went to his local dealer for another, but as the dealer had not a licence he was not able to supply it. He informed the reader, however, that if he would bring his set along the replacement would come under the heading of "repair," and this would be in order.

As the reader was unable to find anyone else in the locality who could supply a valve, for those with selling licences were out of stock, he was put to the expense and the trouble of hiring a taxi to transport the set to the dealer and back again. This particular dealer had applied for a licence but his application was turned down because of the opposition of a large firm of retailers who had been in the district for some time and had virtually cornered the local trade. In these days of labour shortage and petrol economy it is an absurd state of affairs that a dealer may not sell a particular piece of apparatus except as a "repair," when other dealers who are entitled to sell are out of stock. The licensing system has, indeed, virtually granted a monopoly to a few, and monopolies, as we know, seldom work for the benefit of the public.

We went to some trouble to investigate this case and we found that the dealer with the licence was off-hand and impertinent to customers. The serviceman without the licence, on the other hand, is a capable fellow, an amateur transmitter, has splendid equipment, is reasonable in his charges, and having been an amateur in his early days has an interest in amateurs and is not merely interested in making a good living out of the business.

His competitor who is entitled to sell goods which he does not stock has no knowledge of radio; he is not interested in servicing problems, and such customers who ask him to undertake this work are sent round to other local dealers. It seems to us that the system of issuing licences is unfair, in that it does not take into account consumer demand. When we drew the attention of the Board of Trade to this particular case we found them most helpful, and at the moment of going to press they are reviewing the matter. There is a shortage of radio components, and a shortage of service engineers. The public suffers as a result of both these very acute shortages.

Radio is an important part of our national life and it is essential that every wireless set should be kept in working condition. Apart from that there is the question of economy in time and material. A small defect promptly attended to will prevent major damage. If it is not attended to expensive components may be ruined, thereby providing an increased commodity demand for parts which are in short supply. It is our view that the whole system needs to be remodelled in the light of experience. If a service engineer is supplied with valves he should be entitled to sell them, whether for servicing or as an over-the-counter sale.

As labour is scarce members of the public should be encouraged, when they have the necessary ability, to do their own repairs. The attitude of the trade in placing every obstacle in the way of skilled amateurs and endeavouring to force them into the shops of those who are incompetent and impolite, is out of tempo with the period in which we are living.

There is another aspect of this matter to which the attention of the authorities is drawn. It is the outrageous charges now being made for performing comparatively simple repairs. Charges seem to start at 25s. Some dealers charge an examination fee, even though they carry out the repair! There should be some standard charge for work plus cost of replacements. It is difficult, of course, to accuse dealers of dishonesty, for to many members of the public a wireless set is a box of mystery. This type of customer is the pigeon which the dishonest dealer plucks. A loose connection to such a dealer means burnt-out transformers, a new set of valves, and several fixed condensers, plus labour charges and an examination fee. The trade has made efforts to purge the retail trade of this type of shark.

If readers know of such cases, and will forward the name and address to us we will see that such names are sent to the proper authorities.

Refresher Course in Mathematics

OUR readers will remember the series of articles under the above title which we published in this journal. The series progressed from arithmetic to the calculus, and included fractions, decimals, duodecimals, logarithms, trigonometry, algebra, mensuration, longimetry, planimetry, stereometry, trigonometrical tables, the metric system, arithmetical, geometrical, and harmonical progressions, ratio, proportion and percentages, interest, discount, present value and annuities, and of course, the calculus.

This series, with much additional matter, has now been republished in book form at 8s. 6d., or 9s. by post. Copies are available from booksellers, or from the publisher, Book Dept., George Newnes Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Editorial and Advertisement Offices: "Practical Wireless," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. 'Phone: Temple Bar 4363. Telegrams: Newnes, Rand, London. Registered at the G.P.O. for transmission by Canadian Magazine Post.

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

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

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

ROUND THE WORLD OF WIRELESS

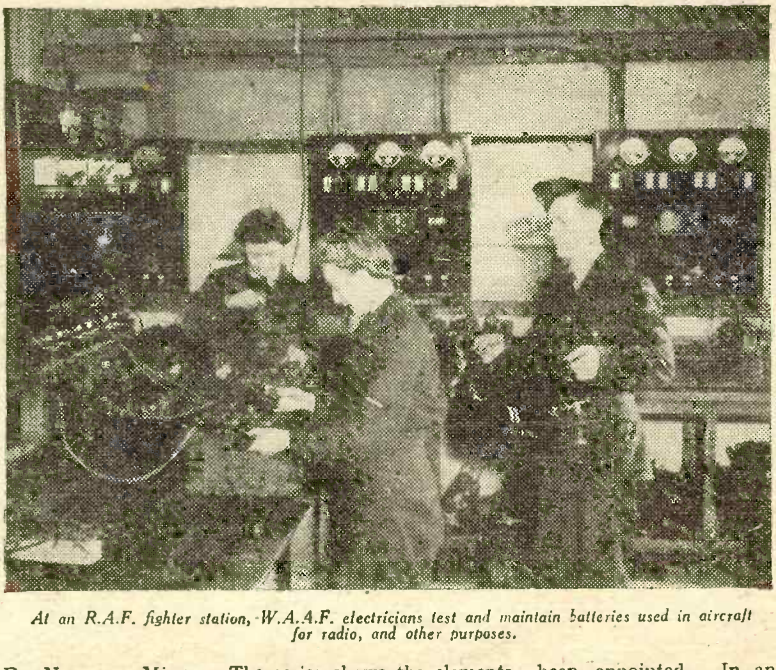
Radio Trades Examination

WE understand that the syllabus for its servicing certificate examination has been drawn up by the technical committee of the Radio Trades Examination Board, and after it has been considered by the Board the approved syllabus and examination regulations will be issued. For latest details see "Thermion," page 505.

Western Music for Indian Listeners

IN response to the growing demand from Indian listeners for guidance and explanation in the field of Western musical appreciation, the B.B.C. is presenting, in its Eastern Service, three new series of illustrated talks on European music. Arthur Bliss, B.B.C. Director of Music, introduced the series.

Each of the three series has a separate weekly half-hour programme. Music occupies 22 of the 30 minutes and commentary the rest. "Music of the East and West" is presented on Mondays by Princess Indira of Kapurthala and Scott Goddard (music critic of a London national newspaper), with script written by Dr. Narayana Menon. The series shows the elements common to both Indian and Western music, demonstrates Indian instruments and their Western counterparts. In the second series "Sa Re Ga of Western Music," Mr. Z. A. Bokhari, B.B.C. Indian Programme Organiser, presents (on Wednesdays) a simplified aspect of the development of European music. That is music more likely to appeal to Indian listeners knowing little or nothing of Western music, but versed in Indian music. The scripts are written by Dr. Mukerjee. The third series, "Music in the Making" (Fridays), is more advanced than the other two. Hubert J. Foss, one of Britain's best broadcasters on music, illustrates the differences and similarities, in terms of rhythm, melody and harmony, between music of the East and of the West.



At an R.A.F. fighter station, W.A.A.F. electricians test and maintain batteries used in aircraft for radio, and other purposes.

Travellers' Tales

"TRAVELLERS' TALES" is a new B.B.C. weekly series presenting pictures of people and places overseas through the eyes of travellers past and present. It is broadcast each Monday in the Home Service, recorded and rebroadcast in the Overseas Service, and also transmitted by radio stations throughout the British Commonwealth.

"Travellers' Tales" is designed to appeal to a world-wide audience, and emphasis will be laid on the human interest of travel amongst people of all races; listeners will hear of their life, work, play, customs and music. There will also be the excitement and interest of the travellers' own adventures, from travellers of our own time to those explorers who did their greatest work in the days of difficult and dangerous travel.

Leslie Baily, who in his "Scrapbook" programmes evolved an attractive and successful formula for combining every kind of material, dramatised episodes, talks, interviews, music and song from all parts of the world, will be using much the same technique in "Travellers' Tales," his programme taking us all over the Empire. "Travellers' Tales" are produced by Eric Fawcett.

Moscow's Guns Heard on Radio

FOLLOWING the repeated broadcasts of Stalin's Order of the Day recently listeners in this country heard the firing of the guns broadcast by Moscow radio. The pealing of the bells and the singing of a choir were also heard.

New B.B.C. Appointments

MR. ROBERT FOOT, who, since January, 1942, has been joint director-general of the B.B.C., has been appointed director-general and chief executive officer of the Corporation.

The new appointment of editor-in-chief is also announced, and to fill it Mr. W. J. Haley, joint managing director of the Manchester Guardian and Evening News, Ltd., has been appointed. In announcing these appointments recently the B.B.C. stated that the director-general and the editor-in-chief will be jointly concerned with the character and quality of the whole of the B.B.C.'s output. They will be assisted by a central executive.

B.B.C. Salvage

IT is reported that 57 tons of waste paper were salvaged by the main branches of the B.B.C. during the first six months of this year. This figure is exclusive of amounts collected by local authorities from various provincial centres of the Corporation. By reducing the size and thickness of paper used, and typing on both sides of the sheet, the B.B.C. has also saved 22 tons of paper in 20 months.

The World We Want

CAN poverty be cured? Can wars be prevented? Can we achieve security, Freedom from Fear and Freedom from Want and yet keep our civil liberties? The B.B.C. has planned a new series of talks, "The World We Want" which it is hoped may provide material for discussion among the many groups and organisations that are studying such problems.

The talks began on October 4th and will continue for the next three months. These are really individual problems. The housewife wants to know how long rationing is to continue; men and women in the services are anxious about post-war employment; industry enquires what controls will be relaxed and which will remain. Speakers will not provide final answers to these questions, but will try to place the problems against their national and international background. The series will open with discussions about the immediate future—the stabilising of peace, the assurance of regular employment, and wages sufficient to maintain a good standard of living. Later on, the ways in which these aims can be achieved will be debated.

In the new year it is hoped to broadcast a further series dealing with topics of reconstruction in the post-war world; among them European Relief (United Nations Relief and Rehabilitation Administration); Feeding Europe (the Hot Springs Conference and after); and the future of Civil Aviation.

Science at Your Service

ANOTHER series, planned to help those who still meet regularly round the loudspeaker for subsequent argument, is "Science at Your Service." The importance of scientific development in the national life will be the theme of 12 broadcasts, on Fridays.

The purpose is to remind listeners that science is not of interest only to workers in laboratories and research stations, but impinges on everyone in the daily round. Subjects to be dealt with include our weather, to show, for instance, how recent advances in meteorological research will affect the future of air communication, the future of sea transport, progress in agriculture, and the location of oil and minerals by modern scientific methods. Two talks will deal with the science of metals, rubber, and plastics, and will explain how the study of their structure by means of radio-active and X-ray technique helps in predicting their behaviour under differing circumstances.

Building Research

RECENT building research will be covered in a third group of talks, which will describe new materials ready to play their part in the homes of the future, and tell how heating, lighting, and cleaning problems can be scientifically met. Developments in engineering will be another subject, and the series will conclude with a talk on the main theme, "Science in National Life."

Canada's Radio Listeners

A RECENT survey of radio in the Dominion of Canada shows that approximately 1,900,000 homes out of 2,700,000 own receivers.

New U.S. Short-wave Transmitters

ACCORDING to a recent report from the United States it is estimated that there will be 36 short-wave broadcasting stations operating by the middle of next year, radiating programmes for overseas. The power of some of the new transmitters is likely to be about 250 kW.

F.M. Transmitting Licences

IT is interesting to note the confidence which Americans are showing concerning the future of F.M. broadcasting. In addition to the 50 stations already operating, there have been applications for licences for the erection of 40 more stations.

Composed in a Trench

A MARCHING song, "Fighting for our Homeland," heard recently in the B.B.C. Overseas Service, was written on the battlefield during a lull on the El Alamein front in September, 1942. Sergeant A. C. Dawson, of the New Zealand Expeditionary Force, was sitting in a slit trench on Ruweisat Ridge when the idea came to him. He ruled out the music staves on the only paper available—the blank side of a discarded Italian routine orders sheet, and wrote down the song. At the first opportunity he sent it to the B.B.C. It was accepted, scored for military band, and sung by Pilot Officer Tod Hilton, Australian baritone.

Sergeant Dawson conducted a piano-accordion band before he joined up three years ago, and is an accomplished player of piano and piano-accordion. He often broadcast from the New Plymouth station in New Zealand, but this is his first attempt at serious song-writing.

New Police Radio Link

TECHNICAL experts of Scotland Yard have perfected a new system of linking up 200 police stations and all Metropolitan Police cars with headquarters by means of two-way wireless telephones. With this system it will be impossible for messages to be overheard by unauthorised persons. A number of key stations have already been equipped, but it is unlikely that the new system will be put into full operation until after the war.

Soldiers demonstrating the emergency transmitter, named the Gibson Girl, which has been developed for use in the rubber rafts of U.S. war 'planes. A turn of a crank enables the machine to send out an SOS signal, thus often saving days of futile searching for aircraft that have been forced down.

Line Cord Testing

A Simple Method of Testing the Resistance Wire in Line Cords

By F. J. FORBES

THE shortage of line cords and the necessity for conserving stocks prompted the author to design apparatus to test the resistance wire in these cords.

Often the break in the resistance wire is a few inches from either end, or, alternatively, at a junction for pilot lamps' shunt or rectifier anode limiting resistor; these are in addition to those breaks caused by hot spots and kinking.

It is quite permissible to join the resistance wire at any point, provided that it is done efficiently and neatly. Of course, the other conductors must be inspected to see if the rubber is perished. The problem of finding the break is indeed tedious and lengthy by most methods used, and at the same time may damage the cord. Several methods were tried with equipment that is easily available, and as the writer required a small A.F. amplifier it was decided to make use of this—previous experiments on these lines having proved fruitful.

General Principle

The property of the line cord's capacity to another conductor is made use of. This conductor, which is taken to the grid of the first valve of an amplifier, consists of a metal tube through which the line cord is passed. To one end of the resistance wire an A.F. signal is injected and the cord is then fed through the metal tube until maximum signal is obtained. This condition indicates the break.

Practical Application

The pick-up head is a metal tube 1in. long with the centre hole just fitting the cord to be tested; failure to obtain a working fit results in the signal "sailing," this being due to the line cord varying in distance to the walls of the tube, and thus the capacity, this effect being more pronounced in the twisted core types. (Fig. 2.)

Several heads will be required as cord sizes vary, and these can be made up as different types come to hand; they should be of the plug-in type, to facilitate changing as well as threading and removal of the cord.

The amplifier has quite a high gain but is orthodox in circuit as the diagram, Fig. 1, shows. Care must be taken to well shield the input section to the 6C6, in order to prevent stray pick-up of signal and hum; with this in mind, a gate was made to enclose the head. Slots on either side of the gate admit the cord under test, and a hinge is fitted at the back to enable it to be opened.

With the chassis earthed and no connection to the head, the gain control can be advanced to maximum, and there should be no audible hum, only valve hiss.

Testing Cords

To test a cord, first set the gain control at minimum, pass one end of the cord into the head. To the other end of the cord an A.F. signal is injected into the resistance element, the other cables being earthed with the signal generator to the amplifier chassis. Earthing the spare cables prevents them carrying the signal into the head. The gain control is advanced until the signal is just audible, and the cord is then slowly pulled through the head until an increase in signal strength is found, this point indicating the break. The cord should be pulled to and from the above point to "tune" the signal; there will not, of course, be sloping sides to the maximum as with a radio signal and a receiver. Instead, the signal is just audible and rises very rapidly over about 1in. of cord to maximum; the start of the signal increase is just before the break.

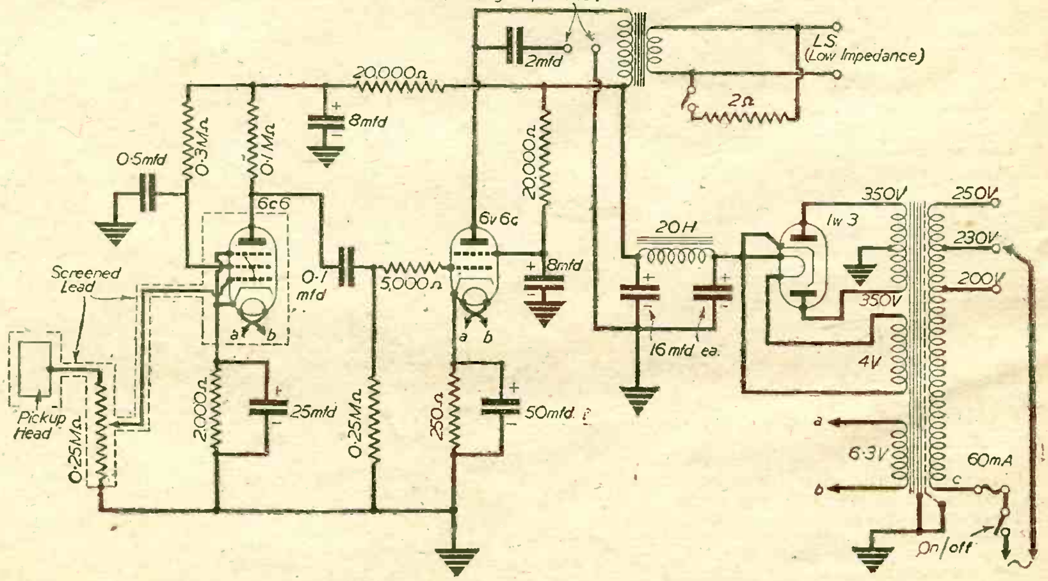


Fig. 1.—The circuit of the amplifier which is used in conjunction with the special pick-up head.

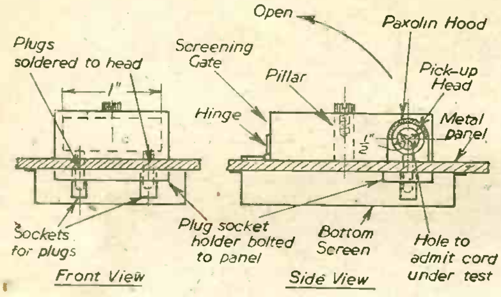


Fig. 2.—The special pick-up head and screening gate.

At first breaks can be located to within 1in., and with some practice to less, the actual time taken to locate the fault being less than that required to set up the test. The success of the test depends on the strength of the input signal; the output from the signal generator should be decreased so that direct pick-up is impossible, and the amplifier gain should be set so that the signal is only just audible. When the break point has been located the signal should be reduced still further, and this will enable the break to be found with considerable accuracy.

The use of the lower frequencies should be avoided, as the maximum cannot be so easily distinguished; the best frequencies were found to be between 1 and 4 kc/s. Any tone controls should be set for maximum top response.

Cords with two or more breaks may occur, but in general they should be treated as a single fault at first; that is, a signal should be searched for that closely approximates a direct input.

Although it has not been encountered, a corroded joint or break may give a poor balance between maximum and minimum on signal, but with a load test or ohmmeter check would be completely open circuit.

Other Uses

It has also been found useful to have a screened lead terminating in a test prod which has a small plug socket at the end. The following adaptors were made for various tests: a probe point. for picking up signals direct from receivers. etc.; a half-round head, for testing long cables such as extension speaker leads—this can be placed over cables that are stapled against the wall; and, finally, a small "knife" for sorting and pick-up of cables in a bunch. (Fig. 3.)

The above tests should be carried out in the same way as for line cords: that is, find the open circuit line and feed it with a signal, and earth all others.

Many other uses have been found for a permanent amplifier such as the testing of speakers, 'phones, pick-ups and volume controls. Also, scrap line cord in which the rubber has perished can be used for very useful spaghetti type resistors; if a break is present it can be found by the above method and measuring the resistance of the length on either side of the break will give all the data to find the length for any value of resistance, it is then fairly easy to strip the braid off the length required.

While the above apparatus has been built mainly for bench work, there is no reason why a portable battery outfit could not be used, and for those who lack an A.F. generator a simple multi-vibrator would be easy to construct and use.

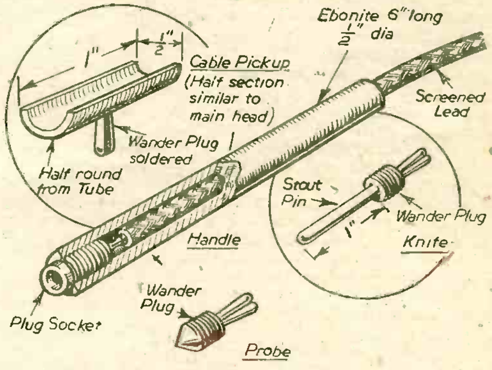


Fig. 3.—The screened lead and adaptors which are useful for other tests.

Metres and Megacycles

MANY attempts have been made at different times to induce the constructor and experimenter to adopt the frequency designation instead of describing a transmission in terms of wavelengths in metres, but these have met with little success so far as the broadcasting bands are concerned. This is perhaps unfortunate in many respects, since the frequency notation has much to recommend it, and wavelengths have invariably to be converted to frequencies in order to make calculations of inductance, etc. The position on the short waves, however, is different, for almost every short-wave enthusiast speaks in terms of megacycles, and all amateur transmitters announce the frequency of their transmissions in preference to giving the wavelength.

Because of this the beginner on short waves often finds difficulty in calibrating his receiver by making use of the many available transmissions. Actually, the conversion from megacycles (millions of cycles, or thousands of kilocycles) to wavelengths is perfectly simple, since 1 megacycle is equivalent to 300 metres, 2 megacycles to 150 metres, 3 megacycles to 100 metres, 4 megacycles to 75 metres, 10 megacycles to 30 metres, 15 megacycles to 20 metres, 60 megacycles to 5 metres, and so on. The short-wave experimenter will find it very helpful to cultivate the habit of thinking in terms of megacycles instead of in metres, for this will save a good deal of trouble in applying the simple conversion calculation.

It might at first seem that matters would be complicated by using the megacycle notation, since it is not easy to convert, say, 14.6 megacycles to metres—this works out at approximately 20.548 metres, and is found by dividing 14.6 into 300—but the point to remember is that the transmission was no doubt arranged for 14.6 kilocycles, and not for its metre equivalent. The custom of using the megacycle notation for short-wave transmissions is growing rapidly, and will, undoubtedly, become universal by the time that the ultra-short-wave television transmissions come into operation again. It will therefore be worth while to get accustomed to it now.

Mains Transformer Design

By P. G. HEATH

(Concluded from page 469, October issue)

THE electrostatic screen can take the form of metal foil, provided the overlapping ends are insulated and do not make contact, or a separate winding of wire can be used for this purpose, one end being taken to earth. A good insulating medium must be used between the primary and secondary due to the screen being at earth potential. Following the secondary winding, is wound either the winding for the rectifier heater; or that for the valve heaters, whichever is convenient, insulation having to be placed between windings, that is, between the layers of the winding. This can consist of layers of paper, two or three, space permitting. If the design is for very high voltage, layers of empire cloth are recommended for insulating material between windings. End pieces of insulating fibre, usually square in shape, are used to protect the sides of the windings and to anchor the output or terminal leads in place. Thin sheets of mica or mica composite may be also used as insulating mediums, though high-grade bond paper is dependable.

Insulating Varnishes

Some textbooks suggest shellac or common varnish for impregnating windings, but these, due to moisture content, are not recommended. A proper air-drying insulating varnish may be used on all windings, former faces and cheeks, and if given time to dry thoroughly, will be found satisfactory. Some manufacturers employ a baking varnish for oven drying, but unless the equipment is specially designed for this purpose, the fumes given off are noxious, inflammable, and in a confined space possibly explosive. Lacquers of the collodion, amyll or banana oil types should never be used, as in the event of a burn-out or short-circuit, flames would be evident and possibly cause a serious fire. Accumulator topping compound could with small transformers, in an emergency, be used as an impregnating medium, as also might be used a mixture of beeswax and rosin. Paraffin wax is useless for this purpose, the melting point being too low.

When fine gauges of enamelled wire are used for windings, keep the paper between coils as thin as possible, for if a winding is uneven insulation varnish can seep through, add to the thickness and thus raise the heating temperature beyond a safety point and possibly damage electrolytic condensers, etc.

Mains Frequencies versus Primary Turns

The lower the frequency of the electric mains, the higher the number of turns required for a primary winding, a statement best stressed perhaps from the following examples, which should be viewed as approximations only: Assume a 2in. cross-sectional area assembly for operation on 230V mains at various frequencies. For 50 c/s, turns = 840. For 30 c/s, turns = 1,025. For 60 c/s, turns = 768. For 20 c/s, turns = 1,105. For 100 c/s, turns = 435. For 40 c/s, turns = 935. Halving a cross-sectional area permits of a doubling of the number of turns, so that with a 1 sq. in. one and a 50-cycle mains frequency, an approximation of 8 TPV is suitable, but if this area is halved the turn numbers must be doubled, and vice versa; but if the mains frequency is doubled, the turn numbers are halved and vice versa. It should be additionally understood that there are tables available for different makes of stampings. Further variations in wire table characteristics have been noted, but as manufacturers of laminations usually issue tables of their own, these can be adhered to. A simple equation for computing for a mains frequency other than 50 c/s is: Core area = $(50 \times A)/f$, where A is the core area of the table one is working from, and f is the mains frequency of operation.

American-type Mains Transformers

When rewinding American made transformers some understanding of the mathematics applicable to their design should be considered. Literature on the subject usually refers to *rating*, really referring to *total core loss* and shown in figures of from 0.75 watt to 2.75 watts *per pound of core material*. As 1 watt per lb. is an approximate average, the rating is determined by weighing the core alone, and as losses average from 6 to 10 per cent. of the total rating computation is not difficult. A 10lb. core, for example, would have a nominal rating of around 150 watts, and would possibly handle 180 watts without overheating, or conversely, be used for a 100-watt output. Without scales the weight could, of course, be calculated from the cubic content or volume, the sheet steel laminations approximating ¼lb. per cubic inch. To find the number of primary turns let:

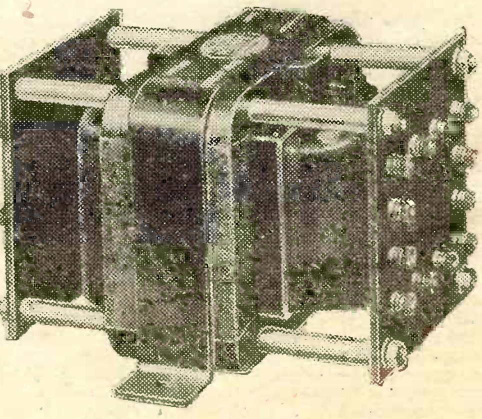
$$E = \frac{4.44 \text{ N B A T}}{10^8},$$ where E = volts. N = c/s.

B = number of magnetic lines per square inch of the magnetic circuit. A = number of square inches of the magnetic circuit, T = turn numbers. The value of B, with 50-cycle mains is 50,000, with a 50 per cent. increase for 25-cycle mains operation. Around 9 TPV, for 50-cycle mains, is the average type met with in this country, or 12 TPV for 25-cycle work.

There must be also considered the differences of diameter between American and British wires. For example, British S.W.G. No. 24 closely approximates American B. & S. No. 25. S.W.G. No. 32 approximates B. & S. No. 32. S.W.G. No. 18 approximates B. & S. No. 17. In general, regard the S.W.G. as a slightly thinner gauge than the B. & S., this being more in evidence as sizes decrease, B. & S. No. 40 = S.W.G. No. 44. If these points are observed, rewinding is simplified and efficient functioning assured.

Primary Tappings

Finally, a word about tappings on primaries used to permit a transformer to function from various values of mains voltage, 200 to 250 volts usually. If these must be included, the TPV ratio is adhered to and the tappings taken out at the various voltage points in the winding. If possible, avoid using tappings, for the more in use, the more are the chances of weakening the insulation; but if used, let the tap come at the end of a layer, a turn or two one way or the other is not likely to affect things. Note, too, if stripping down a primary, how the connecting leads are anchored to the winding, using the same care with the replacement. (*Courtesy of The Institute of Practical Radio Engineers.*



A fine example of design; a Ferranti mains transformer.

Low Frequency Amplifier Design—2

Choke-capacity and Transformer Coupling Systems are Analysed in the Second Article of this Series

(Continued from page 451, October issue.)

THE essential factors underlying the design of an amplifier with choke-capacity coupling are identical with those governing the design of a resistance-capacity-coupled amplifier, as described last month. Only one component is changed—that which constitutes the anode load—an iron-cored choke being used instead of an anode resistor. The choke has a certain inductive reactance; this is measured in ohms, so there is a direct comparison with resistance.

There is one major difference, however, for, whereas the ohmic value of a fixed resistor remains constant, that of a choke varies according to the audio frequency current passed through it. This is evident when it is remembered that the reactance, in ohms, of a choke is equal to $2\pi fL$, where π is the usual 3.14, f is the frequency in cycles per second, and L is the inductance of the choke in henries. The value obtained in this manner is not the exact impedance of the choke, because account is not taken of the inevitable self-capacity between the turns. This capacity, in parallel with the inductance, reduces the impedance to a certain degree. With a well-made component the effect of this shunted capacity is not great, and comes into noticeable effect only on very high audio frequencies.

Anode Choke Inductance

Just as we were able to find the most suitable value of resistance for the anode load, so we can determine mathematically the optimum inductance value for the choke. It is evident, however, that we must adopt some sort of standard frequency in order to obtain a practical answer. The obvious course would be to take a figure for f which is in the middle of the audio range, or at least in the middle of the most-used portion of the audio range; between, say, 50 and 1,000 cycles. In practice, there is another and easier method of approach. That is to base all calculations on a frequency of 50 cycles per second, and to allow the reactance of the choke to be equal to the internal resistance of the valve in whose anode circuit it is wired.

It is not difficult to calculate that the result of this is to produce full amplification at around 1,000 cycles and produce a 3 dB loss at 50 cycles. Bearing in mind that a change in output level of 2 dB is about the least that can be detected by the human ear, it will be seen that the result should be satisfactory.

Simple Mathematics

A calculation of inductance required in the anode circuit of an L.F. valve having an internal resistance of 10,000 ohms will make the calculation readily understandable. It has been stated that we should have a reactance in ohms at 50 cycles, which is equal to the internal resistance of the valve. Expressed in mathematical form this is: $2\pi fL = R_a$

This can be rewritten to read: $L = R_a/2\pi f$

Substituting the known figures we have:

$$L = 10{,}000/6.28 \times 50$$
$$= 200/6.28$$
$$= 31.8 \text{ henries.}$$

It would appear that the impedance at the higher audio frequencies would be extremely high. In practice it is not normally exceptional, since the self-capacity already mentioned has an increasing effect as the frequency rises. It is therefore reasonable to assume an average impedance equal to between four and six times the internal resistance of the valve when the choke inductance has been estimated as explained above. From this it will be evident that calculations of other component values will be exactly the same as for resistance-capacity coupling previously dealt with.

Pros and Cons of Choke Coupling

What are the advantages and disadvantages of choke coupling? There is only one real advantage, which is that the D.C. resistance of the choke is low, and therefore the drop in H.T. voltage across it is generally negligible. A good choke having a working inductance of 50 henries would not be expected to have a D.C. resistance in excess of about 300 ohms. Note now that reference has been made to "working inductance." This is perhaps not a standard term, but it is explanatory. The inductance of a choke passing little or no current may be 100 henries, but, depending on the design, this figure will be reduced to a greater or lesser extent as the current through it is increased.

In choosing a choke of a certain inductance it is consequently necessary to ensure that the inductance value required is that which applies when the D.C.

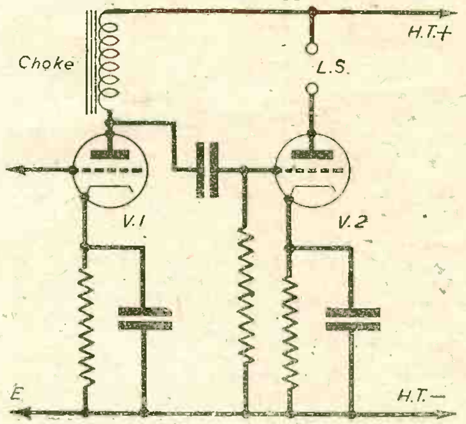


Fig. 1.—The essentials of a choke-capacity coupled amplifier. It will be seen that the circuit is almost identical with an R.C.C. amplifier.

anode current of the valve is passing through it. A choke with a rated inductance of 50 henries at 3 mA would be useless if such an inductance were required and if the valve passed an anode current of 10 mA.

The disadvantages of choke coupling are fairly obvious from what has already been written. Impedance, and hence stage gain, varies with frequency, if self-capacity is not considered. This may be self-corrected if the self-capacity is of suitable value. And if it is found that high-note response is excessive, a fixed condenser having a value between .0005 and .002 mfd. can be wired in parallel with the choke. Another disadvantage is the comparatively high cost of a good-quality choke. Summing up, it may be stated that choke-capacity coupling is generally worth while only when it is necessary to avoid a drop in anode voltage; that is, when the H.T. supply voltage is limited and the valve is being loaded to such an extent that the highest possible anode voltage is required.

Transformer Coupling

In the case of transformer coupling we have the undoubted advantage that a voltage step-up is possible, additional to the voltage amplification provided by the valve itself. Thus, a transformer having a turns ratio of one-to-two (twice as many turns on the secondary as the primary) will give a voltage step-up of nearly two-to-one; resistance, iron and inductance leakage losses account for the use of the word "nearly." With modern high-mu valves the advantage just quoted is not necessarily very important, since there may be a danger of providing *too much* amplification or stage gain, with the result that the amplifier becomes unstable. After all, there is very little point in using a one-to-one transformer when the same result could be obtained by using resistance or choke coupling!

But when it is possible to make good use of voltage step-up, the use of a transformer is fully justified; that is, if one is prepared to pay the price demanded for a high-grade component.

Smoothing Out the Response

The output curve for a transformer-coupled stage is normally far from straight. Not only is there a tendency for the amplification to show a marked falling off at frequencies below about 70 cycles and a rise from about 1,000 to 2 000 cycles, but there are also several other "peaks" due to resonances. A simple method of "smoothing out" these resonance peaks is to shunt the secondary with a fixed resistance (see Fig. 2). It is fairly obvious that the resistance will produce an overall reduction in amplification, but this need not be serious if too low a resistance value is not chosen. And if the reduction in gain is a little too severe, a transformer of higher step-up ratio can be used. An important point which must be borne in mind when using a shunt resistance in this manner is that the resistance across the secondary is "reflected" as a shunt across the primary.

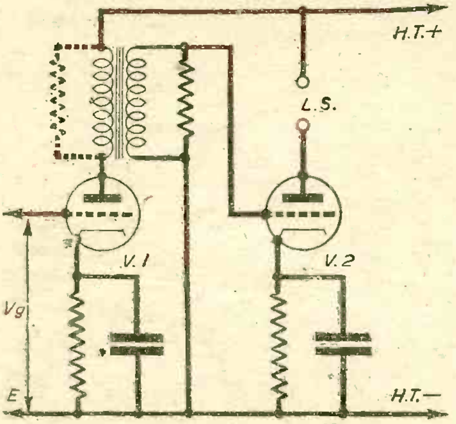


Fig. 2.—A transformer coupled amplifier. The secondary is shunted by a fixed resistor. This has the effect of producing an "image" resistance in shunt with the primary, as indicated by broken lines.

The "reflected" or "image" resistance can be found from the following simple formula: $R_p = \left(\frac{P}{S}\right)^2 \times R_s$ where R_p is the "reflected" resistance, P is the number of primary turns, S is the number of secondary turns, and R_s is the resistance across the secondary. It will be seen that in practice the expression within the brackets would be written as the step-up ratio, and no account would be taken of the actual number of turns.

"Reflected" Resistance

As an example, suppose that use is made of a 1 : 5 transformer and that a 200,000-ohm resistor is connected across the secondary. The effect of this on the primary would be the same as if a resistor of 8,000 ohms were connected in parallel with the primary. This result is obtained by squaring the primary/secondary ratio and multiplying by 200,000. In other words, we multiply 200,000 by one-twenty-fifth. In most cases the result of using a resistance of such a value with a high-ratio transformer would be marked, and deleterious. As a general guide it can be stated that the image resistance should not be allowed to exceed about three times the internal resistance of the preceding valve.

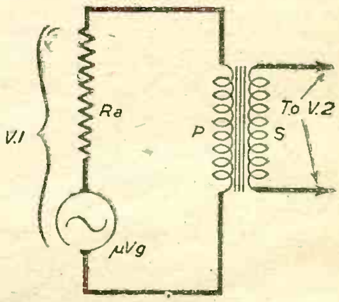
The principles governing the choice of a transformer for use in a circuit such as that shown in Fig. 2 are similar to those considered previously in relation to the iron-cored choke. Primary inductance is determined exactly as is the required inductance of a choke, again taking into consideration the D.C. current passing through the primary to the anode of the valve. The effect of self-capacity is also the same as for choke coupling. Additionally, however, the capacity "reflected" by the secondary must not be forgotten; this is not only the self-capacity of the windings, but also the "Miller Effect" capacity, which was dealt with in the previous article.

Effect of Internal Resistance

It may help to obtain a grasp of the reasons underlying the choice of primary impedance if the diagram given in Fig. 3 is studied. Here the valve is represented as an alternator, its internal resistance is shown as an ordinary fixed resistor, and it will be seen that the transformer primary is in parallel with the alternator and resistor in series. Assuming the grid input voltage to the valve to be V_g ("shorthand" for grid volts) the output from the valve will be μV_g volts, μ being the amplification factor of the valve. This output voltage is divided between the internal resistance and the impedance of the primary.

Obviously, then, if the internal resistance is high in relation to the impedance of the transformer primary, the voltage across the latter will be small. On the other hand, if the primary impedance is higher than the internal resistance, a good proportion of the output voltage will be developed across it, and therefore the efficiency of the amplifier will be increased. Provided that the primary impedance does not fall below the ohmic value of the internal resistance, not less than half the valve output voltage will be usefully employed. That explains why we arrange that the primary reactance at 50 cycles per second is equal to the internal resistance of the valve. If an appreciably higher inductance were used we should obtain greater output at low frequencies, but there might be a definite loss at high frequencies, since self-capacity would be greatly increased. Moreover, if the step-up ratio were fairly big there would be a still greater rise in self-capacity across the secondary. This explains, incidentally, one important reason why it is seldom satisfactory to employ a transformer having a step-up ratio in excess of one to five; with modern valves it should seldom be necessary to have a ratio greater than one to three to obtain full loading of the following valve.

Fig. 3.—This diagram helps to show the effect of primary impedance in relation to valve internal resistance. If L_p equals R_a, the A.F. voltage across the primary will be $\mu V_g/2$.



Other Transformer-coupled Circuits

In later articles of the series we shall see how various forms of "trickery" can be resorted to, in order to obtain better response, or higher response at certain audio-frequencies, when using transformer coupling.

(To be continued.)

Oscillators

A Survey of the Operation of Several Well-known Oscillators

By S. A. KNIGHT

Fundamental Requirements

FOR any oscillator, mechanical or electrical, it is necessary to have a system consisting of two elements each capable of storing energy and releasing the energy from one to the other at a natural frequency which is dependent upon the magnitude of the elements.

In the case of the electrical oscillator the elements are as follow:

(a) An inductance which is capable of storing energy in its magnetic field, and

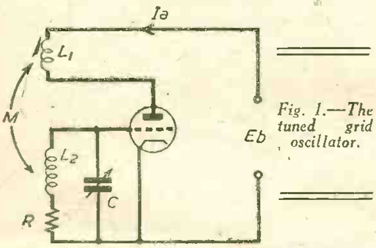


Fig. 1.—The tuned grid oscillator.

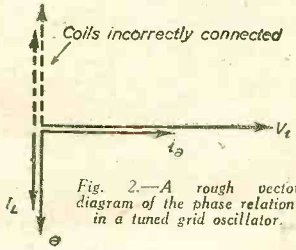


Fig. 2.—A rough vector diagram of the phase relation in a tuned grid oscillator.

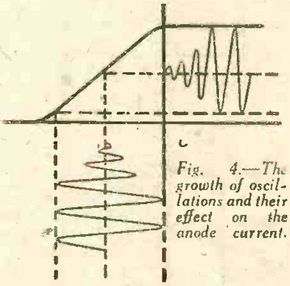


Fig. 4.—The growth of oscillations and their effect on the anode current.

(b) A condenser which can store energy in its electrostatic field.

Energy can be released from one to the other at a frequency which, as we saw in the articles on A.C. theory, is given ideally by the equation $\frac{1}{2}\pi\ LC$. Resistive elements which are, of course, invariably present, slightly modify this natural frequency.

Now a source of energy is also required to provide:

(a) The starting energy, and

(b) Energy to make up losses such as heat losses due to the resistive elements.

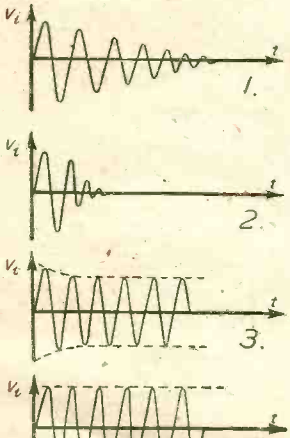


Fig. 3.—The five cases of oscillatory conditions in a tuned grid stage with various forms of feedback.

Some mechanism is required to ensure that energy is released from the source at the correct moments to maintain the oscillations. In radio circuits this mechanism is generally a valve amplifier.

The Tuned Grid Oscillator

We will commence our survey with the operation of the tuned grid oscillator shown in Fig. 1, where L_1 and L_2 are the anode and grid inductances respectively, the grid coil being tuned in the conventional manner by condenser C.

The operation of this arrangement is no doubt fairly familiar to most readers, but the conditions necessary for the maintenance of oscillations may not be so apparent. Roughly the functioning is as follows:

On switching on the H.T. supply, anode current commences to grow, and the increasing flux in L_1 links with the turns of L_2, so that an e.m.f. is induced in the grid tuned circuit. Thus the grid circuit absorbs energy which comes originally from the H.T. battery.

Normal oscillations of the grid LC circuit will cause a voltage v_i to appear between grid and cathode which is varying sinusoidally at the natural frequency of the LC circuit.

This will cause corresponding oscillations in I_a, the anode current; hence energy will be transferred to the grid circuit and, if conditions are properly arranged, in such a manner as to assist the original oscillations.

In Fig. 2 is shown a rough vector diagram of the events occurring in the oscillator. Starting with v_i, then assuming that L_1 is very small, the anode current is approximately in phase with v_i. (In practice there is a slight lag.) The anode current I_a, in passing through L_1 causes an e.m.f. (e) to be induced in the grid circuit; since this tuned circuit is at resonance the current produced by the e.m.f. will be in phase with e.

The voltage across L will lead this current by 90 deg. and so will assist or oppose the original v_i according to the direction of the connection of the coils.

By obtaining this feedback in the correct manner it will be possible to offset the damping caused by the resistance of the grid circuit, i.e., the resistance of this circuit virtually becomes zero. The amount of energy fed back will depend upon the value of coupling M.

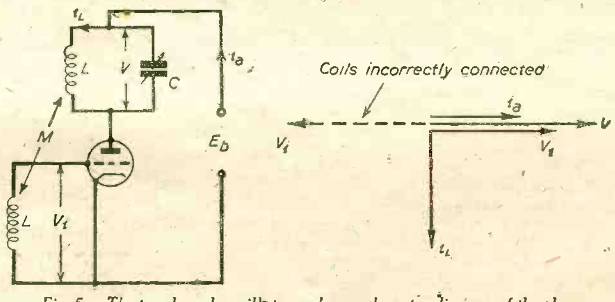


Fig. 5.—The tuned anode oscillator and a rough vector diagram of the phase relations therein.

Maintenance Conditions

Since L_1 is small, the anode load is small, and so :

$i_a = gm. \ v_i$ (approx.).

In other words, the anode volts V_a are very nearly constant.

We have : $e = M.di_a/dt$.

But if $i_a = \hat{i}_a \sin \omega t$.

Then $di_a/dt = \omega i_a \cos \omega t$

$= \omega \hat{i}_a \sin (\omega t + 90 \text{ deg.})$

$= \omega i_a$

$\therefore e = \omega M i_a$

In order that oscillations may be maintained, the power fed back must be greater than or equal to the amount of power dissipated.

$\therefore$ *ei_L must be greater than $i_L^2 R$*

$\therefore$ *e must be greater than $i_L.R$*

$\omega M i_a$ must be greater than $v_i. \ \omega C.R$

$\therefore$ *$\omega M . gm.v_i$ must be greater than $v_i. \ \omega C. \ R$*

$\therefore$ *M must be greater than CR/gm.*

This latter is the result of most importance as we shall now see.

Consider the five cases shown in Fig. 3.

Case 1, with no feedback, the oscillations set up by the act of switching on the H.T. supply, rapidly die away.

Case 2, with negative feedback, caused by incorrect connection of the coils. This time the oscillations are damped exceedingly quickly, the energy fed back opposing instead of assisting in the maintenance of them.

Case 3, this being positive feedback, but a case where M is less than CR/gm.

Case 4, again positive feedback, but this time M is equal to CR/gm. In this instance the feedback is far too critical, for any slight increase in C or R, or a decrease in gm will cause the oscillations to collapse. Case 5 is therefore adopted, where M is greater than CR/gm.

The amplitude of oscillations increases until a condition of stability is reached. Consider Fig. 4 and the growth of oscillations with their effect on the anode current.

Suppose where the oscillations commence to grow, M is set so that it is greater than CR/gm, gm being, of course, the slope of the Ia/Vg characteristic.

Now when the amplitude increases to such an extent that the peaks of the cycles traverse the curved portions of the characteristic, then the average value for the slope, i.e., the effective gm, is decreased.

Hence the ratio CR/gm increases and will so increase until at stability M is just equal to $CR/\text{average } gm$.

If we now suppose that something tends to cause the amplitude to decrease, then the effective gm will increase and M will again be sufficient to maintain oscillations, i.e., the amplitude remains fairly constant and self-regulation is obtained.

The Tuned Anode Oscillator

This oscillator is shown in Fig. 5, together with a vector diagram of the circuit conditions.

Starting with i_a, then if the anode circuit is at resonance the voltage v across it will be in phase with i_a. The current i_L through the inductive branch lags i_a by 90 degrees approximately, and the e.m.f. injected into the grid circuit will lead or lag i_a by 90 degrees according to the direction of connection of the coils.

This e.m.f. appears between grid and cathode (v_i) and if this is in phase with the anode current, energy is being fed back in such a manner that oscillations can be maintained.

In practice i_L lags on i_a by an angle less than 90 degrees and v_i will not be quite in phase with i_a, but it is nevertheless true to say that it *will* be possible to maintain oscillations if *v_i has a component antiphase to V_a*.

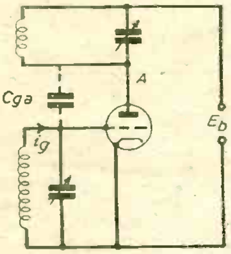
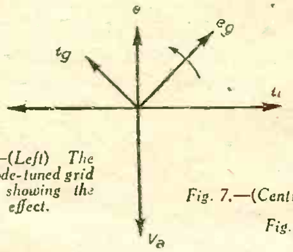


Fig. 6.—(Left) The tuned anode-tuned grid oscillator showing the Cga effect.



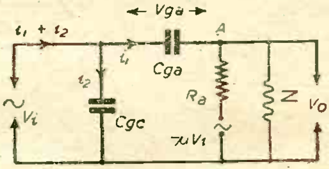


Fig. 7.—(Centre) A simple vector of the TP-TG oscillator phase relations.

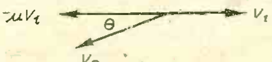
Fig. 8.—(Right) Equivalent circuit of Fig. 6.

The Tuned Anode—Tuned Grid Oscillator

Primarily, the working of this oscillator depends upon the Miller Effect, where feedback from the anode to the grid circuits takes place through the grid-anode inter-electrode capacity Cga and modifies the input impedance of the stage in a manner depending on the nature of the anode load. (Fig. 6.)

We shall deal with it first, however, in a manner which does not involve a great deal of mathematics. In the practical tuned anode oscillator which we discussed above, the coupling between the grid and anode coils is generally made variable for reasons of efficiency. In the TP/TG (tuned plate, tuned grid) oscillator, however, these coils are fixed in position and their mutual inductance is constant, the grid coil being this time tuned by a condenser C. This gives the effect of a variable coil coupling as we shall see, although M is not really altered. It becomes possible to vary the potential fluctuations on the grid resulting from any given current in the anode circuit without moving the grid or anode coils in any way.

If we suppose that the grid circuit of Fig. 6 is tuned



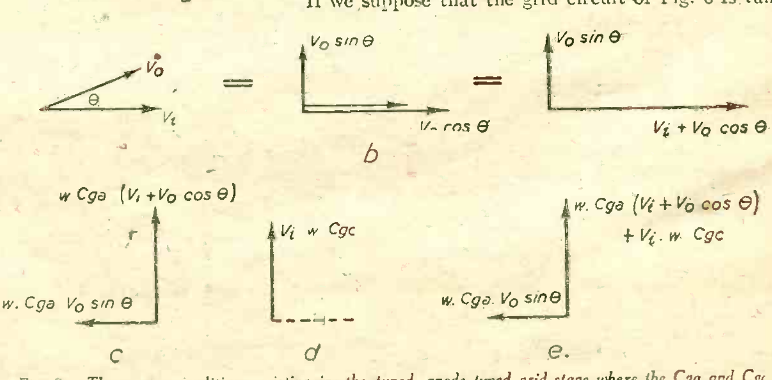


Fig. 9.—The vector conditions existing in the tuned anode-tuned grid stage where the Cga and Cgc are brought into the calculations.

to the same frequency as the plate circuit and that a current i_L is flowing in the latter, then an e.m.f. (e) is induced into the grid coil as we saw in the previous oscillators and a current ig will flow in the grid LC circuit. As we saw in A.C. theory, the p.d. across the grid condenser (eg) is very much larger than the induced e.m.f. (e); it is equal to the product of e and the step-up ratio of the grid coil and condenser circuit. The phase of this p.d. is incorrect, however, for the maintenance of oscillations, but it can be shown that if the grid circuit is tuned to a frequency *higher* than that to which the anode circuit is tuned the p.d. developed across the grid condenser is still much greater than e, and that a component is present which is correctly phased such that oscillations may be produced and maintained.

This condition is best explained vectorially. In Fig. 7 is shown the phase relations in the circuit when the grid circuit is tuned above the frequency of the anode circuit. In a case where their frequencies are identical, the vector i_L is parallel to the vector of the p.d. across the grid condenser eg, consequently there is no component of grid potential which is antiphase to the anode potential; this latter condition is essential, as we have seen, for the maintenance of oscillations.

Now, as the grid circuit is tuned away from that of the anode circuit the vector eg will shorten in length (a decrease in magnitude), but it will begin to rotate in an anti-clockwise direction.

When it reaches a position somewhat as shown in the figure it is possible to resolve it into two components, one of these being antiphase to the anode potential V_a, while the other will be at right angles to the anode p.d. It is the former condition which is of importance, and the magnitude of this vector will, of course, depend on the tuning of the grid circuit. By correctly off-setting the grid-tuning condenser the phase and magnitude of the grid p.d. oscillations can be adjusted such that the circuit functions most efficiently and oscillations are maintained.

In a simple tuned plate oscillator, oscillations die away very rapidly if the feed-back between the coils is negative due to incorrect connections. If the grid is tuned, however, by a condenser and this circuit is offset to a frequency *below* that of the anode circuit, oscillations will be produced and maintained. In this case a vector representation can be constructed as previously, except that in this instance the grid current lags on the induced grid e.m.f.

In this simple survey of the TP/TG oscillator the Miller Effect has been ignored; actually the Cga coupling does have a great effect on the working of this unit.

For those who are not particularly strong on mathematics, it is recommended that they miss the next section out of their reading—here the Miller Effect and the nature of the anode load on the working of the oscillator will be considered.

Mathematical Considerations

The Miller Effect—the feedback from anode to grid circuits takes place through the Cga and modifies the input impedance of the stage in a manner depending on the nature of the anode load. Consider Fig. 6, reduced to its equivalent circuit of Fig. 8, where Z is the anode impedance. In Fig. 9a is a vector representation of the phase relations in this circuit, and the arrangement is best considered in this way:

Let θ be the angle by which v_0 leads v_i. If in practice v_0 lags on $-uv_i$ then the angle θ would be negative as the vector diagram depicts. By applying Kirchoff's second law round the outside of the complete circuit we have:

$v_i = Vga + V_0 =$ vector sum.

$\therefore Vga = V_i - V_0 =$ vector difference.

This can be drawn vectorially by constructing a vector v_i and then drawing a vector v_0 in the opposite direction, i.e., $-v_0$ and adding this to v_i (Fig. 9b).

The current through the grid-anode interelectrode capacity Cga is now given by:

$i_1 = Vga.\ \omega.\ Cga$, leading Vga by 90 deg. (Fig. 9c), while the current through the grid-cathode-capacity, Cgc is given by:

$i_2 = V_i\ \omega\ Cga$, leading V_i by 90 deg. (Fig. 9d).

But the total grid current $= i_1 + i_2$ (Fig. 9e).

Thus the grid current has a component $-v_0.\ \omega\ Cga \sin\theta$ in phase with v_i, and a component $(v_i + v_0 \cos\theta)\ \omega\ Cga + v_i\ \omega\ Cga$ in leading quadrature with v_i.

Hence the applied voltage v_i will look into an impedance which will be partly resistive and partly capacitive. The stage will therefore have an input resistance R_i and an input capacitance c_i.

Input Resistance:

$R_i =$ applied voltage/in-phase component of grid I.

$= v_i / -v_0\ \omega.\ Cga \sin\theta$.

But $v_0/v_0 = V.A.F.\ (m)$.

$\therefore R_i = 1/-m\ \omega.\ Cga \sin\theta$.

Input capacitance:

Quadrature component of $i_g = (v_i + v_0 \cos\theta)\ \omega.\ Cga + v_i.\ \omega.\ Cgc$.

$= \omega.\ v_i((1 + m \cos\theta)\ Cga + Cgc)$

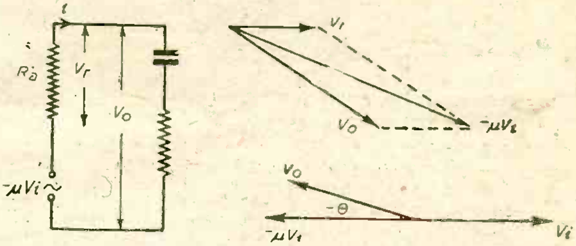


Fig. 10.—Simple equivalent circuit and vectors of the TP-TG when the anode load is capacitive.

Input Reactance = applied voltage/quadrature component of i_g.

$= v_i / \omega.v_i\ ((1 + m \cos\theta)\ Cga + Cga)$

$= 1/\omega.\ C_i$.

$\therefore C_i = (1 + m. \cos\theta)\ Cga + Cgc$.

We have thus obtained general formulæ for both R_i and C_i, and we shall next investigate the forms that these expressions take for the various types of anode load.

CASE 1. Anode Load Resistive

In this case θ is zero and therefore R_i is $1/0$ which equals infinity. $C_i = (1 + m)\ Cga + Cgc$.

CASE 2. Anode Load Capacitive

In this case the equivalent circuit of the stage is depicted in Fig. 10, together with the vector representations. Now we have already defined θ as the angle by which v_0 leads $-u\ v_i$. In this case v_0 lags $-u.v_i$ and hence θ is negative. Thus sine θ is negative though $\cos\theta$ is still positive.

$\therefore R_i = 1/-m\ \omega\ Cga\ (-\sin\theta)$.

= a positive quantity.

Therefore the resistive component of the input impedance is in parallel with the tuned grid circuit. This introduced additional damping so that the energy fed back from the anode to the grid will not tend to maintain oscillations.

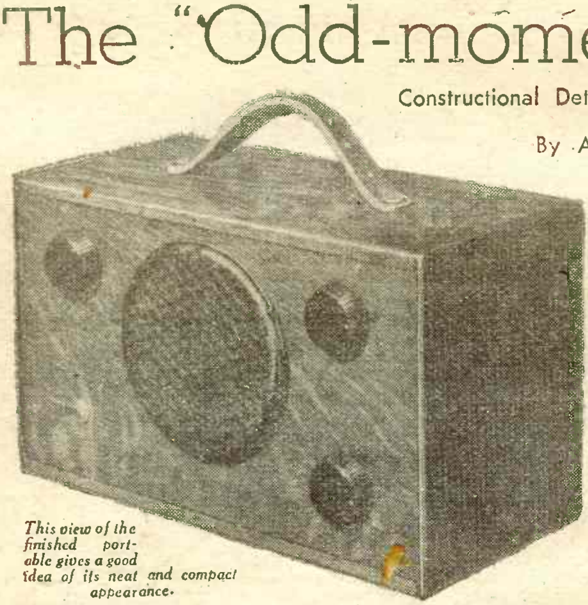
(*To be continued.*)

The "Odd-moment" Portable

Constructional Details of a Useful and Compact Receiver.

By A. W. LINES, A.M.(Brit.)I.R.E.

(Concluded from page 464, October issue)



This view of the finished portable gives a good idea of its neat and compact appearance.

The handle can be made from a piece of stout leather strap. The writer used a speaker front from an old car radio, but failing this the opening could be backed by a piece of cloth with perforated zinc behind, or one or two wooden bars could be glued across the front, and a point to watch is that the various electrodes in V1 (VP2B) are all brought out to separate pins, and connections should carefully be made in accordance with the wiring diagram.

Testing

After completing the wiring, carefully check over for mistakes, and then insert the low tension unit cells in place. The carbon rod is the positive of each cell, and the zinc case negative. The cells can be held in position by a piece of elastic webbing, a rubber band, or even, at a pinch, by a piece of string. Then plug in the valves, connect the high tension units, and switch on. The first test should be to check the reaction circuit. If no trace of reaction can be obtained, and all connections, valves, etc., appear to be in order, change over the connections to L3. Reaction should be very smooth, with no trace of overlap, on all wavelengths above about 215 metres (1,450 kc/s.). Tune by means of the two right-hand knobs, that on the top left-hand corner being for reaction.

As to results, selectivity will be found to be quite adequate, and when necessary can be made really good by the judicious use of reaction and the directional properties of the frame aerial. In Essex, in daylight, the Home Service (449 metres) the European News (375 metres) and the Forces (342 metres) were all received at full strength, the two latter without use of the reaction control. A number of weaker stations could be tuned in, and it was just possible to receive the Home Service programme on 203 metres. After dark a number of Continental stations could be received at good strength.

General Assembly

THE valveholders are bolted to the baseboard by small bolts and nuts, and soldering tags are fitted to those nearest the panel, above and below the baseboard. Those above are used to "earth" the panel brackets, speaker frame, etc., to the wiring below. Wire first filament and earth wiring, being careful not to omit the 40 ohm resistor across the filament pins of the output pentode. Fit last the resistors in the high-tension wiring and the various flex wires for connecting the speaker, high-tension batteries, etc. The two 45 volt high-tension units are connected in series, as follows: Black wire from negative of first unit, through side support of baseboard to one end of R5 and C8 (the wire from the lower end of the auto-transformer is also connected here), and a wire from the other end of R5 to one contact of the three point switch. Then a red wire from positive of first unit through side support of baseboard and joined underneath to a black wire carried on through the other side support and up to the negative of the second unit. Finally, a red wire from the positive of the second unit through the side support and to the centre pin (underneath) of the output valve (V3). The reason for the joint in the wire connecting the two high-tension units is so that each shall have a red wire to its positive socket, and black to its negative socket, to avoid errors in plugging in.

The Cabinet

The cabinet can be made of any available wood—only small pieces are required, and it should be possible to find some scrap pieces for the purpose about most houses. The original set is made up in oak, with an oak-faced panel, and polished. The cabinet is made up without back or front, and the set inserted from the front, small glued blocks just inside the front edges holding the set in place by means of screws through the panel. Other glued blocks are used, top and bottom, each side of the chassis, to prevent the high tension units from pushing right in and fouling the controls back of the panel. The back, carrying the frame aerial, was held in place in the original set by fitting into a groove in the bottom, with a rebate on each side and the top, and two small brass turnbuckles at the top. Many equally suitable arrangements will no doubt occur to the constructor. When inserting the set in the cabinet, the back is first pushed through on edge, from the front.

PRIZE PROBLEMS

Problem No. 449.

THE quality of reproduction from Arnold's set had gradually become worse. Distortion was obviously present, in fact, speech eventually became unintelligible. Arnold made a visual examination of the wiring, etc., but he was unable to check voltages and current consumption as he was without suitable meters. He did find, however, that if he removed the G.B. negative plug, results improved, but even so they were still below normal. The bias plug had not been tampered with, in fact, he had never previously removed it. What do you think was the cause of the trouble?

Three books will be awarded for the first three correct solutions opened. Address your solutions to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 449 in the top left-hand corner, and must be posted to reach these offices not later than the first post on Thursday, October 14th, 1943.

Solution to Problem No. 448.

Robinson had overlooked the fact that the resistance of the speaker produced, when the output valve was taking 16 mA's, a voltage drop of 32 volts, thus leaving only 88 volts on the anode of the valve. Robinson had set his bias voltage on the assumption that 120 volts were on the anode, whereas, he should have adjusted the bias to suit actual operating conditions.

The three following readers successfully solved Problem No. 447, and books have accordingly been forwarded to them.

H. Eastwood, 17, Green Walks, Prestwich, Manchester; K. Marsh, "Westside" 202, Newton Road, Lowton, Nr. Warrington; J. Hogg, 4, Hindley Gardens, Fenham, Newcastle-on-Tyne, 4.

The Manufacture and Testing of Valves—4

Fixing the Base : Metallising the Bulb : Ageing

By LAURENCE ARTHUR

(*Continued from page 459, October issue.*)

THE description given of the process of exhaustion, is of one valve only. In practice 60 or 100 valves are simultaneously travelling round a machine, not unlike a roundabout, with one rotary oil pump for each pair of valves. Fixed gas or electric ovens bake the valves for the necessary time; the eddy current heat coils fall into place at the required positions; the filament or heater current is switched on and off automatically, and the only manual operations are the placing of the stems of the valves into close-fitting rubber tubes, already connected to the pumps, at the start of the run, and the final sealing off at the end of the process.

Bases

The majority of bases used on valves are made from a black phenolic resin compound, but some types have bases of ceramic or ebonite. In all cases it is essential that the bases shall be non-hygroscopic, homogeneous, have adequate mechanical strength, and possess considerable surface resistivity. Among British and American types there are 4, 5, 6, 7, 8 and 9-pin varieties, and, unfortunately, pin diameters and spacings have become extremely varied. Some years ago an attempt at standardisation was made with the international octal, but later developments, particularly with valves designed for ultra high-frequency transmission and reception, brought in further different pin arrangements.

The octal bases had, for the first time, a locating key on a projecting central spigot, which simplified the insertion of a valve into its socket. Despite the various styles, the dimensions of those types of bases and pins in general use are strictly defined by British Standards Association specifications. Pins are usually of nickel plated brass, and in the majority of cases they are of a springy nature, this being made possible by longitudinal slits. A number of American types have so-called "solid" pins, which are actually stiff tubes. Types of bases are shown in Fig. 26.

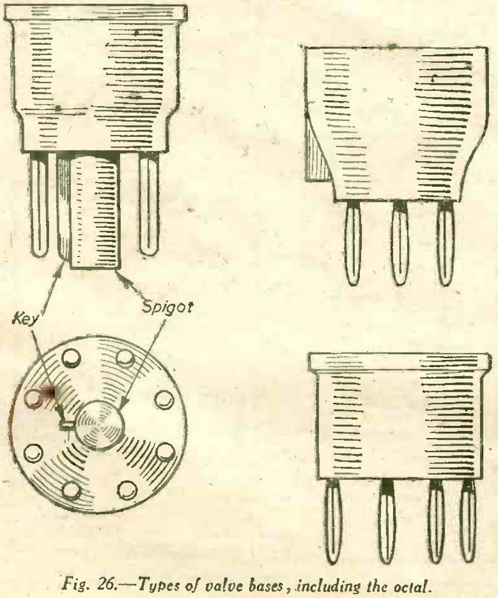


Fig. 26.—Types of valve bases, including the octal.

Bases are secured to the bulb with a cement not liable to loosen on exposure to a warm or moist atmosphere. There are two main varieties—one made principally from shellac, and the other in the form of a bakelite paste. A small amount of cement is applied by hand to the inside rim of the base.

Connections to Pins

The external copper connecting wires from the foot are straightened out with tweezers, and arranged in a definite order before threading them through the hollow pins. This process of threading is not very difficult with a 4-pin valve, but when a larger number of pins are used, great care has to be taken that the wires are inserted in the correct pins. If the wires can be drawn directly to the pins without crossing one another, they are usually left bare. If they do cross, one or more has to be passed through a short length of systoflex or thin glass tubing. After the wires have been threaded, they are pulled tight with tweezers as the base is pushed up into position on the sealed-in end of the bulb. It is now necessary to bake the cement in the base in order to make it set firm. Valves are fitted on to a rotary baking machine, which passes them through an electrically heated oven on a level with the bases. The period of rotation is so arranged that at the end of the journey the cement is completely baked. The shellac variety is still somewhat soft, hardening when cool, but the bakelite kind is baked hard. A similar method is used to secure the external top cap connection, where one is necessary, the wire being threaded through a small hole in the cap.

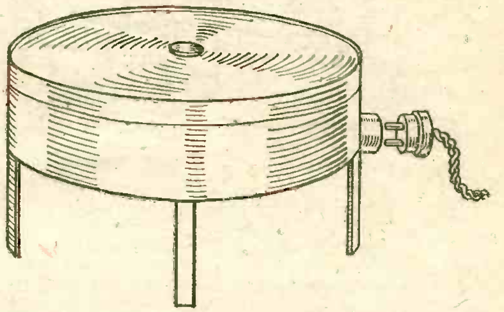


Fig. 27.—Electrically heated soldering pot showing central hole to accommodate spigot.

From the baking machine the valves go to the soldering bench. First of all the copper wires extending through the pins are cut off short. The valve pins are pressed on to a felt pad moistened with a liquid flux, and are then held, momentarily, in a shallow electrically-heated soldering pot, all the pins being soldered simultaneously (Fig. 27). If the base has a spigot, like octal bases, the soldering pot has a central hole to accommodate it.

A large number of valves are metallised, that is, covered with a metal coating which can be earthed, thus providing an effective shield. Protecting covers are slipped over the top cap and base and the glass is brushed with a black gelatinous liquid. When this is dry it is sprayed with molten metal which is obtained by forcing zinc, spelter or bronze powder under pressure through a flame of hydrogen and oxygen. This process is done on a rotary machine, the valves being held in revolving holders so that the metallising is evenly applied. The connection from the metallised coating to the appropriate pin on the base can be made in several ways, but the preparation for it is made at the time the base is fitted. It may consist of a short bare copper wire extending about an inch up the outside of the bulb and secured to the glass by a gummed paper ring; a rather longer piece of copper wire twisted around the bulb at the upper edge of the base; or a wired nickel clip fixed between the bulb and the base. Fig. 28 shows the various types. In all cases the connection is made by spraying the molten metal over the wire or clip. When cool the resistance measured between any point on the metallising and the pin must not exceed 1 ohm.

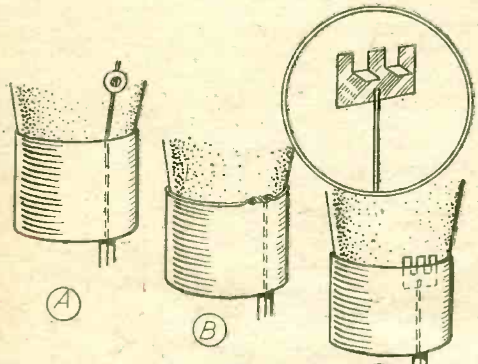


Fig. 28.—Connections from metallised coating to pin. A. Copper wire secured to glass by gummed paper. B. Copper wire twisted round bulb. C. Nickel tag held between base and bulb.

The next process is one of the most important in the whole job of valve manufacture. It is called ageing or thermal activation, and on it largely depends the effective life of the valve and the stability of its characteristics during life.

As previously described, the filament or cathode tube is coated with compounds of barium and strontium. (At the time of coating these are either carbonates or nitrates which are broken down into oxides when the filament or cathode is raised to a high temperature in the exhausted bulb. Hence the description "oxide coating.") These oxides either do not emit electrons or may have only poor initial activity, and the ageing or activation process consists in the reduction of the oxides to metallic barium and strontium. This is done by applying a moderately high voltage between the anode and the previously heated filament or cathode. The emission is very low at first but the activation proceeds as the temperature is increased and, as ageing nears completion, the temperature can be progressively lowered without reducing the emission. This process varies in time according to the type of valve, but generally ranges from 15 to 45 minutes. The increase of temperature is produced by over-running the filament or heater—sometimes at twice the rated voltage—and the voltage applied to the anode (and, in certain cases, also the screen and grid) varies from 100 to 250. The schedule of times and voltages is carefully worked out by trial and error methods until the desired degree of stabilised emission is obtained.

In practice there are various ways of ensuring that schedules are accurately maintained, one method being to fit the valves into the outer edge of a rotating table, the period of rotation being set for the required time and the voltages being applied automatically from suitable contacts. Another method is the "escalator," or endless belt, idea which can deal with hundreds of valves at once, times and voltages being pre-set. The simplest form is a rack holding 50 or 100 valves. The holders are filled, the time of switching on noted, appropriate changes of voltages made at progressive times and the supplies switched off before the rack is emptied at the completion of the period. It is usual to fit lamps as resistances in the high voltage circuits, the voltage being automatically reduced as the emission increases.

At this stage it is usual to "burn off" the valve, and this is done by applying the lead from one side of a Tesla high frequency coil (the other side being earthed), to each pin on the base and the top cap. This discharge burns off any high resistance leak across micas or the top of the foot caused by the deposit of vapours from the getter during volatilisation.

The valve is now completely made and is ready for testing, the first check being that of insulation between the electrodes measured when the valve is cold. Requirements for different types of valves vary, but a representative specification would demand a resistance exceeding 100 megohms (when measured at a voltage not less than the maximum which will be applied to the valve) between any two electrodes, excluding cathode and control grid in all valves, and heater and cathode in indirectly-heated valves. Insulation between cathode and control grid is tested at a lower voltage and the resistance must not be less than 60 megohms.

A percentage of each batch of valves is checked for capacity between the electrodes. The amount may range from 1 per cent. of ordinary broadcast receiving valves to 100 per cent. of those destined to be used for ultra high-frequency transmission or reception, the variation being due to the fact that the capacities between electrodes offer serious leakage paths at extremely high frequencies. In a triode there are three capacities to be measured, (1) the input capacity—that between grid and filament or cathode; (2) the output capacity—that between anode and filament or cathode; (3) the leakage capacity—that between grid and anode.

(To be continued.)

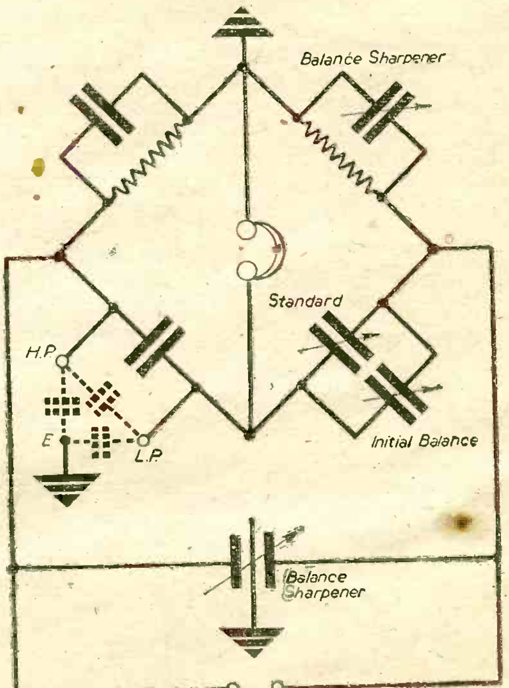


Fig. 29.—Diagram of Sullivan capacity bridge.

Elementary Electricity and Radio—10

Biasing: A Simple Transmitter Circuit Analysed

By J. J. WILLIAMSON, A.Brit.I.R.E.

(Continued from page 480, October issue)

CONTINUING the examination of biasing systems, we can now consider:

(5) Cathode biasing is the same in action as H.T. biasing, except for the fact that the H.T. biasing voltages are produced by a common resistance, whereas the cathode biasing is achieved by the insertion of a resistance in the cathode circuit of the valve concerned. This type of biasing is generally used in mains valves that are indirectly heated. Fig. 51.

(6) The use of a diode as a rectifier to produce a steady biasing voltage is shown in Fig. 52. This type of biasing is used extensively in modern sets for automatic volume control (A.V.C.).

Notice that in all types of biasing, except battery biasing, the resistance across which biasing voltages are produced must be decoupled by means of a suitable condenser.

Analysis of the Straight Receiver

L_1C_1 in conjunction with L_2C_2 provides the tuning arrangements. Fig. 54.

V_1 is an R.F. amplifier employing a screen-grid valve with T.A.-C. coupling. R_5 ensures that the screen potential shall always be lower than the anode potential. R_1 is a potentiometer for adjusting the potential on the screen and hence the "volume." C_3 is the screen decoupling condenser.

C_6, C_7 and C_8 are coupling condensers, their valves depending upon the frequencies to be passed.

C_6 and R_2 produce cumulative grid detection. R_3 and R_4 prevent R_{11} and R_{12} from partially short-circuiting grid and filament of V_3 and V_4. R_{11} and R_{12} are H.T. biasing resistances.

Across R_8 R.F. voltages are developed, which cause R.F. currents to flow via C_{10}, C_9, L_3 and C_4; these R.F. currents passing through L_3 cause a feed-back of energy via the magnetic field produced to L_2, which, together with C_2, is connected via C_{12} and C_6 to grid and filament of the detector—thus reaction is provided, and reaction control made possible by means of the variable condenser, C_4.

L.F. potentials are set up across R_8, and these are fed via C_7 and C_9 to the input of V_3, the L.F. amplifier. R_6, in conjunction with C_9, by-passes R.F. currents past the resistance of the H.T. supply. R_9 and C_1 decouple V_3 in the same way.

T_1 enables a high P.D. to be maintained on the anode of V_4, the output valve, whilst permitting a large passage of A.F. power to the output. T_1 is usually a step-down transformer.

General Examples

(1) State the purpose of each component in Fig. 53.

Answer for Article Eight

(1) 216 kc/s, or 296 kc/s. (2) 111 kc/s, or 113 kc/s.

Simple Transmitter

The frequency of an oscillator will change if the inductance or capacity of its tuned-circuit changes; thus, anything that can alter these factors will cause instability.

If an aerial and earth are connected directly to the oscillator's tuned-circuit then any movements of the aerial would cause frequency changes; therefore, the oscillator must be isolated from the aerial and earth system. This is done by the use of an R.F. power amplifier.

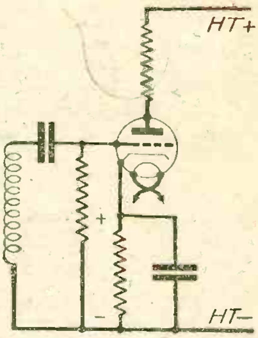


Fig. 51.—Cathode biasing.

Temperature changes, humidity changes, valve capacity fluctuations due to heating, mechanical vibration, the effect of nearby objects (hand-capacity), etc., will also cause alteration of the oscillator's frequency. To remedy instability it is obvious that the components should be very rigid; kept dry and at an even temperature; materials that do not expand or contract greatly with changes of temperature should be used; the valve should be operated at the lowest power

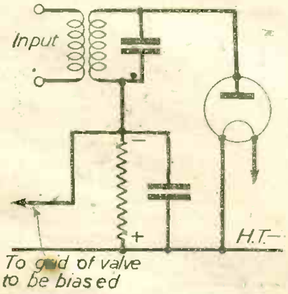


Fig. 52.—Diode biasing.

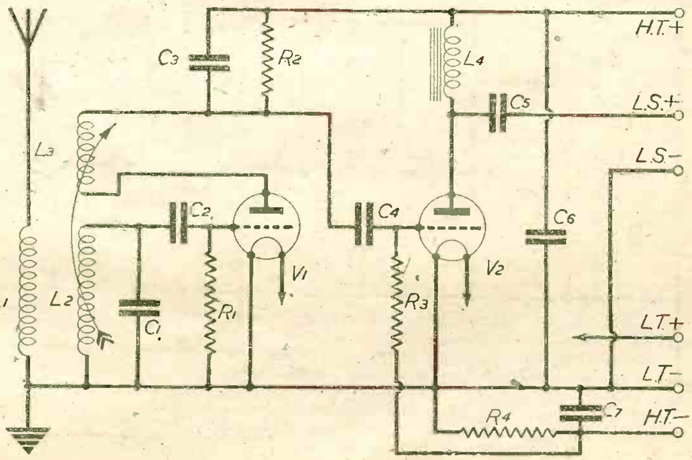


Fig. 53 (right). Circuit diagram of a simple "straight two."

possible, added power being obtained by the use of an R.F. power amplifier, which also isolates changes of aerial capacity from the oscillator's tuned-circuit; also, the oscillator should be completely screened and all leads to it fitted with R.F. chokes to prevent R.F. currents from passing and causing added instability. The oscillator which has been arranged for high-frequency stability is known as a "Master Oscillator" (M.O.).

Tuning of transmitter tuned-circuits is usually carried out by means of variable inductance rather than condensers, because it is far more practicable to construct variable inductances rather than variable condensers when high R.F. voltages and currents have to be allowed for. A simple transmitter is shown in Fig. 55.

Use of a Power Amplifier

The P.A. prevents the aerial from causing instability of the oscillator; also, an increase of radiated power and hence range are obtained. The P.A. of Fig. 55 is to operate under "Class C" conditions, and is grid modulated. Another tuned-circuit becomes necessary in the anode-circuit of the valve, the aerial and earth representing its capacity, i.e., an open oscillatory circuit; this tuned-circuit has "forced" oscillations in it (they depend upon the oscillator's frequency), thus alterations to the resonant frequency of this circuit will cause a change of amplitude, and not frequency, of the radiated power; therefore, elaborate precautions to ensure stability are not necessary in this case.

The Anode Tap

Maximum power is to be obtained from the P.A., when the value of its load impedance is equal to the anode resistance of the valve. If the frequency of the transmitter is changed then the impedance of the P.A.'s anode load will change; thus, in order that maximum power output can be maintained at different frequencies, the anode connection to the inductance of the tuned-circuit is made variable. B in Fig. 55 shows the anode tap.

Tuning Methods

In order to adjust a transmitter, certain operations must be performed. (1) The M.O. must be set up to the required frequency; (2) the P.A. must be adjusted to the frequency of the M.O.; and (3) neutralising must be carried out—if fitted. Tuning must be done with the minimum interference with other stations, and the

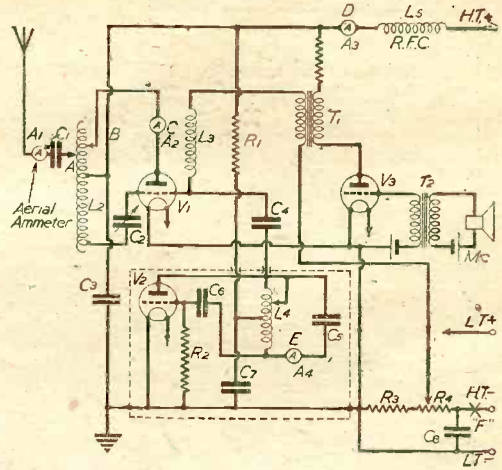


Fig. 55.—Circuit diagram of a simple M.O.-P.A. transmitter.

transmitter's frequency must be accurate, few harmonics being produced. The M.O. could be set up by calibrations, or by the use of a wavemeter. A meter capable of indicating R.F. currents (hot-wire or thermo-couple) is usually inserted in the oscillator's tuned-circuit, as shown in Fig. 55 (E). Notice that the valve's anode current does not pass through the meter.

In aligning the P.A. tuned-circuit, use can be made of the fact that the anode current of the P.A. will fall in value when the tuned-circuit is in resonance with the M.O.'s frequency; thus, a meter placed either at C or D in Fig. 55 would indicate the correct tuning of the P.A. by its "dipping," or registering of minimum input.

An aerial ammeter is often placed in the aerial circuit as shown in Fig. 55 to facilitate tuning of the P.A., and to satisfy the operator that the transmitter is radiating.

In order to prevent the transmitter creating interference during the tuning process, it is usual to tune with reduced power, or to bias the P.A. well beyond cut-off; in the latter case tuning of the P.A. and neutralising can be carried out by reference to the M.O.'s meter. The P.A., if unneutralised, would pass maximum energy to its tuned-circuit from the M.O. when the tuned-circuit was adjusted to the same frequency as the M.O., i.e., minimum reading of the M.O.'s meter would give the correct indication.

Neutralising could now be performed by adjusting the neutralising condenser for maximum reading in the M.O.'s meter, when energy transfer via the lag of the P.A. valve is prevented.

General tuning instructions could be as follows: Set up M.O. by calibrations or wavemeter; adjust P.A. tuning for minimum in the input meter or the

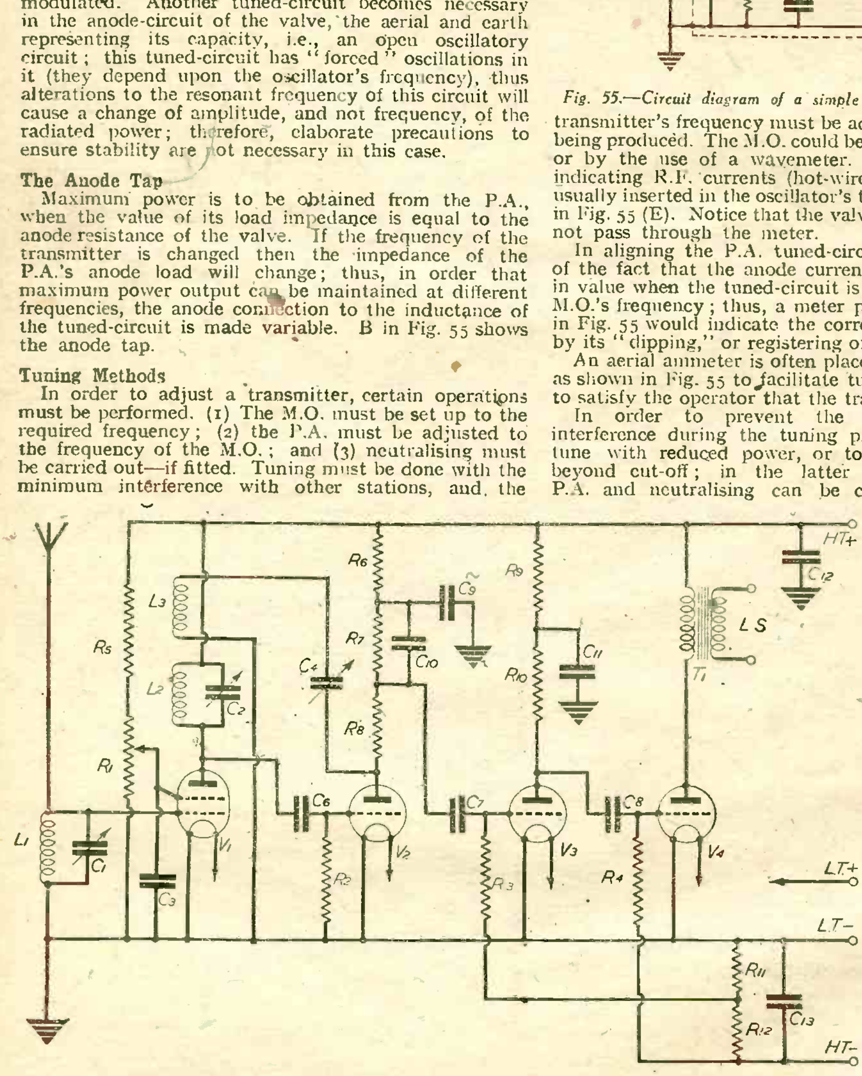


Fig. 54.—Theoretical circuit diagram of a four-valve "straight" receiver.

(Continued on page 503.)

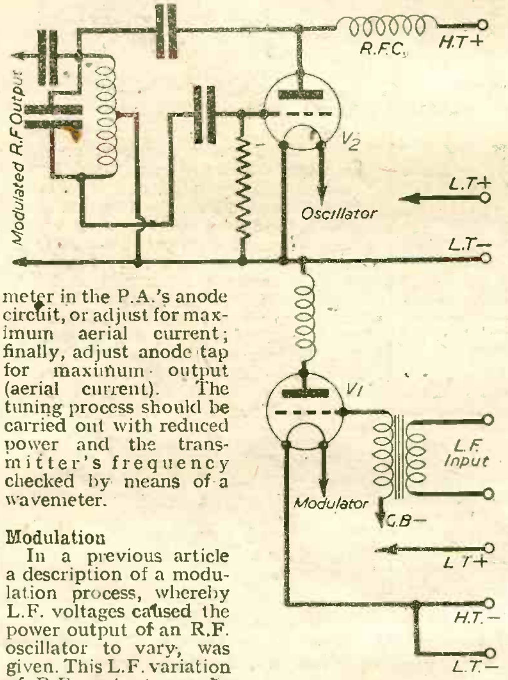


Fig. 56.—Series modulation circuit.

meter in the P.A.'s anode circuit, or adjust for maximum aerial current; finally, adjust anode tap for maximum output (aerial current). The tuning process should be carried out with reduced power and the transmitter's frequency checked by means of a wavemeter.

Modulation

In a previous article a description of a modulation process, whereby L.F. voltages caused the power output of an R.F. oscillator to vary, was given. This L.F. variation of R.F. output can be achieved by causing the anode voltage of the R.F. oscillator to vary at L.F. rates. Two forms of this type of modulation exist; (1) series modulation, and (2) heising or choke modulation. Other methods exist, one of which will be discussed, namely, grid modulation of either P.A. or M.O.

Series Modulation

Voltages at L.F. applied to grid and filament of V_1 (modulator valve) will cause the current through V_1 and V_2 (R.F. oscillator valve) to vary at L.F., thus the anode current of V2 will be varying at L.F. as well as R.F. rates and the magnitude of the R.F. voltages produced in the oscillator's tuned circuit will vary at L.F. rates, Fig. 56.

Choke Modulation

V_2 (the modulator valve), is an L.F. amplifier with an iron-cored choke as its anode load. L.F. voltages produced across L_1 will cause the anode voltage of V_1 (oscillator valve) to fluctuate, thereby causing an L.F. variation of the R.F. output. Fig. 57.

Grid Modulation

This type of modulation can be carried out by applying the L.F. voltages to either P.A. or M.O. Grid modulation of the P.A. occurs in the circuit of Fig. 55. Referring to Fig. 55, L.F. voltages produced across the secondary of T_1 are applied via L_3 to the grid of the P.A. and via R_3 and part of R_4 to the filament of the P.A., also applied to these points is a steady biasing voltage from L_3 and a part of R_4 and R.F. voltages from the oscillator. Modulation of the R.F. voltages is now obtained providing that the valve is correctly biased.

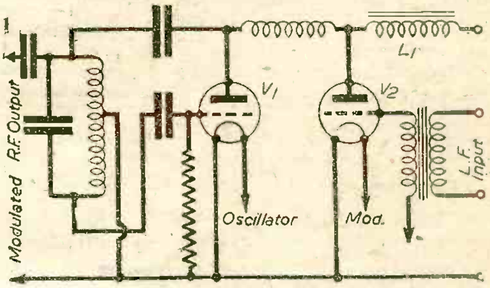


Fig. 57.—Choke modulation.

The necessity for biasing voltages is shown by Fig. 58 (a) and (b). Fig. 58 (a) shows the effect of incorrect biasing (zero), wherein the L.F. voltages merely "swing" the R.F. voltages to and fro—the amplitude of the R.F. is not affected. In Fig. 58 (b) the application of correct biasing (Class "C") cause pulses of R.F. current having their amplitude changing at L.F. rates to pass through the valve, and modulation has been obtained.

Keying Continuous Wave Transmitters

C.W. is used mainly for the transmission of morse signals; thus, some method of "stopping and starting" the transmitter to provide the morse symbols must be used. The keying operation must give clear cut dots and dashes, no "key clicks" being caused—due to transient oscillations. Two major factors govern the type of keying employed, (1) the morse speed at which the key is to operate, and (2) power of the transmitter.

(To be continued)

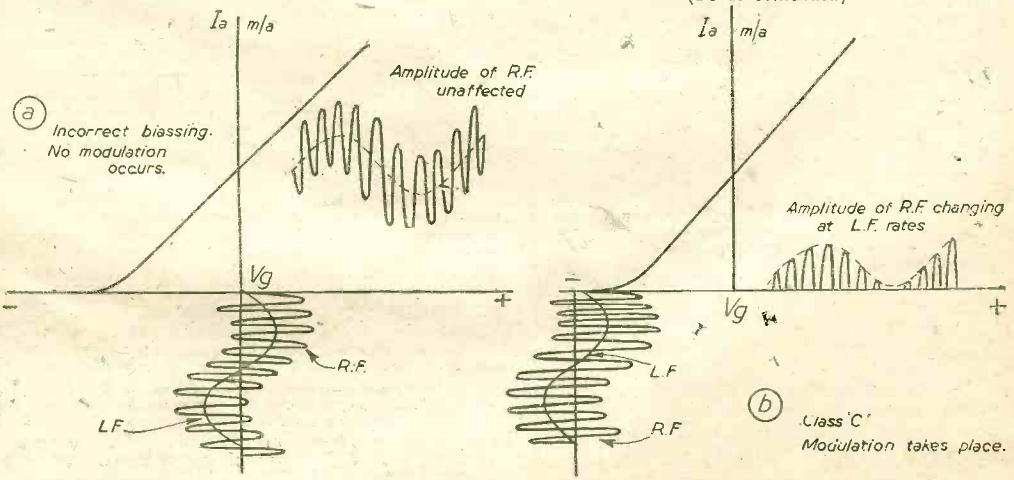


Fig. 58.—Graphs representing modulation conditions.

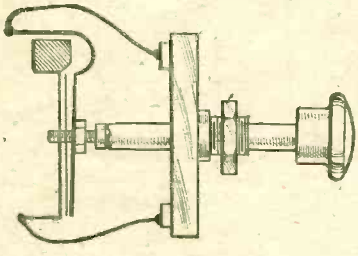
Practical Hints

Trimming Condenser

THE accompanying sketch shows a device I rigged up, consisting of an old push-pull switch and a trimming condenser.

My set has plug-in coils, and every time I changed these coils the trimming condenser had to be adjusted, which meant taking the set out of the cabinet every time.

The device overcomes this difficulty and is fixed to the panel of the set, the trimming condenser being soldered to the two side contacts of the switch. The adjusting rod was then soldered to the screw-head of the trimming condenser. I found this saves a lot of time and is more accurate than the old way.—S. WARE (Plaistow).

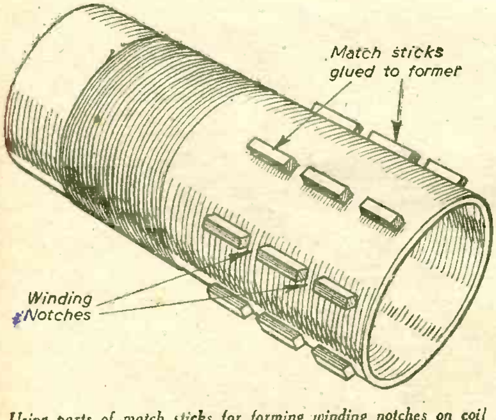


A condenser-trimming device.

Making Coil-former Notches

I HAVE devised the following scheme for providing winding notches on coil formers, which may be of some interest to other constructors.

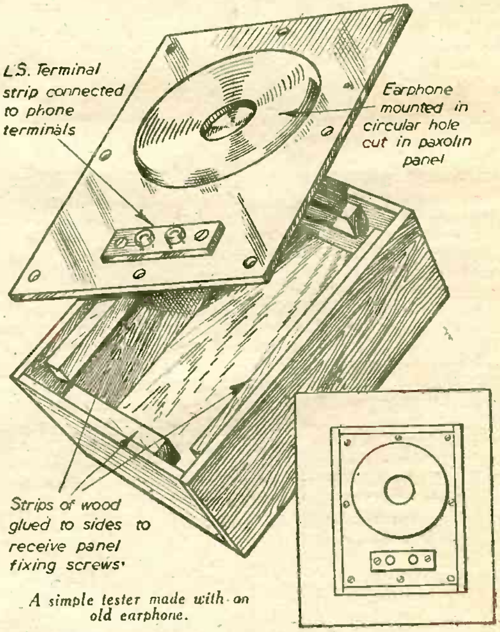
Ordinary matches are taken, their heads cut off, and the pieces of wood then stuck with firm glue on the sides of the coil former at equal distances from each other. When the glue is dry, notches are cut where desired and then the whole former varnished. The notches can hold any long and reaction windings and it is quite easy to wind in them.—DAVID ELLIS (Putney Hill).



Using parts of match sticks for forming winding notches on coil formers.

Simple Tester

THE simple device shown in the sketch was made from an old earphone which was in my junk box, and an ordinary L.S. terminal socket, mounted on a thin sheet of paxolin, and housed in a small wooden box. I have found it very useful for testing sets where I suspected the speaker, and for numerous other jobs, such as using it with an oscillator for lining-up stages when trimming. I use it with my little crystal reflex set which I built from a recent "Hint," and I find it is more like a midget loudspeaker than an earphone when used like this.—J. MCCULLUM (Wellington).



A simple tester made with an old earphone.

Controlling Tone

THE high efficiency of the pentode makes this type of valve very suitable for use in receivers having only one L.F. stage, and, provided that the speaker has a pentode matching transformer attached, the substitution of a pentode for a power valve invariably results in increased volume. It is often found, however, that excessive treble response is obtained after this substitution has been effected. There are several methods of correcting this, the easiest being the connection of a fixed condenser of approximately .0002 mfd. across the secondary winding of the L.F. transformer—i.e., across G. and G.B. terminals. Although this method of tone control proves satisfactory in practice, it is advisable to adopt the more elaborate method of connecting a resistance in series with a condenser across the primary of the speaker transformer. The required values vary slightly with different makes of valves, but a 5 000-ohm resistance in series with a .01 mfd. condenser will prove correct in most cases. If it is desired to make the control variable, the resistance should be of the variable type, a value of 20,000 ohms being suitable.—R. H. (Watford).

ON YOUR WAVELENGTH

By THERMION

Name-plugging

ONE of the rules which the B.B.C. imposes on those who broadcast is that the matter broadcast must be free from advertisement. Yet it permits a blatant form of self-advertisement in some cases by artists who in the dialogue merely plug one another's names. If a sketch is being broadcast perhaps a couple of the characters will take part in their real names instead of imaginary names. Several of the broadcast items include name-plugging of this sort. In half-an-hour's programme a particular artist's name was plugged no less than 20 times. I suggest that the B.B.C. should put a stop to this. I repeat what I wrote some months ago that now that fear of invasion has gone there is no need for announcers to tell us who is reading the news. It does not matter to the listener whether the news is being read by the office boy, or one of the B.B.C. typists, so long as the bulletins are read clearly and the pronunciation is good.

The announcement of the name of the reader is giving undue importance to a comparatively simple task.

Carrying Radios in Cars

IN the early days of the war it was illegal to carry a radio set in a car because it was thought that fifth columnists might be touring the country with portable transmitters or with wireless sets which could quickly be converted to transmitters. Thousands of cars were stopped and examined to make sure that they were not fitted even with car radio.

This really meant that dealers could not deliver wireless sets to their customers, but, owing to protests made by the manufacturers and the dealers, this was modified.

Caravaners were, of course, affected by the Order. According to the Home Office, the owner of a caravan may instal a wireless set, but it is still necessary for it to be removed or dismantled by the removal of valves or batteries before it is taken on to the road. Similarly, a wireless set may be transported in a car so long as it is rendered inoperative in this way.

Sir Ernest Fisk at Brit.I.R.E. A.G.M.

SIR LOUIS STERLING presided at the annual general meeting of the British Institution of Radio Engineers, held on Friday, September 3rd, in the Lecture Hall at the Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1.

He introduced the accounts and read the annual report. The list of nominations for council officers for the coming year was proposed and passed unanimously by the meeting. Sir Louis revealed that the Brit.I.R.E. Parliamentary Committee has under consideration for the coming year proposals for a national scheme for basic research in the radio industry, to be sponsored by the Government.

At the conclusion of business, the president welcomed Sir Ernest Fisk, who, he said, pioneered radio development between this country and Australia.

Sir Ernest, addressing the meeting, made a most lucid and interesting survey of the history of wireless telegraphy and broadcasting from the beginning of the century, describing some of the technical and prejudicial difficulties that had to be overcome before direct Empire communication, so essential to Australia, could become an accomplished fact.

He considered it a privilege to be asked to address the institution, and as first president and immediate past-president of the Institution of Radio Engineers of Australia he was very glad of the opportunity. He looked forward to the time when the two bodies could work in co-operation, and he knew he was speaking for every member of the Australian body when he said this.

B.I.R.E. Radio Trades Examination Board

I HAVE received a copy of the syllabus of the Radio Servicing Certificate Examination which has finally been approved of by the Board of British Institution of Radio Engineers.

The first examination under the auspices of the Board will be held on Saturday, May 20th, 1944, and thereafter in May of each year. The examination will be held in principal technical schools throughout Great Britain and will comprise a three-hour written paper and a three-hour practical test. The examination fee will be two guineas.

In order to be eligible for entrance to the examination, a candidate must have been fully engaged in radio service work for not less than three years, but a full-time course at a recognised technical school in radio service or radio engineering will count as one year towards the requisite three years period.

Communications should be addressed to the Board at 9, Bedford Square, and the secretary will be very pleased to give any further information required

Defeating "Buck-shee" Listener.

[Press Item.—Nine out of every ten people in this country now own wireless sets. The remainder, of course, merely open their windows !]

A Scrooge-like listener, once, 'tis said,
A rush of brains had to his head,
To save his own bawbees.
He had no radio of his own,
A licence fee he would disown,
So thought up clever wheeze.

With meanness which we must deride
He left his windows open wide
When neighbours listened in.
And with his greedy ears well cocked,
At "wasting money" still he mocked,
And looked on it as sin !

When neighbours tumbled to his stunt,
They looked at it with much affront—
Such meanness they despised.
They turned their radio sets well down ;
Now, strained his ears, and watch him frown,
At silence much surprised !

Such be the fate of hounds like him,
Who, with a parsimonious grin,
Sniff up their Scrooge-like snout.
What joy we feel to see them fail
When they set out upon the trail
Of listening-in for "nowt."

"TORCH."

Our Roll of Merit

Readers on Active Service—Thirty-fifth List.

C. Clark (Cfn., A.A. Command School).
C. J. Lane (Cpl., R.A.F.).
H. Skinner (Leading Seaman, R.N.).
F. Hill (L.A.C., R.A.F.).
B. T. Hughes (A.C., R.A.F.).
R. Davies (L.A.C., Bat. Flt.).
R. A. Young (A.C., R.A.F.).
L. McCallum (A.C./1, R.A.F.).
E. A. Wardrop (Drv., R.A.S.C.).
H. L. Jones (L.A.C., R.A.F.).
R. T. Lock (Mech., R.N.).
D. Reeve, (Cfn., R.E.M.E.).

The shadow output meter housed in a neat and servicable case.

YOUR SERVICE WORKSHOP—8

A Shadow O

Every Serviceman Needs an Output Meter. In t

of a Novel Instrument.

SINCE the description of the valve tester in last month's issue, an opportunity has occurred for testing a few more valve types, one of which, particularly, readers may like to know how to carry out. This is the magic eye valve or tuning indicator and a type that is often met with in servicing. The procedure for testing is as follows: Switches S1 and S2 to "normal" and "full emission" respectively. Electrode switch code number set to correspond with base connections, taking the screen supply to target anode, but leaving voltage at zero. After the anode current has been checked the screen voltage is increased until the familiar fluorescent glow appears in the top of the valve. The mutual conductance figure for the triode section should be average for a medium impedance triode.

"Class B" valves, to which grid bias is not applied, cannot be tested by the mu con. method, so the emission test is applied to see if the anode current approximates that of the maker's figure, and it is important that the two sections match reasonably well if the valve is to be regarded as perfect. The code number will require to be altered for each section; similarly QPP valves which, however, may be given a mu con. test. A point worth remembering is always to return the heater adjustment plug to 2 volts after a valve test. By this means no harm can be done inadvertently in any successive test.

To guard against short circuits when valve testing, it will be obvious that the same number (except 0, to which there is no connection) must not appear twice in the code number on the electrode switch. Also, if this latter is fitted with a *metal* switch shaft it must, of course, be insulated from the springs between the sections. The simplest method is to use ebonite rod as first suggested, if this is obtainable.

Other uses for the power pack in the valve tester will suggest themselves to readers, since low tension A.C. voltages may be taken from the heater sockets of any valve holder, and H.T. from "anode" or "screen" sockets on the valve panel. Similarly, the "neon test" may be put to other uses.

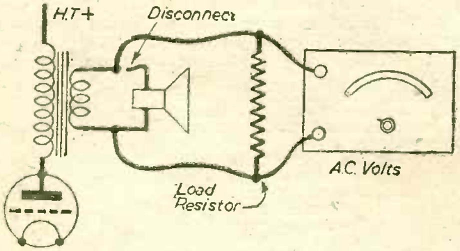


Fig. 1A.—Connection for load resistor in place of L.S. speech coil.

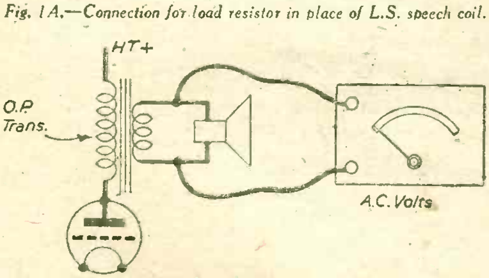
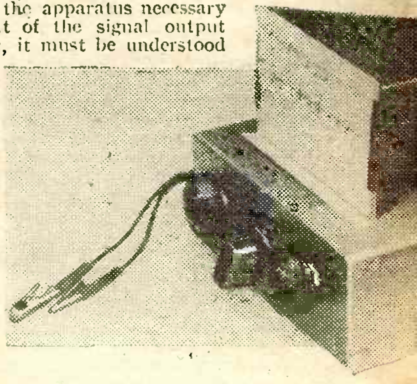


Fig. 1.—Simple method of measuring A.F. output.

Output Meters

When considering the apparatus necessary for the measurement of the signal output voltage of a receiver, it must be understood that the nature of the signal is audio frequency, and it is necessary to employ an instrument suited to A.C. measurement. Such an instrument is called an "output meter" and one of the most useful forms consists of a metal rectifier type A.C. voltmeter, which may be calibrated in terms of the milliwatts or watts developed across the primary or secondary of the receiver's output transformer. It is robust, sensitive and reasonably accurate at all frequencies. Fig. 1 shows how this type of meter is connected across the secondary of the output transformer. The voltage developed across this winding is not very great and a 5 or 10 volt A.C. range will be suitable.



The complete unit, showing the formation

In making tests or measurements with an output meter, it is practically useless to attempt to use a broadcast programme for the purpose, as the meter needle will rise and fall according to the type of programme material being received. The tuning note radiated by the B.B.C. can be utilised, as this is of constant intensity, but the usual and more satisfactory method is to use a signal generator or oscillator such as that described in the issue of PRACTICAL WIRELESS for June, 1943. The

tput Meter

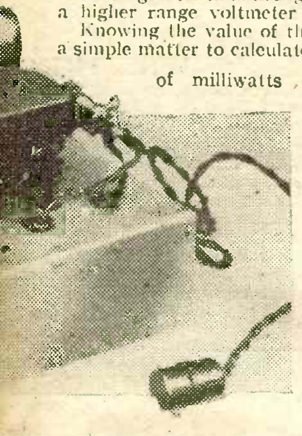
Article Constructional Details are Given

STANLEY BRASIER

gnal is fed into the receiver under test, and the steady nplified A.F. voltage is then measured. A constant gnal such as this is liable to be disturbing if reproduced a the speaker, so it is usual to disconnect the loud-eaker from the O.P. transformer secondary, and place it with an artificial load of the same resistance. ee Fig. 1A.)

It is sometimes necessary or more convenient to nnect the output meter to the primary of the O.P. nsformer, in which case it is essential to isolate e meter from any D.C. by a condenser of large capacity. though it blocks D.C., the condenser has to pass A.C., erefore a good quality paper type is used and not ectrolytic. Using this arrangement, if it is desired to sconnect the L.S. speech coil as suggested above, e load resistance must be equal to the optimum d of the output valve in use. In the arrangement own in Fig. 2 it will be seen that a convenient method y be used whereby a 4-way switch connects to either four load resistors, the values of which are made itable for output valves of the most usual types. e L.F. voltage developed across the load resistor will be much greater than in Fig. 1 and 1A, therefore a higher range voltmeter should be used.

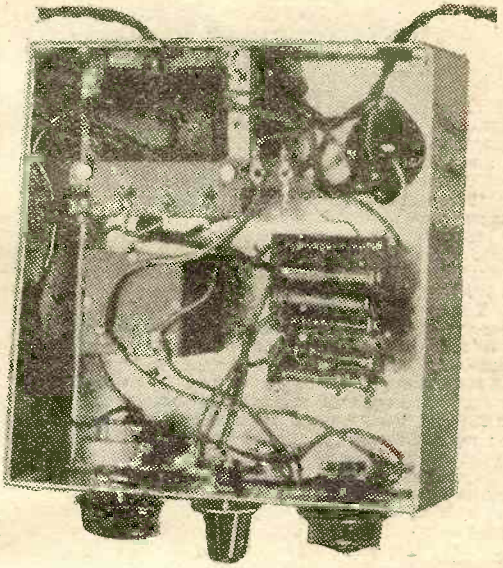
Knowing the value of the load resistor, it is a simple matter to calculate the power in terms of milliwatts or watts from $\frac{V^2}{R}$ where V is the voltmeter reading and R the ohms value of the load. For example, assuming a voltmeter reading of 100 volts and a load of 10,000 ohms the power output would be $\frac{100^2}{10{,}000} = 1$ watt; and from this simple formula the voltmeter scale may, if desired, be calibrated in milliwatts.



he screen and light shaft.

The valve voltmeter is frequently used as an output ter, and the one described in PRACTICAL WIRELESS, ly, 1943, is quite suitable for connection to an O.P. nsformer secondary and could be joined in place of A.C. voltmeter in the diagrams of Figs. 1 or 1A. hen using a valve voltmeter, the range of which makes possible to be joined to the high potential side of the tput, it is important to remember that the instrument st be safeguarded against D.C. by the inclusion of ge fixed condensers—preferably one in series with h lead.

Another type of meter which is useful for comparative ts, and tuning circuits to resonance, is that which kes use of a small neon lamp joined across the output. a result of increasing power the lamp glows more ghtly and vice versa. The indicator is fairly sensitive at low levels of illumination but is of little value where definite measurements (or even indications) are required.



The underside of the chassis which shows the simplicity of the wiring.

For this purpose it is necessary to employ some form of meter which gives a definite reading—not necessarily quantitative—because when trimming a receiver for maximum response it is useful to know, for example, that having switched off for some adjustments the reading is the same, or different, when the set is again switched on.

Shadow Output Meter.

In view of the acute shortage of meters of all types, the writer set out to design an output meter giving definite indications in which a meter (in the usual sense) was not required. The result may be seen from the illustrations on these pages, while the circuit diagram of the shadow output meter is shown in Fig. 3. Reference to the latter will show that audio frequency voltages are applied to the anodes and cathode of a mains driven diode valve via the 4 mfd. condenser, which prevents D.C. from reaching the valve. The rectified anode

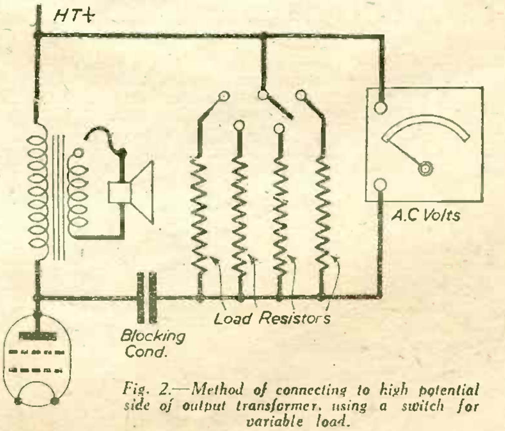


Fig. 2.—Method of connecting to high potential side of output transformer, using a switch for variable load.

current is used to operate the indicating device in a way which will be explained later. The switch S2 selects either of four load resistors and S1 adapts the instrument from an output meter to a 50-cycle A.C. voltmeter. The *output* meter is not intended to give quantitative measurements, but rather to indicate output level and variations of output such as are required when trimming a receiver and for general service work.

The indicator is of the electro-magnetic type and consists of a coil, a circular magnet and a soft iron vane, pivot mounted in small bearings. These three component parts are conveniently available in the form of commercial shadow tuners now sold as surplus goods. The coil in these units may be unsound, in which case the bobbin has to be rewound. This may not be very difficult if the break in the wire is fairly near the outside of the winding, as a simple repair can therefore be made. In other instances, the wire could be unwound until the break is found, or the constructor may prefer to remove the old wire completely and refill the bobbin with number 45 s.w.g. enamelled wire which, if not obtainable, could be taken from, say, an L.F. transformer or choke. The number of turns is of no consequence so long as the bobbin is filled approximately as before. The resistance of the completed coil is about 2,000 to 3,000 ohms.

The moving vane has to be modified as shown in Fig. 4; most of the top portion is cut away and a stiffish bristle taken from a brush is stuck along the lower edge so that the total length is ⅞in. and that it moves parallel to the base throughout its swing. The pointer or needle consists of a short, straight length of *thin* bristle fixed at right-angles to the horizontal thicker bristle so that it points upwards in a vertical direction. A spot of hard wax is the best means for fixing, as it allows adjustments to be carried out if necessary. The movement and its bearings are delicate and the above procedure must be effected with care in order that they are not distorted or damaged. It is important that the movement be kept as light as possible—hence the use of a bristle extension and pointer.

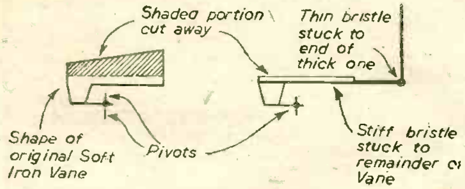


Fig. 4.—Showing how the movement is adapted.

How it Works

Before proceeding further, an explanation of how the meter works will be useful. It must be noted that the magnet (taken from the shadow tuner) is not a complete circle, and for this reason the movement always comes to rest in line with the gap. The movement is held in a central position in the shadow tuner, but for the purposes of the output meter we require the position of rest to be at an angle of, say, 45 deg. to one side, so that the pointer may travel through the largest arc. The coil is mounted under the permanent magnet and when a direct current of sufficient magnitude is passed through it in the correct direction it overcomes the force of the magnet and causes the movement to alter its position, the amount being dependent on the strength of the current. Thus, when the movement is connected in the cathode circuit of the diode valve, it will readily respond to any steady or varying direct current, such as that produced by the A.F. output from a receiver after being rectified by the diode valve.

The indication produced by such a small movement, would, to all intents and purposes, be useless in practice, so that some method of amplifying the indication is necessary. In the instrument shown this is achieved as follows: A strong light is concentrated on a small aperture measuring ⅛in. × 5/32in. in the small end of the tapering light shaft. The other end is in the form of a screen approximately 4½in. × 3in. made of a piece of glass behind which is a thin paper scale. The pointer which is in the path of the direct ray of light cuts the latter, and so, by shadow effect, a very much larger pointer is thrown upon the screen. When the instrument is in operation, therefore, the shadow pointer moves across the 4in. scale from left to right.

(To be continued).

LIST OF COMPONENTS

- One chassis, 7in. x 7½in. x 2½in.
- One shadow tuner.
- One 5-pin valve holder, chassis mounting.
- One mains transformer, 200-250 volts input, 4v. 1 amp. output.
- One 4 mfd. Mansbridge type block condenser.
- One rotary on-off switch (see text).
- One rotary S.P. 4-way switch (Yaxley type).
- One S.P.D.T. rotary switch.
- One escutcheon, 4⅞in. x 2in. x 1½in. (see text).
- One indirectly heated double diode valve.
- One pilot lamp 4.5 volts 0.3 amp. with holder.
- Resistors, 2 watt: one 2,000 ohms, one 5,000 ohms, one 8,000 ohms, one 10,000 ohms. One cabinet.
- Tin plate for light shaft, wire, screws, glass, etc.

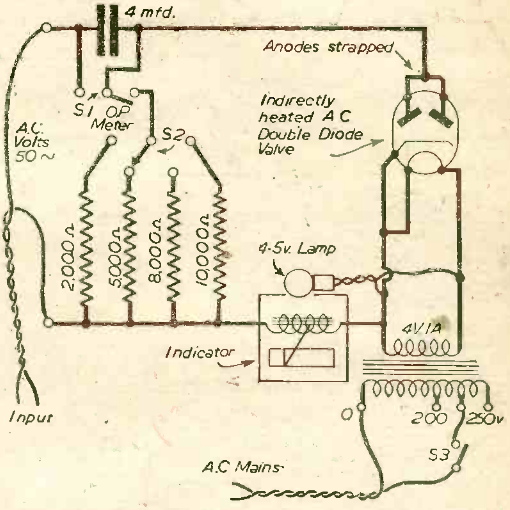


Fig. 3.—Circuit diagram of the output meter described in the text.

Radio Examination Papers—24

Remote Volume Control, Crystal Microphones and Pick-ups, Frequency Modulation, Reading a Tuning Curve, Voltage Regulation and the Design of a Multi-purpose Test Meter are the Subjects of Questions and Answers This Month. By THE EXPERIMENTERS.

QUESTIONS

1. *Describe a simple and efficient form of remote-operated volume control.*
2. *What is the principle of the crystal microphone and pick-up, and what are the main characteristics of these components?*
3. *State briefly the difference between frequency and amplitude modulation. Name some of the most important advantages and disadvantages of the two systems.*
4. *Given a wavemeter, the calibration curve of which is shown in Fig. 3, what should be the setting of the tuning condenser for a wavelength of 41 metres?*
5. *Draw a simplified circuit of a valve-type voltage regulator and explain how it functions.*
6. *How would you modify a milliammeter designed for a full-scale reading of 5 mA, and of unknown resistance, to permit of its use for reading currents up to 10 mA, and up to 50 mA?*

1. Remote Volume Control

THE simplest and most effective remote volume control is that consisting of a potentiometer or variable resistor for varying the grid bias on one or more variable-mu valves. This type of control does not affect the quality of reproduction, nor does it introduce any undesirable capacity effects. In addition, this type of control prevents overloading of the H.F. and I.F. stages, whereas a control acting on the low-frequency-amplifier portion of the receiver does not regulate the input to the H.F. stages.

The method of connecting a remote variable-mu volume control in a set having only one controlled stage is shown in Fig. 1. In this circuit, the use of a mains type receiver is assumed. In the case of a battery set the control would consist of a 50,000-ohm potentiometer wired across the bias battery and connected to the set by means of three flexible leads.

When the receiver is provided with automatic volume control, it is generally better to use a form of remote control which acts upon the low-frequency side, since the A.V.C. will itself prevent overloading of the pre-detector stages. A type of control which is often found very convenient for mounting on the external speaker consists merely of a variable resistor of about 20 ohms wired in series between the speech coil and one end of the secondary winding of the speaker-feed transformer, as also shown in Fig. 1. The variable resistor should be connected by means of short, low-resistance leads and should have a definite "full-on" position, in which the resistance element is completely short-circuited.

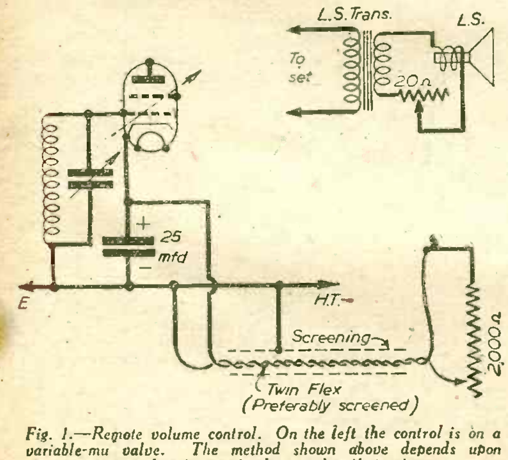


Fig. 1.—Remote volume control. On the left the control is on a variable-mu valve. The method shown above depends upon variation of resistance in the speech-coil circuit.

Another widely-used form of L.F. volume control consists of a potentiometer of about 50,000 ohms, of which the two outside terminals are connected to the "external speaker" terminals of the set, while the speaker itself is connected between the slider and one of the outside terminals. This applies when the external speaker is of the usual high-resistance type.

2. Crystal Microphones

Various forms of quartz and other crystals possess what are described as piezo-electric (or pressure-electric) properties. This means that if a "slice" of one of these crystals is placed between two metal plates and then compressed, a potential difference will be set up between the plates. Contrarily, if a potential is applied to the two plates from an outside source, the crystal will undergo a (very minute) change in shape.

The second property is that which is made use of when quartz or tourmaline crystals are used for frequency stabilisation, as previously mentioned in these "Examination Papers," and does not concern us at the moment. The first-mentioned property is that which is relevant to the question. If a suitable "slice" or wafer of crystal is mounted between metal plates, one of which constitutes

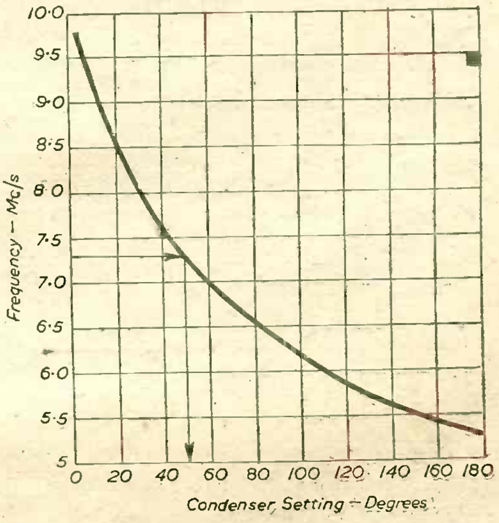


Fig. 3.—A tuning or calibration curve for a wavemeter. Arrows show the method of finding the condenser setting for a frequency of 7,313.1 kc/s. In practice, the curve would be drawn on graph paper with considerably more squares, much smaller in size, than those shown here, for clarity in reproduction. Hence, the readings could be taken with very much greater accuracy.

a diaphragm, it is not difficult to see how a microphone may be produced. As the pressure applied to the crystal is increased and reduced due to vibration of the diaphragm, varying potentials will be set up between the two metal plates. It is necessary only to apply this fluctuating potential to an amplifier in order to reproduce the sound applied to the diaphragm.

Practically the same arrangement may be used with a crystal-type pick-up, except that the needle-holder or stylus is attached to one of the metal plates between which the crystal is held. The other plate is rigid, and therefore movement of the needle point causes the crystal to be compressed and released.

Generally speaking, the output from a crystal microphone or pick-up is less than that from a component using a moving coil or moving armature. Additionally, the impedance of the crystal is high, and therefore a volume control load in the region of 5 megohms is necessary; this resistance also completes the grid-circuit electrically, so that the input valve may be biased normally. The crystal itself is an insulator.

The sensitivity of a crystal microphone or pick-up is fairly uniform above 600 cycles per second, rises slightly down to between 500 and 400 c/s, and more sharply from there to around 100 c/s. Good response to the lower audio frequencies is therefore obtained. It is important that the input valve of the amplifier should have a low cathode-grid capacity in view of the high cathode-grid load; it should also have a very high value of anode lead. Resistance-capacity coupling is generally to be preferred for this valve.

3. Frequency and Amplitude Modulation

In the usual system of modulation (amplitude modulation), the audio and radio-frequency voltages are combined in such a manner that the amplitude of the radio frequency is caused to rise and fall at the audio frequency. This can be seen in Fig. 2, where *a* is an audio frequency, *b* is a carrier wave or radio frequency, and *c* is a combination of the two, where it is assumed that 100 per cent. modulation is obtained; that is, the amplitude of the audio and radio frequencies is the same.

In frequency modulation, the audio frequency is applied to the radio-frequency carrier in such a manner that the frequency of the latter is caused to vary at audio frequency, although the amplitude of the modulated carrier remains constant. This is shown diagrammatically at *d* in Fig. 2.

The chief advantage of amplitude modulation is that it is easy to apply, and can be picked up by means of a very simple type of receiver. Its principal disadvantage is in the transmitter, where the power amplifier valve must operate at comparatively low efficiency. This is because a large handling capacity and a high H.T. voltage are required to deal with the high peak-amplitude modulation voltages.

One advantage of frequency modulation has already become apparent. Another is the almost complete lack of interference at the receiver due to static and man-made static. This is because these forms of interference are, virtually, amplitude-modulated signals to which the F.M. receiver does not respond.

4. Wavemeter Calibration Curve

It will be seen from Fig. 3 that the wavemeter calibration curve shows the frequency in kilocycles, against dial readings in degrees. Before we can use it we must therefore convert the required wavelength—41 metres—to frequency in kilocycles. This is easy enough if it is remembered that the speed of radio waves is 300,000,000 metres a second, or that a wavelength of 300 metres corresponds to a frequency of one megacycle, 1,000 kilocycles or 1,000,000 cycles.

If, therefore, we divide 41 into 300 and multiply the result by 1,000 we shall have the frequency in kc/s corresponding to 41 metres. This gives a frequency of 7,313.1 kc/s, accurate to the first place of decimals.

Knowing this, it is necessary simply to find this on the vertical axis of the graph, take a horizontal line from here to the curve, and then to drop a vertical from the point of intersection. The point at which the vertical line cuts the horizontal axis gives us the correct setting for the wavemeter condenser. The accuracy of the setting depends upon the scale to which the curve is drawn and also upon the accuracy of division of the condenser dial.

5. Valve-type Voltage Regulator

The circuit of one kind of valve-type voltage regulator is shown in Fig. 4. It will be seen that the controlling valve is a tetrode, while a triode is used as the actual regulator. A high resistance is wired in the anode circuit of the tetrode, while bias is applied so that at normal output voltage from the regulator the tetrode will not pass any anode current. In those conditions there will be no voltage drop across the anode load, and therefore the grid of the triode rectifier will be at zero potential.

Should the output voltage tend to increase, the tetrode will pass an anode current, and therefore a voltage drop will occur across the anode resistor. Since one end of this resistor is connected to the filament of the rectifier and the other to the grid, any voltage drop will appear as grid bias on the triode. This bias will reduce the output from the regulator and so correct the tendency for the output voltage to rise.

The "regulated" output voltage can be pre-selected over a small range, by adjustment of the potentiometer to which the grid of the tetrode is connected. This gives

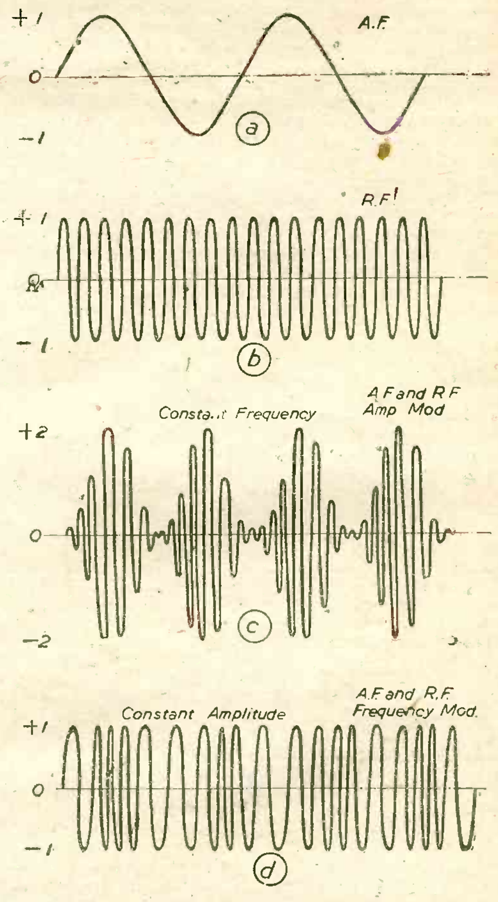


Fig. 2.—Diagrammatic comparisons between amplitude and frequency modulation. In amplitude modulation a and b combine to form c. In frequency modulation, a combination of a and c forms the type of wave shown at d.

a vernier control of bias, from full cut-off to a less negative potential. Values are not assigned to the components, since they are governed by the particular valves employed. It will be understood that this arrangement is suitable only when reasonably low D.C. currents are required, since a power valve—not a special rectifier—is used as regulator.

3. Increasing Milliammeter Range

If the full-scale reading of a milliammeter is to be increased, it is necessary to connect a resistor in parallel with the meter. The object of this is to allow a certain proportion of the total current to pass through the meter and the remainder through the shunt resistor. Thus, if half the current were to pass through the meter and half through the resistor, the total current flowing in the circuit would be exactly twice that shown on the meter scale. Similarly, if three-quarters of the total current passed through the shunt and one-quarter through the meter, the scale reading would indicate only one-quarter of the total current in the circuit; consequently, the meter reading would require to be multiplied by four.

When the resistance of the meter is known, values of suitable shunt resistors can easily be determined by simple proportion. Thus, if the meter had a resistance of 60 ohms, its full-scale reading could be multiplied by four by connecting a resistor of 20 ohms in parallel with it.

This method obviously cannot be applied if the meter resistance is not known. A suitable shunt value must therefore be found by trial. The simplest method is to connect the meter in series with a fixed resistor and battery so that the current passed is between one-half and the full scale reading. A careful note should be made of the exact reading. Next, a variable resistor should be wired in shunt with the meter, without altering any other connections; the variable resistor should then be adjusted until the meter needle shows exactly half the original current. That means that the meter reading has been doubled, and all scale figures should be multiplied by two.

Having found a shunt to give double the scale reading (10 mA in the case of the meter mentioned in the question), the series resistance and/or battery voltage

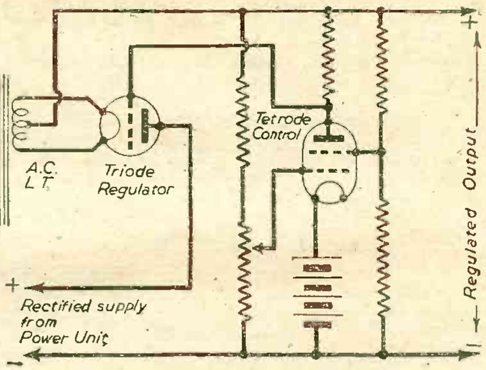


Fig. 4.—How a triode and tetrode may be used to provide accurate voltage regulation of a low-current supply.

should be altered so that the needle gives a reading of 5 mA; the actual current in the circuit is then 10 mA. Another variable resistor should then be wired in parallel with the meter and the original resistor. Leaving everything else as before, this resistor should then be adjusted carefully until the needle points to 1 mA. That means that the previous scale reading has been multiplied by five, or the original reading by 10.

In practice, it may not be convenient to use proper variable resistors, but a wire-wound resistor can be made up to approximate size and the length of wire gradually reduced until the desired scale reading is obtained. In this respect it is worth remembering that the normal resistance of a good moving-coil milliammeter reading up to 5 or 10 mA. is generally between about 50 and 100 ohms. The resistance of 36-gauge Eureka wire is 14.84 ohms per yard.

B.B.C.'s Music Plans for the Winter

THE B.B.C.'s autumn-winter schedule of music programmes is more comprehensive and ambitious than ever, and has been planned on a scale to give it artistic unity as well as programme diversity.

The B.B.C. Symphony Orchestra began on October 6th a series of fortnightly symphony concerts each of two hours' duration, and these will include outstanding classical masterpieces as well as representative modern music.

More choral concerts will be heard during the winter season. Choral societies in the North, Luton and Leicester, as well as the B.B.C. Chorus, will co-operate with the orchestra in the performance of great British works such as Elgar's "The Apostles," and Walton's "Belshazzar's Feast." The second Wednesday of every month will be devoted to choral and orchestral programmes. It is hoped to give Delius's "Mass of Life" and Bliss's "Morning Heroes." In addition, and alternating with these broadcasts, the B.B.C. Chorus will collaborate with the Symphony Orchestra in giving such classical choral works as Bach's St. John Passion and Beethoven's Mass in D. This will be the first broadcast performance of the St. John Passion in its original form.

Opera will play a big part in the scheme. An important opera will be broadcast from a studio on the last Wednesday of every month, and on Saturdays. Every month a performance by the Sadler's Wells Opera Company will be heard. Three "centenary" opera programmes are planned: "Don Pasquale," "The Bohemian Girl," and "The Flying Dutchman."

Listeners are frequently asking for repeat performances of new works given at the Proms and in the studio, in order to get better acquainted with them. During this season, on Thursdays and Fridays, there will be performances of important new works recently played for the first time at the Promenade Concerts, and also of neglected works of the nineteenth century, such as Liszt's "Faust Symphony" and Mahler's "Das Lied von der Erde."

The importance of Sunday as a listening day will be stressed. Every Sunday a complete concert will be broadcast by an orchestra such as the London Symphony, London Philharmonic, Liverpool, Hallé, and Birmingham Orchestras. The "Music of our Time" series, which met with great success last year, will be continued and will include such vital and significant works as Stravinsky's "Apollo Musagetes," Shostakovich's "Leningrad" Symphony, and a new symphony by Hindemith, Bliss's Piano Concerto, Prokofiev's Second Violin Concerto and Janacek's Slavonic Festival Mass.

First-class artists have been engaged for a series of chamber-music concerts, when some of the great masterpieces in this medium will be broadcast also on Sundays.

Alternating Current

Parallel Circuits : Power in an A.C. Circuit : The Operator j : Mutual Inductive Coupling

(*Continued from page 430, September issue*)

The Parallel Resonant (Rejector) Circuit

An alternating p.d. of E volts, when applied to a parallel circuit consisting of a condenser and an inductance as shown in Fig. 21, will cause a current I to flow whose magnitude will depend upon the values of $E\omega C$ and $E/\omega L$. If we assume that there is absolutely no resistance in the circuit, we can simply draw the current through L ($E/\omega L$) lagging E by 90 deg. and the current through C ($E\omega C$) leading E by a similar angle. The sum of these vectors will then give the total current flowing in the circuit, and three different results may result from this calculation. These are as follows :

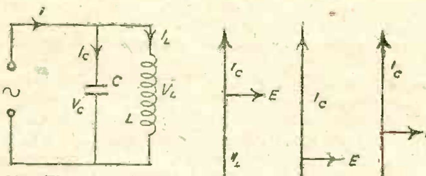


Fig. 21.—Three possible vector conditions of the parallel resonant circuit, where $I_C = E\omega C$ and I_L $E/\omega L$.

(i) $E/\omega L$ may be greater than $E\omega C$, in which case their sum is a vector whose length is $E(1/\omega L - \omega C)$, lagging behind the applied e.m.f. by 90 deg. The circuit then behaves as a pure inductance whose impedance can be shown to be equal to $\omega L/1-\omega^2 LC$.

(ii) $E\omega C$ may be greater than $E/\omega L$, in which case their vector sum is a vector whose length is given by $E(\omega C - 1/\omega L)$, leading the generator e.m.f. by 90 deg. The circuit then behaves as a pure capacitance whose reactance is given by $\omega L/\omega^2 LC - 1$.

(iii) The vector $E\omega C$ may be equal to $E/\omega L$, when their sum will be zero. In this case the impedance of the circuit $= E/I =$ infinity, since I is zero. This is the resonant condition of the circuit, and the resonant frequency fo is such that $E/\omega L = E\omega C$.

Resonance of a Parallel Circuit

At resonance :

$$E/\omega L = E\omega C.$$
$$1/\omega L = \omega C.$$
$$\omega^2 = 1/LC$$
$$\therefore fo = 1/2\pi\sqrt{LC}$$

In the practical circuit resistive elements are always present, and the vector representation of this case is shown in Fig. 22(a). Since most of the resistance is obviously in the inductive branch, the current through the condenser branch is shown leading the applied p.d. by 90 deg., while the current through the inductance lags on the applied p.d. by an angle ϕ. The sum of these two vectors will give the resultant current I, the total current flowing.

At the resonant point, when I is in phase with the applied p.d., this resultant will be along the reference vector E, this state of affairs being shown in the triangle of Fig. 22(b)

For resonance :

$$I_L \sin\phi = I_C$$
$$\sin\phi = \omega L/\sqrt{R^2+\omega^2L^2} : \cos\phi = R/\sqrt{R^2+\omega^2L^2}$$
$$\therefore E\omega C = \frac{E}{\sqrt{R^2+\omega^2L^2}} \quad \frac{\omega L}{\sqrt{R^2+\omega^2L^2}}$$
$$\therefore C = L/R^2+\omega^2L^2$$
$$\therefore C(R^2+\omega^2L^2) = L$$
$$\omega^2L^2C^2 = L - CR^2$$
$$\therefore \omega^2 = L - CR^2/L^2C.$$
$$= 1/LC - R^2/L^2.$$
$$\therefore \omega = \sqrt{1/LC - R^2/L^2}.$$

Therefore the frequency at resonance is given by :

$$fo = 1/2\pi\sqrt{1/LC - R^2/L^2}.$$

Impedance of a Parallel Circuit at Resonance

Let the current at resonance $= I_O$.

Then $Z_O = E/I_O = E/I_L \cos\phi$.

$$= \frac{E\,.\sqrt{R^2+\omega^2L^2}}{E}\frac{\sqrt{R^2+\omega^2L^2}}{R} = \frac{\sqrt{R^2+\omega^2L^2}}{R}$$
$$= \frac{R^2+(1/LC-R^2/L^2)L^2}{R} = \frac{R^2+(L^2/LC)-R^2}{R}$$
$$= L/CR.$$

Since the current is in phase with the generator voltage, the impedance Z_O must be a pure resistance. We define :

Impedance at resonance = Dynamic Resistance $= R_D$
$= L/CR$.

Relation Between I_L, I_C and I_O

As we saw earlier, if the resistance of the parallel circuit is zero, the vector diagram becomes as in Fig. 21, where I_L lagged E by exactly 90 deg. and was exactly antiphase to I_C. The circuit then has an infinite R_D and the feed current is at Zero. In practice R is never absent, and I_L is not exactly antiphase to I_C.

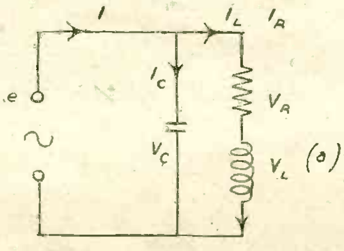
Since, however, R is generally small, we can say :

$I_L = I_C =$ the Circulating Current.

We have :

$I_O = E/R_D$: $I_L = E/\sqrt{R^2+\omega_0^2L^2}$ or really $E/\omega_0 L$

$\therefore I_L/I_O = E/oL$. $R_D/E = R_D/oL$.



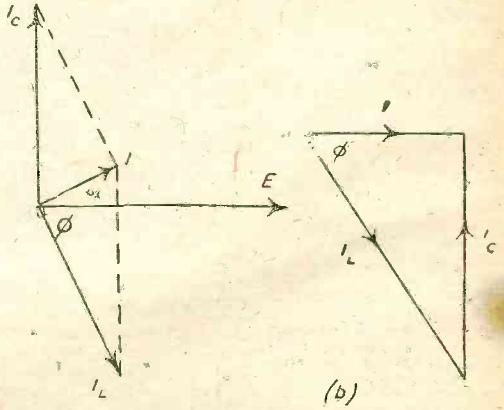


Fig. 22.—The practical parallel circuit with resistance, showing the resonant condition in the triangle (b).

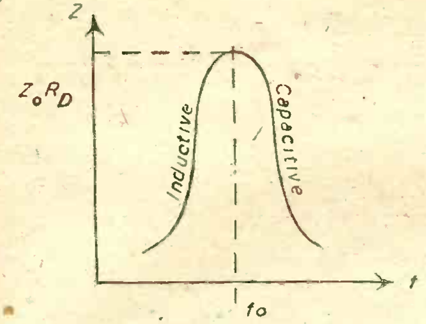


Fig. 23.—The response curve for the parallel case.

Thus by introducing a condenser in parallel with the inductance, we have increased the impedance of the circuit from $\omega_0 L$ to R_D.

Thus Circuit Magnification = Q Factor = $R_D/\omega_0 L = I_L/I_0$

∴ Circulating current = $Q \times$ Feed Current.

Other useful forms of R_D are:

$L/CR = R \times (1/R^2.\ L/C) = RQ^2$.

Also $R_D = \omega_0 L.Q$.

Selectivity of a Parallel Circuit

At resonance, impedance is a maximum—theoretically —R_D, and as the frequency deviates from resonance the response decreases (Fig. 23).

Thus the peakiness of the response curve is again a measure of the ability of the circuit to discriminate between frequencies. The peakiness is again dependent upon Q.

Power in an A.C. Circuit

During a complete cycle of voltage the power consumed by a circuit varies from instant to instant, and its mean value over a complete cycle is what is normally inferred.

When there is current flowing in a circuit, such as a purely capacitive one, power delivered during one quarter cycle is returned to the generator during the next, and the power consumption of the arrangement is zero. This is known as "wattless" current. In actual practice such arrangements do not exist and power is consequently taken. As will be readily seen, the phase angle ϕ is one of the main factors in the problem.

Let $e = \hat{e} \sin \omega t$

$i = \hat{i} \sin (\omega t + \phi)$

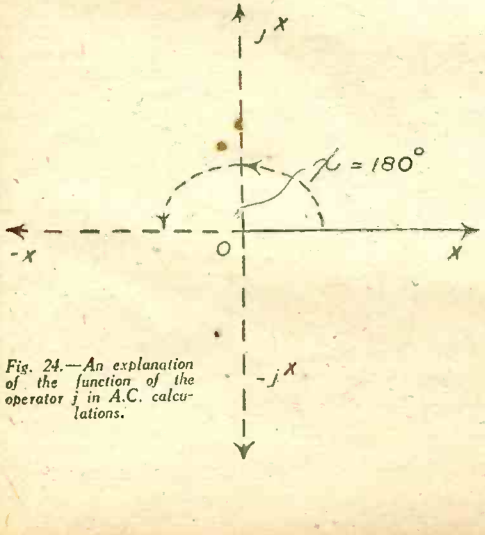


Fig. 24.—An explanation of the function of the operator j in A.C. calculations.

where ϕ is the phase angle between e and i.

The power at any instant $p = e\,i$

$= \hat{e} \sin \omega t.\ \hat{i} \sin (\omega t + \phi)$

$= \hat{e}\,\hat{i}\,.\,1/2\,(\cos - (\phi) - (2 \cos \omega t + \phi))$

$= \hat{e}\,\hat{i}/2\,(\cos \phi - \cos (2\omega t + \phi))$

Now take the mean value of p over a complete cycle. Since ϕ is constant the first term is constant, while over a complete cycle the mean value of the second term is zero.

∴ Mean Power = P = $\hat{e}\,\hat{i}/2.\ \cos \phi$

$= \frac{\hat{e}}{\sqrt{2}} \frac{\hat{i}}{\sqrt{2}} \cos \phi$

$p = EI \cos \phi$

The Operator j

Alternating quantities are represented by vector diagrams as we have seen. The operator j, or j notation, generally facilitates calculations involving these vectors, j being the square root of minus. *i.e.*,

$j = \sqrt{-1}$

$j = -1$

$j(-j) = 1$

and so on.

In Fig. 24, consider the vector X to be capable of rotating about a point O. As the vector is rotated, whether in a clockwise or an anti-clockwise direction, through an angle χ, it changes in value from $+X$ to $-X$; in other words, the rotation is equivalent to multiplying the vector by -1.

It is possible to look at it in this way: the angle χ is two successive rotations of 90 deg. and the vector is multiplied by $\sqrt{-1}$ at each rotation. Thus when X passes through 90 deg. a right angle, the value of it changes from X to jX, j being $\sqrt{-1}$.

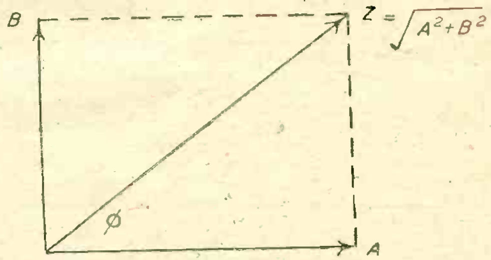


Fig. 25.—The resultant vector $\sqrt{A^2+B^2}$, leading vector A by φ, which can be written as A+jB in the j notation.

Now X may rotate clockwise or anti-clockwise, and it is general to adopt a convention to distinguish between these two possibilities. This convention is simply that if a vector X, lying horizontally, moves in an anti-clockwise direction through 90 deg., its value becomes jX; if it moves clockwise through a similar angle its value becomes $-jX$.

Consider the expression $(A + jB)$. This simply means that added to a vector A is another vector B, B leading A by 90 deg. If (Fig. 25) the vector sum of these two quantities is Z, then:

$Z = \sqrt{A^2 + B^2}$, ahead of A by an angle ϕ, where $\tan \phi = B/A$.

The expression $(A + jB)$ is therefore the vector whose length is $\sqrt{A^2 + B^2}$, leading A by the angle ϕ, and contains in a convenient form all the information therein set down.

The table below gives a few examples of impedances written in the normal and the j notation:

Impedance.	Normal.	j Notation.
L. Henries	ωL	$j\omega L$
C. Farads	$1/\omega C$	$1/j\omega C$
L Henries + R Ohms	$\sqrt{R^2 + \omega^2 L^2}$	$R + j\omega L$
C Farads + R Ohms	$\sqrt{R^2 + (1/\omega C)^2}$	$R - j/\omega C$

Coupled Circuits

We will conclude this A.C. survey with a brief talk on coupled circuits and the transformer.

Coupled circuits are arranged such that energy supplied to one may be transferred to the other.

Common Coupling

Any two circuits which are coupled together by a common impedance have a coefficient of coupling that is equal to the ratio of the common impedance to the square root of the product of the total impedances of the same kind as the coupling impedances that are present in both circuits. (Fig. 26.)

The coupling factor is K

i.e., for common inductive coupling :

$$K = \frac{\omega Lm}{\sqrt{\omega(L_1+L_m)\ \omega\ (L_2+L_m)}} = \frac{Lm}{\sqrt{(L_1+L_m)(L_2+L_m)}}$$

and for common capacitive coupling :

$$K = \frac{1/\omega Cm}{\sqrt{1\omega.\ \ (C_1+C_m/C_1C_m)\ 1/\omega\ (C_2+C_m/C_2C_m)}}$$

$$= C_1C_2/\sqrt{(C_1+C_m)}\ (C_2+C_m)$$

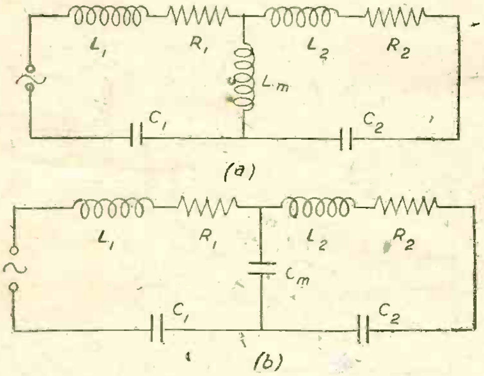


Fig. 26.—Inductive and capacitive coupled circuits respectively.

Mutual Inductive Coupling

Consider the inductively coupled circuits in Fig. 27, where there exists between the coils a certain mutual inductance M. The one circuit contains an alternator, of variable frequency, and is called the primary ; the second circuit is known as the secondary.

The coupling between primary and secondary depends upon the relative positions of L_1 and L_2 and its greatest possible value occurs when the flux created by a current in one, links with all the turns of the other. It can be shown that with this maximum coupling, the coefficient of coupling k

$$= \frac{\omega M}{\sqrt{\omega L_1.\ \omega L_2}} = \frac{M}{\sqrt{L_1.\ L_2}}$$

The maximum theoretical value of k, the coupling factor is unity, but in practice this value is impossible to achieve due to flux leakage and other losses.

The greater the value of k, however, the tighter are the circuits said to be coupled, while when k is small the circuits are said to be loosely coupled.

Reflected Impedance

Let Z_1 be the impedance of the primary alone.

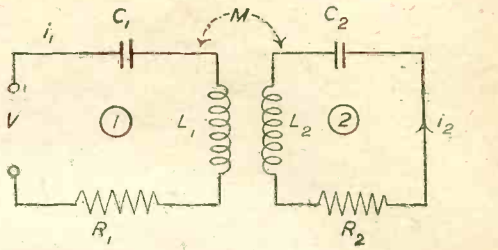


Fig. 27.—Inductively coupled circuits with mutual inductance M.

Let Z_2 be the impedance of the secondary alone.

The current i_1 in circuit 1 will induce e.m.f. in circuit 2 which is given by :

$$e_2 = M.\ di_1/dt.$$

Let $i_1 = \hat{i}_1\ sin\ \omega t$, then $di_1/dt = w\hat{i}\ sin\ (\omega t + 90°$ phase shift)

$$\therefore\ e_2 = \omega M i_1.$$

The current in the secondary :

$$i_2 = e_2/Z_2 = \omega M i_1/Z_2.$$

Now, by applying Kirchoff to the primary circuit :

$V = i_1Z_1 +$ (e.m.f. induced in circuit 1 due to current i_2 in circuit 2)

$$= i_1Z_1 + \omega M i_2$$
$$= i_1Z_1 + \omega M.\ \omega M i_1/Z_2$$
$$= i_1Z_1 + (\omega^2M^2/Z^2)i_1$$
$$= i_1(Z_1 + (\omega^2M^2/z_2))$$

Hence the presence of the secondary circuit increases the effective impedance by an amount :

$$\omega^2M^2/Z_2$$

Loose Coupling

Consider the case of two identical circuits, both tuned and coupled together, i.e., circuits tuned separately to the same frequency.

In this case k will be very much less than unity. The secondary current will be small and the reflected impedance into the primary will correspondingly also be small. Thus, if the input V be constant in amplitude and variable in frequency, i_1 will vary as for a series resonant circuit (Fig. 28(a)).

We have seen that :

$$e_2 = \omega M i_1$$

and since w does not vary greatly over the peak, the e_2 curve will be proportional (the same shape) as the i_1 curve (Fig. 28(b)).

We also know that :

$$i_2 = e_2/Z_2 = \omega M i_1/Z_2.$$

Thus, as resonance is approached, e_2 increases and Z_2 decreases so that i_2 increases very rapidly. The i_2 curve (Fig. 28(c)) is therefore very selective.

(*To be concluded.*)

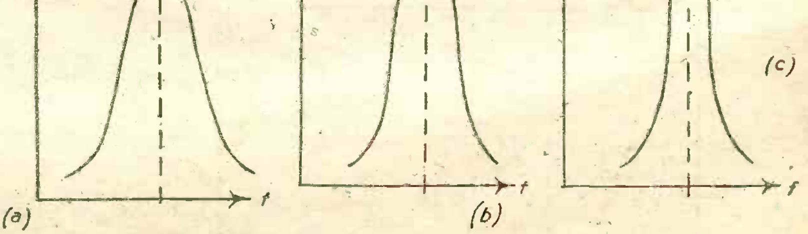


Fig. 28.—Curves obtained from the circuit of Fig. 27 with loose coupling showing the selective i_2 curve.

Valve Data Sheets

COSSOR

Valve-base connections, as seen from underside of base

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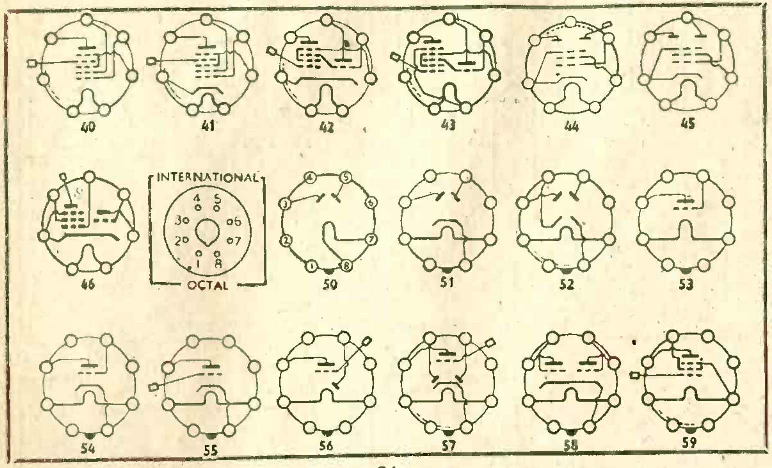

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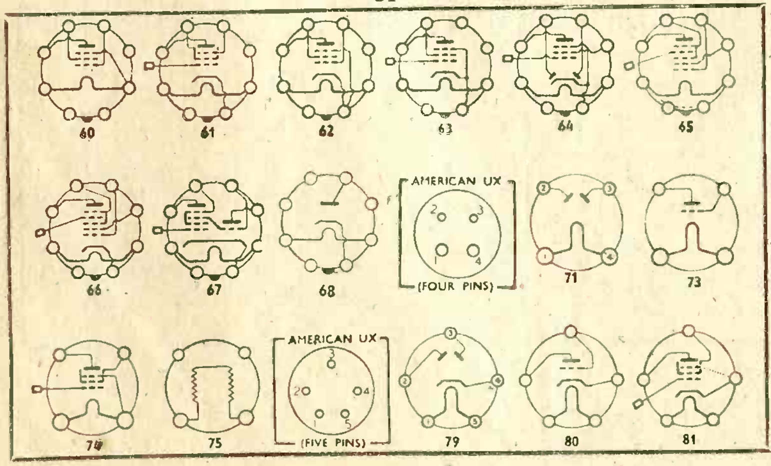

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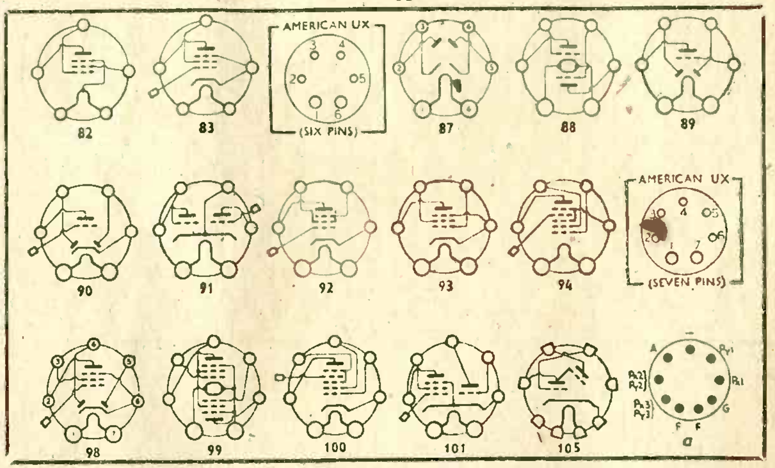

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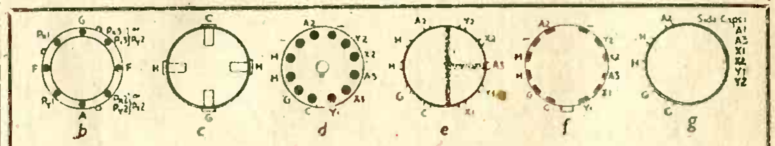

THE base diagrams a, b, c, d, e, f and g, refer to the cathode ray oscillograph and television tubes, the characteristic details of which are given in panels Nos. 26, 27 and 28 on page 471 of the October issue of PRACTICAL WIRELESS.

A word of warning appears to be necessary regarding the reading or interpretation of the base diagrams given in this series of Valve Data Sheets. It must be understood that the pin arrangement shown applies only when viewing the valve pins from their free end, or, if thinking in terms of the valveholder, from the underside.

Valve Data Sheets

MULLARD

1.4 VOLT RANGE

Type.	Description.	Base.	Bulb Finish.	Working Conditions. If.	Va.	Vg2.	—Vg.	Ia.	Characteristics at Working Conditions. Ri.	G.	S. or Sc.	Optimum Load.
DK1	Heptode Frequency Changer	P (53)	Met.	0.1	90	90‡	0	0.55	600,000	—	0.25	—
DF1	H.F. Pentode	P (54)	Met.	0.05	90	90	0	1.2	1,500,000	1,160	0.75	—
DAC1	Single Diode Triode	P (55)	Met.	0.05	90	—	0	0.14	240,000	65	0.275	—
DL2	Output Pentode	P (56)	Clear	0.1	90	90	7.5	7.5	115,000	180	1.55	8,000

REFERENCES:

If = Filament or Heater Current.
S = Mutual Conductance.
Vg2 = Auxiliary Grid or Screen Voltage.
Ri = Anode Impedance.
Va = Anode Voltage
Ia = Anode current.
G = Amplification Factor.
Vg1 = Control Grid Voltage.
Sc = Conversion Conductance.

2 VOLT RANGE

Type.	Description.	Base.	Bulb Finish.	If.	Va.	Vg2.	—Vg.	Ia.	Ri.	G.	S. or Sc.	Optimum Load.
TH2	Triode Hexode Frequency Changer	7-pin (24)	Met.	0.23	135	60	5.0	0.95	600,000	—	0.43	—
FC2	Octode Frequency Changer	7-pin (22)	Met.	0.1	135*	70†	0	0.95	—	—	0.2	—
FC2A	Octode Frequency Changer	7-pin (22)	Met.	0.13	135*	45‡	0.5	0.7	2,500,000	—	0.27	—
VP2	Vari-mu H.F. Pentode	7-pin (18)	Met.	0.18	135	135	0-7	3.0	400,000	—	1.5	—
VP2B	Hexode	7-pin (21)	Met.	0.14	135	60	1.5	2.0	1,300,000	—	1.4	—

* Va = Vg2 = 135 V. † Vg2+5 = 70V. ‡ Vg3+5 = 45V.

2 VOLT RANGE—*Continued*

Type.	Description.	Base.	Bulb Finish.	Working Conditions. If	Va.	Vg2.	—Vg.	Ia	Characteristics at Working Conditions. Ri.	G.	S. or Sc.	Optimum Load
SP2	H.F Pentode	7-pin (18)	Met.	0.18	135	135	0	3.0	700,000	1,200	1.8	—
PM12A	Screened Tetrode	4-pin (5)	Met. or Clear	0.18	135	75	0	2.0	330,000	500	1.5	—
PM12	Screened Tetrode	4-pin (5)	Met. or Clear	0.15	150	75	—	4.25	180,000	200	1.1	—
PM12M	Vari-mu Screened Tetrode	4-pin (5)	Met. or Clear	0.18	150	90	0-7	2.5	—	—	1.4	—
2D2	Double-diode Detector	5-pin (9)	Met.	0.09	125	—	—	0.5	—	—	—	—
TDD2A	Double-diode Triode	5-pin (13)	Met.	0.12	135	—	1.5	1.95	25,000	30	1.2	—
TDD2	Double-diode Triode	5-pin (13)	Met.	0.1	150	—	5.5	2.5	12,000	16.5	1.4	—
PM1A	High Impedance Triode	4-pin (1)	Clear	0.1	150	—	1.0	1.0	41,600	50	1.2	—
PM1HF	Medium Impedance Triode	4-pin (1)	Clear	0.1	150	—	3-4.5	1.5	22,500	18	0.8	—
PM1HL	Medium Impedance Triode	4-pin (1)	Met. or Clear	0.1	135	—	1.5	2.3	23,400	28	1.2	—
PM2HL	Medium Impedance Triode	4-pin (1)	Met. or Clear	0.1	135	—	1.5	2.2	21,500	30	1.4	—
PM1LF	Medium Impedance Triode	4-pin (1)	Clear	0.1	150	—	7.5	4.0	12,000	11	0.9	—
PM2DX	Medium Impedance Triode	4-pin (1)	Met. or Clear	0.1	135	—	4.5	2.0	18,000	18	1.0	—

2 VOLT RANGE—*Continued*

Type.	Description.	Base.	Bulb Finish.	Working Conditions. If.	Va.	Vg2	—Vg.	Ia.	Characteristics at Working Conditions. Ri.	G.	S. or Sc.	Optimum Load.
PM2DL	Driver for Class B	4-pin (1)	Met.	0.1	135	—	4.5	2.0	12,000	18	1.5	—
PM2A	Output Triode	4-pin (1)	Clear	0.2	135	—	6.0	5.0	6,000	12	2.0	7,000
PM2	Output Triode	4-pin (1)	Clear	0.2	150	—	12.0	6.6	4,400	7.5	1.7	9,000
PM202	Super-power Triode (replaces PM252)	4-pin (1)	Clear	0.2	150	—	12-15	14.0	2,000	7	3.5	3,700
PM22	Output Pentode	4-pin (4) or 5-pin (8)	Clear	0.2	150	150	10.0	15.0	—	—	1.3	8,000
PM22A	Output Pentode	4-pin (4) or 5-pin (8)	Clear	0.15	135	135	4.5	5.6	150,000	—	2.2	19,000
PM22D	High Sensitivity Output Pentode	5-pin (8)	Clear	0.3	135	135	2.4	5.0	—	—	3.0	24,000
PM2B	Class B Double-triode	7-pin (15)	Clear	0.2	120	—	0	—	—	—	—	14,900
PM2BA	Class B Double-triode	7-pin (15)	Clear	0.2	120	—	4.5	—	—	—	—	14,000
QP22A	Q.P.P. Double Pentode	9-pin (31)	Clear	0.45	135	135	12.0	3.0	—	—	4.0	16,000
QP22B	Q.P.P. Double Pentode	7-pin (10)	Clear	0.3	135	135	11.7	3.8	—	—	3.1§	14,700

§ S at Va = Vg2 = 100V, and Vgl = 0.

"E" SERIES (SIDE CONTACT)

Vf = 6·3 V. unless otherwise stated.

Type.	Description.	Base.	Bulb Finish.	Working Conditions If.	Va.	Vg2.	—Vg	Ia.	Characteristics at Working Conditions. Ri.	G.	S. or Sc	Optimum Load.
EM1	Tuning Indicator	P (33)	Clear	0.2	250	—	0—5	—	—	—	—	—
EM3	Tuning Indicator	P (33)	Clear	0.2	250	—	0—21	—	—	—	—	—
EM4	Tuning Indicator	P (34)	Clear	0.2	250	—	0—16	—	—	—	—	—
ECH2	Triode Heptode Frequency Changer	P (35)	Met.	0.95	250	100	2.5	3.25	1,500,000	—	0.75	—
ECH3	Triode Hexode Frequency Changer	P (35)	Met.	0.2	250	100	—2.0	3.0	1,300,000	—	0.65	
EK2	Octode Frequency Changer	P (36)	Met.	0.2	250	200§	2.0	1.0	2,000,000	—	0.55	—
EK3	Octode Frequency Changer	P (36)	Met.	0.72	250	100	2.5	2.5	2,000,000	—	0.65	—
EF5	Vari-mu H.F. Pentode	P (37)	Met.	0.2	250	100	3—50	8.0	1,200,000	2,000	1.7	—
EF6	H.F. Pentode	P (37)	Met.	0.2	250	100	2.0	3.0	2,500,000	4,500	1.8	—
EF8	Low Noise H.F. Pentode	P (38)	Met.	0.2	250	250†	2.5	8.0	450,000	—	1.8	—
EF9	Sliding Screen H.F. Pentode	P (37)	Met.	0.2	{250 250	100 250	2.5 49.0	6.0 —	1,250,000 10,000,000	— —	2.2 0.0045}	—

§ Vg3+5=50V. † Vg2=0; Vg3=250.

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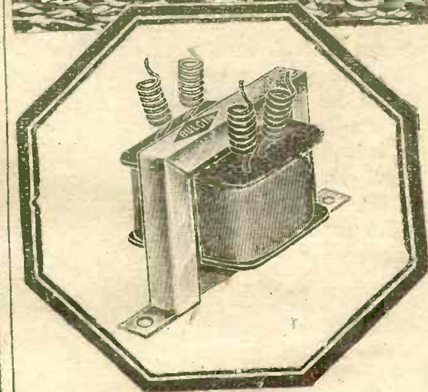

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Secondary Batteries—3

Operating a Charging Station

By G. A. T. BURDETT, A.M.I.I.A.

(Continued from page 467, October issue.)

THE first essential in the charging of batteries is a supply D.C. or continuous current of electricity. Since the supply of electricity in this country, with few exceptions, is A.C. having a frequency of 50 cycles per second, some form of rectification is necessary. It is assumed, however, at this stage that a continuous current supply is available.

Receipt of Batteries

Upon their receipt from the customers, batteries should be labelled with the name and address of the customer, examined and tested, and particulars of such tests recorded in a book (see previous article).

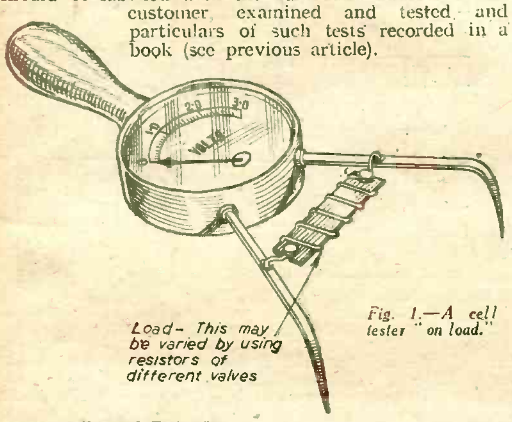


Fig. 1.—A cell tester "on load."

Examination of Batteries

Carry out a general examination of the battery to ascertain whether the case is cracked or otherwise damaged, whether terminals or vent plugs are missing and, where possible, if the plates are buckled, broken or badly sulphated. Clean all terminals and smear Vaseline over them.

Testing

Measure voltage of each cell and the S.G. of the electrolyte. Measure the level of the electrolyte above the plates and if this is low top up with distilled water after the S.G. has been measured. As pointed out earlier in this series, the voltmeter test is of little practical use unless a current is flowing through a cell. Therefore the cell tester (Fig. 1) should be used. This incorporates a suitable load for testing each cell, and will indicate whether a cell is in a bad condition, e.g., shorting of plates by foreign matter or shreds of active material—normally called "treeing." A cell in such a condition should carefully be watched and frequently tested during charging. The batteries should then be placed on a special bench reserved for discharged batteries, and if these are placed in order of precedence for charging, considerable time will be saved. Batteries, of course, are not necessarily charged in order of their receipt, some being more urgently required than others. The more urgent will be placed on the bench for immediate attention.

Vent plugs are removed just prior to connecting the batteries to the charging board. Here again some sort of system should be adopted, or later difficulty will be experienced in finding the right plugs. Where batteries have removable lids, it is usual to place the vent plugs inside the lid during charging, while in other cases the plugs may be stowed on top of the battery. When neither of these methods is possible, great care must be exercised to ensure that plugs are not mislaid.

Testing Polarity of the Supply

Although the output terminals on charging boards are usually marked positive and negative, it must not be taken for granted that they are connected up "the right way round." Mistakes can happen, especially where alterations to the plant have been carried out, or where the boards have been out of service for some time. It is therefore advisable to test the polarity at the output, and this may be done in a number of ways. Fig. 2a illustrates the most conventional manner. A pair of wires is connected to the output terminals of the charging board, and the end of one is placed in a glass or jar containing a solution of sulphuric acid or salt water, while the other is connected to a lamp resistance (the voltage of which must not be less than the voltage of the D.C. supply), a lead from which is also placed in the glass by stheide of the former one. When the D.C. current is switched on bubbles will form around the bare wires. The one from which the greatest number of bubbles rise is the negative lead. As an alternative, the wires can be connected to two lead strips which are placed in the weak electrolyte. Bubbles will rise at the negative strip, while the positive will turn a chocolate brown.

Another method is to draw a pair of wires across a slice of raw potato. The positive lead will trace a green line resembling green ink and the negative will cause bubbles to form (Fig. 2b). A further method is to wet a piece of ordinary blueprint paper and draw both wires across its surface when the positive will trace a white line. Books of polarity testing paper (resembling blotting paper) may be purchased and these will give similar results.

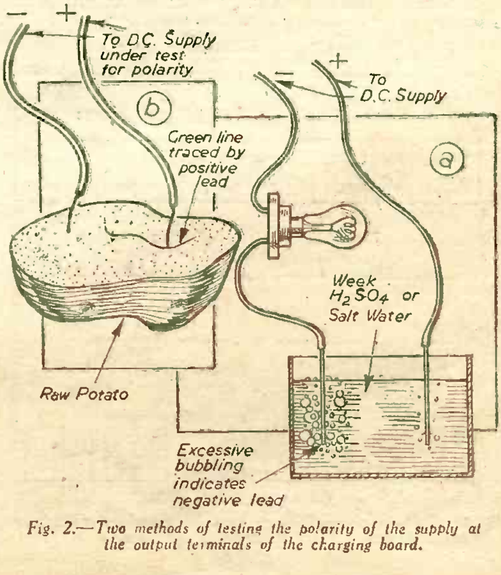


Fig. 2.—Two methods of testing the polarity of the supply at the output terminals of the charging board.

Connecting Batteries to Charging Board

Batteries should be connected to the charging board in such a manner that the plant operates as near to its normal capacity as possible. For instance, if a charging plant has a D.C. output of 6 amps. 36 volts the maximum number of cells which may be charged simultaneously is as follows:

Ascertain the number of cells which may be connected in series (see Fig. 3). For lead acid, allow 2.8 volts per cell and for alkaline 1.85 volts per cell. These values allow for the maximum back E.M.F. of the cell when approaching a fully charged state. Therefore the number of cells which may be connected in one series is equal to:

For Lead Acid Batteries—

$$\frac{\text{Voltage of D.C. supply}}{\text{P.D. of each cell}} = \frac{36}{2.8} = \text{say, 12 cells.}$$

For Alkaline Batteries—

$$\frac{\text{Voltage of D.C. supply}}{\text{P.D. of each cell}} = \frac{36}{1.85} = \text{say, 19 cells.}$$

D.C. supply of a higher or lower voltage will allow a proportionally larger or smaller number of cells to be in series respectively. The usual 20 amp./hour cell has a charging rate of 2 amps. With a single series method, shown in Fig. 3, it is obvious that a possible extra charging current of 4 amps. is not being utilised, viz., the maximum output is 6 amps., charging current in the example 2 amps., which leaves 4 amps. available.

Series-parallel Connections

Fig. 4 illustrates how batteries may be connected in series/parallel in order to utilise the maximum possible output. Three sets of series batteries of 12 cells per series are connected, each series in parallel with the other series. As the total charging current is 6 amps., the current through each series is $\frac{6}{3}=2$ amps. The total capacity of the plant is therefore utilised, e.g., 36 volts 6 amps. will charge simultaneously 36 2-volt cells, each at a rate of 2 amps. Although the theoretical charging current through any series connected in the above manner is 2 amps., the actual charging current passing through will depend upon a number of factors. For instance, if one series of the batteries are in a good condition and approaching full charge, but another series is badly sulphated or fully discharged, only a small proportion of the total current available will pass through the former, as most of it will be forced through the other series, in proportion to their respective states of discharge. Batteries connected in series parallel are therefore liable to be overcharged unless all batteries have practically identical conditions.

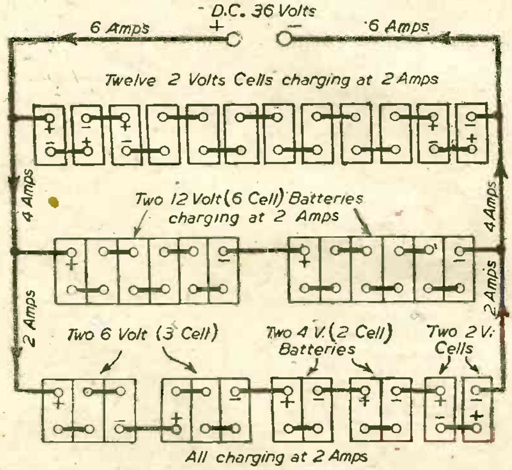


Fig. 4.—Batteries connected in series-parallel. For charging maximum output 36 volts 6 amps. (Lead-acid type 2.8 volts per cell.)

Batteries connected in the above method also require almost constant attention from the operator. Should a connection on one series break or become corroded, and so interrupt the current to that series, the full current will flow through the other cells and possibly damage them. Fig. 5 shows the effect of a severed connection on one series of cells, which entirely disconnects them, resulting in double the current, e.g., 6 amps. instead of 3 amps., passing through the remainder. It is obvious from this that serious consequences may result from the adoption of such methods.

To eliminate these contingencies it is advisable to install a variable resistance in each series, as illustrated in Fig. 6. Each circuit is thus independent and should a connection be severed there would be no rise in current

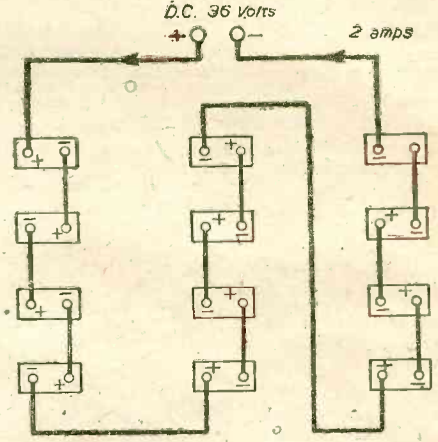


Fig. 3.—Twelve 2 volt cells (lead acid) connected in series. Maximum back E.M.F. of cells when fully charged=2.8 × 12 =33.6 volts. Allowing margin of 2.4 volts.

through the other as the flow of current is controlled by V.R.1 and V.R.2 respectively. It is not necessary to install separate ammeters where these are not at hand. One ammeter alone will be sufficient provided plugs and jacks or some other suitable arrangement is provided for inserting the ammeter when interrupting the flow of current. The clip-on or tong type of ammeter is suitable for this purpose provided the instrument has a wide scale, e.g., the full scale of the instrument is utilised for the range of current to be measured. Should the maximum current be 5 amps., the range of the instrument used should not exceed this by more than 1 amp.

Charging Rate

In each of the above examples, the charging rates given have been hypothetic and not related to any

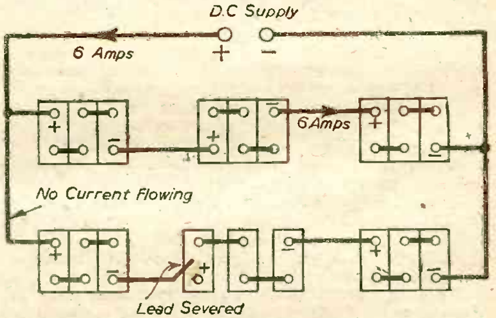


Fig. 5.—Two sets of series batteries connected in parallel. Open circuit on one set causing double current to flow through the other set.

particular size of battery. To preserve batteries, particularly the lead acid type, they should not be charged at higher rates than laid down by the makers. This is usually printed on the label, together with the capacity in amp./hours of the battery for different rates of discharge. Frequently batteries are received for charge where the labels are removed and some method of ascertaining the approximate capacity is desirable. This is carried out as follows:

Capacity of cell = Two-thirds of area of positive plate × number of positive plates in the cell.

For example, a cell is received for charge having seven positive plates, the area of one being 5in. × 4in. The approximate capacity $= \frac{2}{3} \times 5 \times 4 \times 7 = 93$ amp./hours.

Charging rate is usually at the 10-hour rate. Therefore charge at $\frac{93}{10} = 9$ amps. approximately.

Unless the battery is required urgently, a lower charge at the 12-hour rate is advisable. This will be $\frac{93}{12} = 7.8$ amps.

A battery is not to be considered charged when the 10-hour or 12-hour period of charge respectively is reached, but should be ascertained as follows.

Indications of a Fully Charged Cell

The lead acid cell is charged when—

(a) All plates in each cell are freely gassing. A badly sulphated cell will gas freely soon after it is put on charge and the electrolyte will be of a milky colour. This is not an indication of a state of full charge and after a while, depending upon the extent of sulphation, the gassing will cease and the real gassing commences when the battery is reaching fully charged.

(b) There are no further rises in the voltage of each cell with the current flowing when three consecutive readings are taken with the voltmeter at intervals of not less than 15 minutes.

(c) There are no further rises in the S.G. of the electrolyte with current flowing when tested with the hydrometer at three consecutive intervals of not less than 15 minutes.

An alkaline battery is charged when there are no further rises in voltage with the current flowing when measured with a voltmeter at at least three consecutive intervals of 15 minutes. An alkaline battery may be

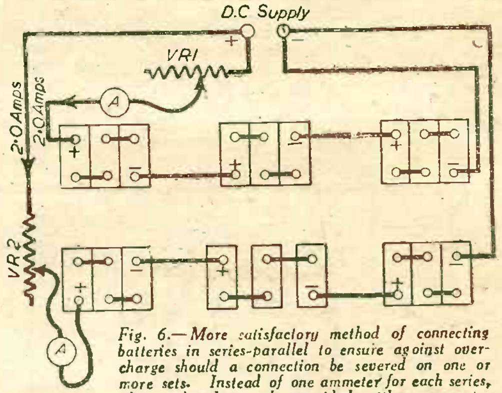


Fig. 6.—More satisfactory method of connecting batteries in series-parallel to ensure against overcharge should a connection be severed on one or more sets. Instead of one ammeter for each series, plugs and jacks may be provided, with one ammeter connected to jack for periodic checking.

safely "overcharged" without causing harm and it is, in fact, advisable to err on the side of overcharging. As the S.G. of the electrolyte of an alkaline battery is constant during charging and the cell gasses throughout the period of charge, no regard can be paid to either of these signs for determining when an alkaline battery is fully charged.

Designing All-wave Receivers

Notes on the Layout of an Efficient Four-valver

MOST commercial all-wave receivers are of the superheterodyne class, and the amateur is inclined to be a trifle bewildered by their complexity. While admitting that superheterodyne receivers as a class are more complicated than T.R.F. receivers, the writer is inclined to think that most amateurs are quite capable of designing their own all-wave receivers, provided they have thoroughly grasped the principles of superhet receivers.

By "design" is meant the physical form the receiver will take. An examination of a variety of commercial designs will reveal differences in the layout of parts, and the finished receiver may take a variety of shapes and sizes, according to the ingenuity of the designer. For example, it may be large enough to form an imposing piece of furniture or a real midget, notwithstanding that nearly all superhet receivers are designed around the same basic circuit.

The amateur, however, has not the same facilities as the research department of a commercial concern. He may not be able to procure the necessary I.F. transformers and, for want of the proper instruments he might not be able to align them properly even if he did get them. Fortunately there is a way out of the impasse by an adaptation of the short-wave converter scheme, in which the converter is not a separate unit but forms a part of the all-wave receiver itself. This does away at once with the necessity for changing aerial and earth, and also connecting up the batteries to the converter—always a troublesome business with the possibility of inferior results due to wrong connections.

Four-valve Circuit

The diagram gives the circuit of a receiver evolved designed for this purpose. It contains no parts which cannot be procured easily by the amateur, and provided it is soundly and sensibly constructed should give no trouble whatever in operation.

It should be pointed out at once that with this circuit superhet results are only possible on the short waves; on the medium and long waves the set functions as a 1-v-1 straight receiver of the ordinary type. This, however, is no disadvantage, since with modern valves the sensitivity and selectivity of such a combination are ample for all ordinary requirements, and it is only on the short-wave side of the spectrum that something superior as regards selectivity and sensitivity is required, and this the superhet alone can give with the minimum number of valves.

An examination of the circuit shows how the scheme operates. With the filaments alight, and all batteries connected, the receiver is ready to operate as a short-wave superheterodyne when S1 is in the left-hand position and S2 closed. All that pertains to the short-wave converter is on the left-hand side of the vertical dotted line, while the conventional three-valve receiver is confined to the right-hand side of the dotted line. By moving S1 to the right and opening S2, the receiver is ready to receive the medium and long waves.

To do this the .0005 mfd. gang condenser is manipulated in the usual manner. Since the aerial is connected to the aperiodic winding of the coil preceding the H.F. pentode with the aerial switch in its right-hand position, and the filament circuit of V1 is broken, it is obvious that the circuit will function as a straight three-valver. No trimmers are shown across the .0005 mfd. gang condenser, but it is essential that these be present and adjusted for optimum results. The reaction condenser is used in the normal manner when receiving the medium and long waves.

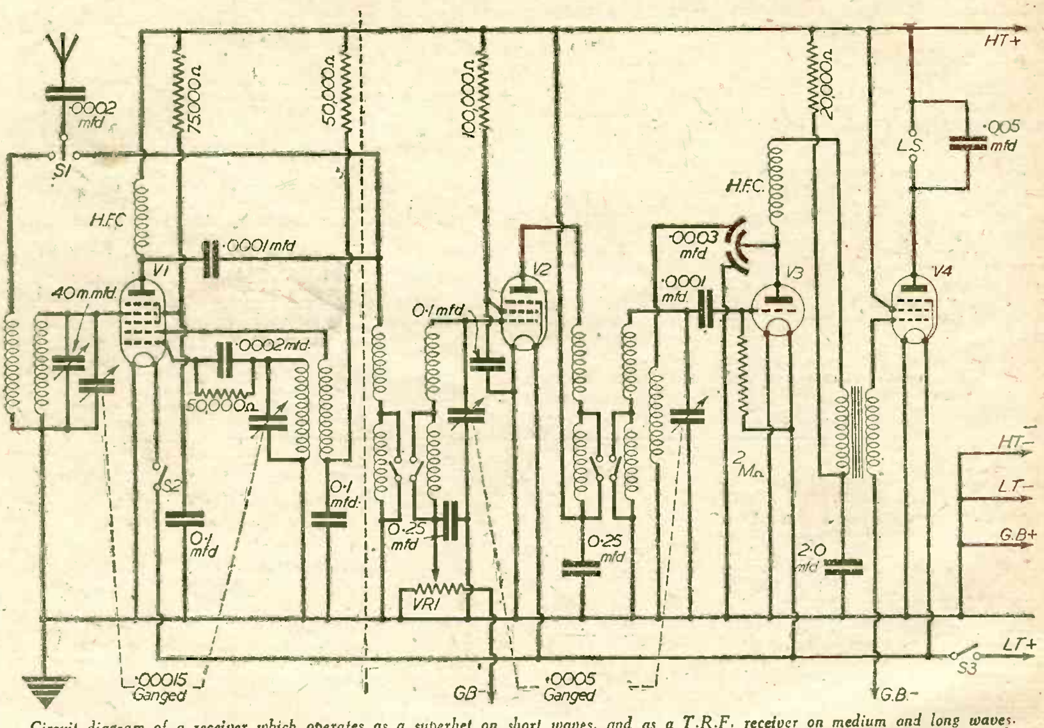
To convert the circuit into a short-wave superhet the .0005 mfd. gang condenser should be placed at the top of the long-wave band, or it may be placed at the bottom of the long-wave band in the region of 300 kilocycles or 1,000 metres. There is a distinct possibility, however, that the particular coils used may be more efficient on the medium waves, in which case the wave-change switch should be manipulated to bring the medium waves into service, and the gang condenser adjusted for either 545 kilocycles (550 metres) or 1,500 kilocycles (200 metres) the exact frequency which will give the optimum results being dependent upon the efficiency of the coils at various frequencies. There is, of course, nothing to prevent the choice of a frequency in between these limits, but if the frequency happens to be in a congested part of the broadcast band there is a likelihood of second channel interference, so that the extremes of the band should be chosen. Whatever frequency is chosen constitutes the intermediate frequency of the superhet receiver, and the gang condenser should not be touched during the subsequent exploration of the short-wave band, which is carried out on the .00015 mfd. short-wave gang condenser.

S.W. Section

On the short waves the heptode (V1) is brought into service, with its associated aerial and oscillator coils. In the anode circuit of the heptode is an all-wave H.F. choke of good quality, and this valve passes its output via a .0001 mfd. condenser to the aperiodic winding of the I.F. transformer. Coil changing can be carried out in the same manner as normal short-wave practice, and it should be noted that the two short-wave coils (the aerial and oscillator coils) are identical, the necessary frequency shift being achieved by means of the 40 m.mfd. trimmer or tracking condenser, which is simply manipulated to bring the stations to their loudest after they have been tuned in by the .00015 mfd. gang condenser.

For very weak S.W. signals the reaction condenser may be brought into play, taking care that it does not cause oscillation. Volume on all signals can be controlled by means of the potentiometer, VR1, which is connected to V2 rather than to V1 as otherwise it would not be able to control the volume when the medium and long waves are being received.

This is an efficient solution to the all-wave problem. It is worth while having a good slow-motion drive mechanism to both the gang condensers—the ease of handling amply repays the added trouble and expense. As far as the actual construction goes, it is best to keep the wiring as short and direct as possible; erect a screen between the converter and the rest of the set, and avoid hasty workmanship.



Circuit diagram of a receiver which operates as a superhet on short waves, and as a T.R.F. receiver on medium and long waves. The S.W. mixer-oscillator circuit is on the left of the vertical broken line, which indicates the position of the metal screen between the two sections of the complete receiver.

GALPINS

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HEAVY DUTY CABLE, V.I.R.. and braided, in first-class condition, size 37/13, lengths 30 to 40 yards. Price by the length, 5/- per yard, carriage paid, or 7/- per yard for short lengths, carriage paid.

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½ WATT WIRE END Resistances, new and unused, assorted sizes (our assortment), 5/6 per doz. ; post free.

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TUNGSTEN CONTACTS, 3/16in. dia.. a pair mounted on spring blades, also two high quality pure silver contacts 3/16in. dia., also mounted on spring blades, fit for heavy duty, new and unused ; there is enough base to remove for other work. Price the set of four contacts, 5/-, post free.

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RESISTANCE MATS, size 8in. by 6in., set of four, 80-80-150 and 690 ohms, to carry ½ to ¾ amp. Price, set of four, 5/- post free.

LARGE TRANSFORMER, input 230 v., 50 cycle. Output, 2,000-0-2,000 volts at 200 m/A., and 11 volt L.T. winding. Price £3/15/0, carriage paid.

MOVING COIL Ampmeter, 2½in. dia., panel mounting, reading 0-20 amps., F.S.D. 15 m/A. Price 30/-, post free.

CROMPTON DYNAMO, shunt wound, output 50/75 volts 25 amp., 4 pole, speed 1,750 r.p.m., massive construction, in perfect working order. Price £9, carriage paid.

MOTOR DRIVEN PUMP, 100 v. D.C. motor. "Keith Blackman," ¼ H.P. ; ¾in. inlet and outlet, gear type pump, in perfect working order. Price £5, carriage paid. Ditto 220v. D.C. motor, ½in. inlet and outlet. Price £7/10/0, carriage paid.

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Practice Type Keys :			
Metal U.S.A. pattern		4	6
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8in. P.M. Loudspeakers in polished wood cases, size 10¾in. high by 11in. wide by 6in. deep, with output transformer tapped for pentode and triode	3	5	0
Or in Rexine-covered cabinets (same size) in grey, blue or brown...	3	5	0
Short-wave Tuning Condensers :			
Wavemaster, ceramic insulation, .0001, .00016, .0002, each		5	0
Eddystone Cat. No. 978 Trimmers		4	9
Cyldon, ceramic insulation, .000025		3	6
Mica Trimmers :			
Mica, high grade trimmers, in 40pf, 250pf, 450pf, 100+100 pf. ... ... each		1	0
Crystal Filters :			
Simmonds Band Pass Crystal Filter Units 465 kc/s, available in alternative bandwidths, 300 c/s and 1,500 c/s each	4	10	0

We have facilities for the Service of communication and normal broadcast receivers. Private customers must please realise that GOVERNMENT PRIORITY repairs necessarily take precedence.

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ELECTRADIX

Supplies of some of these bargains are very limited.

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HUN Ships Wireless, ex Admiralty Prize 8-valve Telefunken ship wall Receiver in large cast aluminium water-tight case ; complete with valves, **£17 10s.** A ditto set at **£17.** One 5-valve Telefunken auto Radio Alarm "SOS" fitted 2 master relays, 4 auto selectors and 20 sub-relays. Screened coils, power transf. for 150 volts. All for ship W/L. **£24 10s.** Two metal enclosed Rotary Deck Aerials for direction finding reception. Complete with cabin wheel, etc., for above, **£6 10s.** each. One Telefunken three-valve S/W Ship Receiver 13.9 to 100 metres, less one valve, **£4 15s.**

B.T.H. Double electric gramo turntables, A.C./D.C. standard pick-ups mains, in steel cabinet 13in. x 31½in. x 10in. For entertainment, works or canteen, **£23.**

G.E.C. Radiogram, 5-valve, A.C. mains, complete in walnut console, in good order **£14.**

MOTORS AND DYNAMOS. Croydon D.C. shunt dynamos or motors, 100 volts, .1 amp., **28/-.** ¼ h.p. 110 and 220v. D.C. motors, £4. Induction ¼ h.p. 230v. 1,425 revs., 50 cycles, A.C., **£4 15s.** 50v., 8 amp., 2,000 rev. Dynamo, **£5 10s.** ¼ h.p. D.C. Motor, 1,750 revs., ball bearing, 500 volts, with pulley, **£5.** 240 volts 1 h.p. City Electric ; 1,000 revs., ball bearing ; 2-groove pulley, **£10.** 2 h.p. 220 volts E.D.C., 1,400 revs., **£15.** 3 kW. Dynamo, 110 volts, .27 amps, **£17.** 460 volts, 6 h.p. D.C. Siemens Bros. 1,680 revs., **£25.** 500 volts, 5 h.p. Crypto, 2,250 revs., double end shaft, **£27 10s.**

Winter is coming. **Windmill builders** want a slow-speed 12 volt automatic Dynamo, 600/1,000 revs., .10 amp. output, Price **£5.**

ROTARY CONVERTORS, radio type, fitted smoother and filters, are scarce. We have the following new machines from Canada : 75 watt size, input 6 volts D.C. to 100 volts, 50/60 cycles A.C., **£12.** Next size, 100 watts input 110 volts D.C. to 110 volts, 50/60 cycles A.C., **£14 10s.** Another size, 150 watts, input 220 volts D.C. to 110 volts, 50/60 cycles A.C., **£16 10s.** We have some large Crypto and E.D.C. machines and also 500 cycle H.F. machines and smaller ones, 50 volts D.C. to 75 volts, .25 amp. A.C., 50 cycles, **£3 10s.**

3½ kW. Electric Welding Dynamo by Siemens Bros., 65 volts, 55 amps., 1,380 revs., **£23 10s.** A.C. to D.C. Motor Generator, 210 volts A.C. to 15 volts, 12 amps. D.C., 1,400 revs., **£15.**

CHARGERS. Tungar double circuit 200/240v. A.C. mains to D.C. 60 volts, 10 amps., **£16.** Davenset Garage Charger, complete, as new, A.C. mains to 30 volts, 6 amps., D.C., **£14.** Westinghouse Metal A.C. to 8 volts, 15 amps., **£22.** Ditto to 8 volts, 32 amps., D.C., **£35.**

FOR THE QUICKEST WAY TO ELECTRADIX HOUSE see MAP on Page 483, October issue of this journal.

When sending enquiries, please enclose stamped, addressed envelope. Thank you.

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Impressions on the Wax

Review of the Latest Gramophone Records

Columbia

A WORK which is unique in music, and which one must listen to with an open and appreciative mind, is Borodin's Second Symphony. The composer came of Caucasian ancestry; of a long line of near Asiatics-Orientals, and this undoubtedly influenced his melodies, harmony and rhythm. It is said that it took Borodin 10 years to compose this great symphony.

The work is recorded by The Hallé Orchestra, and it is fitting that it should have been conducted by Constant Lambert, as it was the very first work he conducted in public when he was an 18-year-old student at the Royal College of Music, and ever since then he has specialised in the performance of this grand composition. It is recorded—in Seven Parts—on *Columbia DX*1125—1128, the remaining side of the latter containing Andantino from "Divertimento in D" (Mozart 251), which is also played by The Hallé Orchestra, but this time under the baton of Laurence Turner.

Isobel Baillie—soprano—has recorded on *Columbia DB*2120, two charming songs which reveal the great beauty of her voice. One is "To a Waterlily," by Grieg, and the other "Sister Dear"—Folk Song Trans. by W. Legge; Music, Brahms.

Another record which will, I feel sure, have a wide appeal is *Columbia DB*2118. On this Patricia Burke has recorded three fine numbers from that popular play "The Lisbon Story," and she is accompanied by the London Hippodrome Orchestra conducted by Debroy Somers. The numbers are, "Never Say Goodbye," "Some Day we shall Meet Again" and "Follow the Drum," all of which are by Harold Purcell and Parr Davies.

Albert Sandler Trio has made a most pleasing record out of "Kisses in the Dark" and "Souvenir." It is another fine example of the perfectly balanced team work of Albert Sandler, Reginald Kilby and Jack Byfield. *Columbia DB*2119.

Coming to the *FB* series, the first I select is one by that ever popular artist Turner Layton, who sings for us "Comin' In On a Wing and a Prayer" and "You Rhyme with Everything that's Beautiful." The number is *Columbia FB*2953.

For the dance enthusiasts, I recommend *FB*2952 and *FB*2954. The former is by Carroll Gibbons and the Savoy Hotel Orpheans playing "When I Look at You" and "Never Say Goodbye"—both foxtrots. On the second record (*Columbia FB*2954) Victor Silvester and his Ballroom Orchestra have recorded "Silver Wings in the Moonlight"—slow foxtrot—and "Canadian Capers," a quickstep.

Parlophone

I PLACE at the top of the Parlophone releases for this month, *Parlophone RO*20523, for the very good reason that it is the latest record made by Richard Tauber. For this recording, he has selected two very popular, and equally pleasing, numbers, one from "The Dancing Years" and the other from "The Lisbon Story." The first is "Memory is my Happiness," and the second "Someday we shall Meet Again" and, needless to say, Tauber sings them, well, as only Tauber can.

Geraldo and his Orchestra, on *Parlophone F*1988 have made a good recording of "Take It From There" and "Never a Day Goes By"—both foxtrots. The vocals are taken by Dorothy Carless. "Manhattan Holiday"—a snappy quickstep, and "Dizzy Fingers" are the two pieces selected by Ivor Moreton and Dave Kaye for their record this month. Their choice is certainly good, but their pianoforte performance is even better, as the compositions provide them with plenty of scope for their undoubted skill. *Parlophone F*1987.

The gay rhythm of a Tango usually makes pleasing listening, and this is particularly so in the case of "Romanesca," a fine tango, which is played by "The Organ, the Dance Band and Me" on *Parlophone F*1990. On the other side of the disc this popular team give us "My Shadow Misses Your Shadow," a fine foxtrot.

The 1943 Super Rhythm-Style Series No. 161 is on *Parlophone R*2882, and Harry Parry and his Radio Sextet have recorded "A Hundred Years from To-day" and "Tea for Two" for this record.

H.M.V.

YEHUDI MENUHIN heads my selection this month of the latest H.M.V. releases. He has recorded, on *H.M.V. DB*6158, "Negro Spiritual Melody"—from the Largo of the "New World" Symphony by Dvořák arranged Kreisler—and, on the other side, Schubert's "Ave Maria" arranged by Menuhin.

The first composition is rich in melody and was written during the period when Dvořák was director of the National Conservatory of Music in New York. Menuhin gives a wonderful performance, being quick to react to the, shall I say, mysterious charms of the Negro and Indian melodies, some of which he introduced.

In the second solo Menuhin treats us to his own arrangement of the ever popular short recital piece Schubert's "Ave Maria" and, as in the previous recording, reveals his true mastery of the violin.

I follow this record with two by another great artist, namely, Moiseiwitsch, who has made a superb recording, on *H.M.V. C*3310 and *C*3311—Four Parts—of "Sonata in G Minor Op. 22," by that noted Russian composer Medtner.

Before leaving the 12in. records, there is one more which I would like to add to my selection, and that is *H.M.V. C*3361. On it is recorded Selection "Martha"—Two Parts—(Flotow) by The Grand Opera Orchestra.

The latest release of H.M.V. 10-in. records is rich in vocals, and, commencing with one in the *DA* series, I recommend *DA*1834, on which John McCormack, tenor, has made an exceptionally fine recording of "White in the Moon the Long Road Lies" and "The Street Sounds to the Soldier's Tread."

On *H.M.V. B*9338 one can hear two duets which are rendered in a most delightful manner by those two great artists, Gwen Catley (soprano) and Dennis Noble (baritone). They have taken "Give Me Thy Hand, Oh Fairest" ("Don Giovanni") and "The Manly Heart" ("The Magic Flute") for this recording, and they are accompanied by The Hallé Orchestra under the conductorship of Warwick Braithwaite.

Another vocal record which calls for comment is *H.M.V. BD*1053, on which Robert Wilson, tenor, has made two good recordings. He sings, in a most pleasing manner, "Heaven Alone" and "Jeanie With the Light Brown Hair."

Master Thomas Criddle, boy soprano, gives a noteworthy rendering of "Smilin' Through" and "Bless This House" on *H.M.V. BD*1052.

Noel Coward scores a direct hit with his latest recordings on *H.M.V. B*9336. I like, in particular, "Don't Let's Be Beastly to the Germans"; it is a good example of his subtle wit and satire.

On the other side of the disc, Noel Coward gives us a fine recitation, "The Welcoming Land," Clemence Dane, thus providing a record of distinctive entertaining value.

Now for a couple of dance records. First, I recommend "A Fool With a Dream," which is linked with "Don't Get Around Much Any More" on *H.M.V. BD*5813. These are two good numbers, well played by Joe Loss and his Orchestra.

On the second record, Glenn Miller and his Orchestra have made a good recording of "Runnin' Wild" and "Pavanne," both foxtrots. *H.M.V. BD*5805.

Open to Discussion

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

Silvering S.W. Coils

SIR,—I noticed in a recent issue of PRACTICAL WIRELESS you advised against the use of "patent" silvering compounds for use on the wire of S.W. coils, as they usually contain mercury.

Here is one that really does *silver*, and is very easy to use.

Take one part silver nitrate (lunar caustic), 2 parts cream of tartar, and five parts common salt.

(The silver nitrate may be obtained from the local chemist.) Crush the above chemicals together and mix with a little water into a thin cream. Store in the dark.

For use, stretch the wire to be silvered (bare copper or tinned copper) between two convenient supports, clean well with emery paper, followed by a wipe with a soft cloth.

Then take some of the mixture on a piece of cloth, and rub on to the wire, all along it. Afterwards, wash off any excess paste and dry.

The paste can also be used for silver plating switch contacts, etc.—J. RUNDELL (Orpington).

B.B.C. Programmes

SIR,—Mr. W. J. Haley, the newly appointed Editor-in-Chief of the B.B.C., is to be congratulated on his frankness and honesty, for in a press interview he said: "I have no specialised knowledge of broadcasting."

There was no real occasion for Mr. Haley to apologise for this, for by British standards it is quite frequently the highest qualification to know as little as possible of the subject one is appointed to manage and control. Gilbert and Sullivan had this fact in mind in H.M.S. *Pinafore*, where one of the leading characters sings: "When I was a youth I served a term As Office Boy in an Attorneys Firm; I cleaned the windows and washed the floor. And polished up the handle of the big front door. I polished up the handle so manfullee, That now I am the Ruler of the Queen's Navee."

And to-day, practically wherever we look, we see men in the highest authority whose main qualification for the jobs they are holding down is that they served their time in polishing up big door handles. And it will be generally agreed that the directors of the B.B.C. themselves do not suffer from any specialised knowledge of broadcasting, and that their own appointments are often made as a reward for political services. They also seem to have been very successful "door-knob polishers."

The ignorant and ill-informed licence holder might jump to the conclusion that such men as George Black or C. B. Cochran provide the type from which the B.B.C.'s Editor-in-Chief of Programmes should be selected, but he entirely overlooks their fatal disqualification, in that they do know their subject from A to Z, and are genuine masters at presenting programmes which meet with all-round general approval.

We will wish Mr. Haley all success in his new appointment, in spite of his self-admitted lack of specialised knowledge, and might one offer him some respectful advice as to how to make good in it? Let him, as one of his very first jobs, kill the crooner and croonette, the stale wise-crack of tenth-rate "comedians," the nasty noises on the saxophone, and the ceaseless plugging of sickly sentimental "vocals" imported from Tin Pan Alley, and liquidate quite a lot of "dug-ins" whose efforts at entertainment only bore us stiff, and leave us no alternative but to switch off.

If Mr. Haley can do these things, we won't worry in the least as to how his appointment came to be made, or whether door-knobs had anything to do with it or not. We will be content and delighted to welcome him as our deliverer from the deadly boredom of the present programmes.

Go to it, Mr. Haley! A vast field and boundless opportunities are in front of you. You will have our sincere appreciation and heartfelt thanks if you give us some improvement in the brain and soul destroying Tin Pan Alley programmes of the B.B.C.—"TORCH."

Station Identification

SIR,—In answer to G. Reeve, Norton-on-Tees, who requested station identification, I should like to offer the following information.

PRL8, Radio Nationale, is the new 50 kilowatt transmitter situated at Rio de Janeiro, Brazil, and operating on 25.60 m., 11 720 kc/s daily at 20.30 B.S.T. for 40 minutes. Reception is usually R9 here in Wales. Transmission is directionally beamed to Great Britain.

The other station on 25 m., 11 m/cs I presume to be Brazzaville, situated in French Equatorial Africa on the border of the Belgian Congo, operating on 25.06 m., 11,790 kc/s., call sign FZ1 or 1, which gives news in English at 19.50 B.S.T. (approx.).

Here are a few stations received in N. Wales, where there are considerable high hills with metal deposits which tend to absorb radio waves. Numerous W. stations, also DJC and half-a-dozen others. Italian Broadcasting System on 19, 25, 31, 41, 47 m. bands. Radio Belge, which is Leopoldville, 25 m. band (Belgian Congo). Allied Nations Radio North Africa (Algiers), 25 m. WRUL, WBOS, WKLJ (19 m.); WCRC (25 m.); Vatican radio (31 m.), HVJ; WKRD (23 m.); WOA4 (28 m., 10 mc/s); HCJB (24 m.), Quito, Ecuador: dialogue, "The Voice of the Andes Mountains."

Can any reader assist me in identifying a station on the 31 m. band, call—CSW?—L. H. COX (Llanbedrog, N. Wales).

A Well-equipped Shack

SIR,—Readers may be interested to hear of the drastic changes that have been made in my "shack" these last three years. My rig has changed from a simple 0-v-2 through gradual changes to the layout described below. This gear, I might add, has been made up from components that have laid dormant in the "shack" from pre-war days, and the time taken elaborating the gear has most certainly been well worth while. Firstly, the receiver: this now consists of a 6J7 tuned R.F. stage, 6K8 mixer and oscillator, two 6K7 I.F. stages and a 6J5 2nd detector (anode-bend); a 6Q7 as magic-eye amplifier, A.V.C. and noise limiter, and the magic-eye a 6AF6; beat-frequency oscillator is a 6J5; rectifier a Mazda VV5; the amplifier consists of a 6J7; 6J7 triode-connected feeding into two 6F6's in Class AB2 running at about 15 watts of audio and this is used with a 5Y3 rectifier. The amplifier is used with the receiver or for the reproduction of gramophone records. The aerial is a 67ft. "Windam" impedance-matched to 14,200 kc/s (a relic of pre-war amateur days!) and this is of 14 S.W.G. enamelled copper and about 55ft. in the air. This station follows the principle of "build your own," and here even the mains transformer and chokes boast this heading!

The idea of rebuilding came to me whilst on seven days' leave from the R.A.F., and seeing the gear laying about to no useful purpose I started building.—LEONARD F. CROSBY (Clapham).

Replies to Queries

A.V.C. Circuits

"I wish to add A.V.C. to my superhet, which is a mixture of commercial and home-made apparatus. There are two I.F. stages and although a double-diode-triode is not fitted, I can easily re-wire the second detector stage to take this valve. Could you supply me with a suitable high-efficiency circuit for the purpose?"—L. T. (Rotherham).

UNFORTUNATELY there are many types of A.V.C. circuit and, therefore, without a diagram or details of your receiver, and full details of the type of set you need, we cannot supply constructional or circuit data. In its simplest form A.V.C. would probably be of little use in a really high-class superhet. Amplified, delayed or a combination of these is to be preferred, and if the receiver is for short-wave use it may also be desirable to include a circuit which also gives noise suppression.

Battery Leads

"My receiver is battery-operated and I have a small cabinet which I wish to use. Unfortunately, there is only room at the top for the set and the batteries must therefore go down below. To make the appearance tidy I was thinking of taking H.T. and L.T. leads all together up the back of the set, but I wonder if this will lead to any trouble, or whether they should be well separated. Perhaps you could help me in this direction."—W. P. (Hayes).

H.T. and L.T. leads may be bunched, and the only point to watch is that insulation is adequate to prevent short-circuits between the two sets of leads. To keep the appearance neat the leads should be laid side by side and tied with good twine in half-hitches throughout the length. It is also possible to place loudspeaker leads with these, but the aerial and earth leads should preferably be kept at the opposite side of the cabinet, and if the aerial lead has to cross over the speaker leads it would be preferable to allow a long length of wire for the lead-in, let this droop to the floor and then rise up to the aerial terminal.

Making a S.W Choke

"I am building a 1-valve S.W. set. Is it possible to make my own H.F. choke, using a glass tube? If so, how many turns should I use and what gauge of wire?"—R. B. (Clapham).

AN efficient H.F. choke of the type mentioned is used in the Simplest One Valver. The tube is a standard chemical test-tube having a diameter of ¾in., and 150 turns of No. 36 gauge enamelled wire should be wound on in five equal sections of 30 turns each. Wind each section as a rough pile and leave a gap of about ⅛in. between each pile, and attach the ends of the winding to the tube by means of sealing wax or ordinary insulating tape.

Meter Resistance

"I have a radio-meter and am not certain regarding resistance tests with the meter. The L.T. resistance is marked 200 ohms, and the H.T. is marked 8,000 ohms. Please will you explain this to me?"—D. R. (Wealdstone).

THE resistance values marked on the instrument have nothing to do with resistance testing. They merely give the resistance of the instrument from which its suitability for making various voltage tests may be gained. For instance, the H.T. resistance, that is, when the H.T. terminals are used, is 8,000 ohms, and thus if the H.T. voltage range is 120 volts, this means that a current of 15 mA will flow and this means that it will be unsuitable for measuring the voltage on the screen of a valve or a low-voltage tapping on a mains unit. By this we mean that it will give an incorrect reading as the meter will take much more current than the screen or the mains unit is designed to pass and thus there will be a voltage drop. Generally speaking, for measuring detector voltage, screen voltage and mains units a meter with a resistance of at least 7,000 per volt is essential.

Stage Gain

"I am rather at a loss to know how to compute the gain of an L.F. stage where resistance-capacity coupling is concerned. I believe that the anode load should be as high as possible, but this in turn governs the anode current and, incidentally, the voltage drop across the resistance. On the other hand, an optimum load value is always given for an output valve. Why not for an L.F. valve? Perhaps you could help me on these points."—J. B. (Slough).

THE anode resistance value must be chosen both in conjunction with the valve impedance and with the H.T. voltage which is available. Obviously an increase beyond a certain value will be of little use owing to the voltage drop, but the amplification of the stage is dependent upon the value of the load resistance, just as the output stage has to be matched, and most manufacturers give suitable values for the resistance. We suggest you follow the series of articles now appearing in PRACTICAL WIRELESS entitled "Low Frequency Amplifier Design."

RULES

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

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

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

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

Send your queries to the Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. The coupon on page iii of cover must be enclosed with every query.

Wearite Universal Coils

"I have a pair of Wearite coils called the Unigen, and was thinking of using these in one of your sets. I believe you used a Universal Wearite coil in the Leader Three set, and I should like to know whether the coils I have got could be included in place of the Universals. Can you tell me the difference between the two types of coil and which is the more efficient?"—H. T. O. (York).

THE Unigen coils are a later development than the Universal coils and are an improved form of the latter. In addition to being more compact, the windings are modified, and in the Unigen coils the primary winding is tapped and may be switched in addition to the secondary winding, thus providing maximum results on both wavebands. If you wish to use these coils in a standard three-valve circuit we refer you to the Centaur Three, for which a blueprint has been issued, number PW.64, price 1s.

Gramo. Amplifier

"I want to get an amplifier (A.C.) for playing gramophone records. What do you recommend for an ordinary house? Would Nos. WM 387 or WM 392 of Blueprint Service be suitable, please?"—G. T. (Boscombe).

THE problem of suitable volume is not simple of solution. While one listener prefers an output of 10 watts, another will be quite satisfied with only 1 watt. For all normal purposes, where you are keen on obtaining real quality, a fairly large output is advised, although the amplifier should not be run "all out." In this way better quality is obtained, as you are always working well within the capacity of the output stage. The Enthusiast's Power Amplifier will deliver about 10 watts, while the second print you mention is only a 5-watt amplifier. Unless you have a very large room and a really good speaker capable of handling the large output, and mounted on a suitable baffle, the 5-watt unit should be quite satisfactory for all normal home purposes.

Earth Connection

"The house into which I have moved has three-socket mains connectors, one socket being, I understand, an earth connection. Is this sufficiently reliable to warrant its use as an earth connection to my radio, and, if not, is there any way of getting a good earth as the building is let off in flats and I am on the upper floor?"—P. W. (Islington).

THE earth pin may certainly be used as an earth point for your receiver and would no doubt give very much better results than would be obtained by a long lead running down to ground level, although the mains earth pin eventually has to go to earth. The connection from the mains supply is no doubt made to iron girders in the building or some similarly well-earthed metal body and, therefore, may be regarded as quite efficient from a radio point of view.

Classified Advertisements

LITERATURE, MAPS, etc.

RADIO SOCIETY OF GREAT BRITAIN invites all keen experimenters to apply for membership. Current issue "R.S.G.B. Bulletin" and details, 1/-. below: **AMATEUR RADIO HANDBOOK** (300 pages), paper cover, 4/-; cloth, 6/6. Radio Handbook Supplement (140 pages), paper cover, 2/9; cloth, 5/-.—R.S.G.B., 28-30, Little Russell Street, London, W.C.1.

WEBB'S Radio Map of the World. Locates any station heard. Size 40in. by 30in., 4/6, post 6d. On linen, 10/6, post 6d.—Webb's Radio, 14, Soho Street, London, W.1. GERard 2089.

MORSE & S.W. EQUIPMENT

FULL range of Transmitting Keys, practice sets and other equipment for Morse training —Webb's Radio, 14, Soho Street, London, W.1. 'Phone: GERrard 2089.

"H.A.C." Short-wave Receivers. Famous for over ten years. Improved one-valve model now available. Complete kit of components, accessories, with full instructions—only 16s., postage 6d. Easily assembled in one hour. S.A.E. for free catalogue.—A. L. Bacchus, 109, Hartington Road, London, S.W.8.

RECEIVERS & COMPONENTS

AMERICAN LEASE LEND VALVES B.O.T. prices. For replacement only. 1A5GT, 1C5GT, 5Y3G, 5Z4GT, 35Z4GT, 35Z5GT, 11/-. 12F5GT, 12SF5GT, 9/2. 6A8GT, 12A8GT, 12SA7GT, 6SA7GT, 14/-. 6F6GT, 12J7GT, 12SK7GT, 12SJ7GT, 35L6GT, 6K7GT, 36, 1A7GT, 12/10. 12Q7GT, 12SQ7GT, 45, 11/7. 25A7GT, 15/3, and many others. British and American.

MIDGET, high-gain aerial and H.F. coils, no reaction, medium wave only, fitted trimmers, ideal for midget T.R.F. receivers, at 8/6 pair.

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CONDENSERS. Tubular paper, wire ends, .1 mfd. and .01 mfd. 9d., 8/- doz., electrolytics (cardboard) 50+100 mfd., 10v. wkg., 15v. surge, 2/6 each.

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PAXOLIN panels, sockets marked, A. E. Pick-up 6d., ext. L.S. 4d.

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Mains transformers, speakers, volume controls, sleeving, etc., etc. Licence to export to Northern Ireland. List available. Stamped envelope with all inquiries please.

Postage on all orders—

O. GREENLICK, 34, Bancroft Road, Cambridge Heath Road, London, E.1. (Stepney Green 1334.)

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SCREWS and Nuts, assorted gross of each (2 gross in all), 10/-.

SOLDERING Tags, including Spade Ends, 6/- gross.

PHILCO 3-point Car Aerials, excellent for short-wave and home aerials, 7/6.

LIMIT Tone Arms, universal fixing for all types of Sound Boxes and Pick-up Heads, 10/-.

ACE "P.O." Microphones, complete with transformer. Ready for use with any receiver, 7/-.

(Continued in next column.)

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CIRCULAR Magnets, very powerful, 1¼in. diameter, by ⅜in. thick, 1/6 each, 15/- per doz.

ERIE Resistances. Brand new, wire ends. All low value from .8 ohms upwards. A few higher value are included in each parcel. ¼, ½, 1 and 2 Watt. 100 resistances for 30/-.

MULTICON Master Mica Condensers, 28 capacities in one from .0001, etc., etc., 4/- each.

SPECIAL ASSORTED PARCEL FOR SERVICE MEN

100 **ERIE** resistances (description above), 24 assorted Tubular Condensers; 6 Reaction Condensers, .0001; 12 lengths Insulated Sleeving; 75ft. Push-back Connecting wire; Soldering Tags, Screws, Wire, etc., 65/-. All brand new.

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MAINS DROPPERS, 0.2 amp., Pye, 3/6.

PUSH BUTTON UNITS. 7-way, 2/9, 8-way, 3/-; no knobs—a really fine job.

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DUAL RANGE COIL, with variometer tuning, fully screened in copper can, 2/3 each. No circuits.

SOLDER, 1lb. reels, fine all-tin instrument solder, 3/6 lb., or ¼lb. reel, 1/-.

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CRYSTAL DETECTOR, New type on ebonite base, 2/6 each. **CRYSTAL** and Catswhisker in metal box, 6d. each.

METER Resistances, wire wound, 50-120, 500, 1/- each.

SLEEVING, 3½d. per yard length. 1 doz. lengths, 3/-. Braided sleeving, 8d. per yard length, 7/- doz. lengths.

T.C.C. Tubulars, 0.1 mfd., 7d. each, 6/6 doz., also .01 mfd. at 6d. each, 6/- doz.

GRID LEAKS, 1.5 meg., 6d. 1.0 meg., 6d.

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TUBULAR Wire-end Condensers, assorted values, new, 3/- doz.

TELSEN Illuminated disc drives, useful for short waves, 2/6 complete.

CLARION slow motion dial, illuminated disc drives, useful for short waves, 2/6 complete.

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SINGLE SCREEN CABLES, 10d. per yd.

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TELSEN 2-pole speaker units, 3/- each.

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MAINS cable leads, 5ft., 1/- each.

Rubber connecting wire, 20ft., 1/6.

ODD TWIN H.F. CHOKES, 1/6 each.

EKCO .2 MAINS DROPPERS, S.H., 2/6 each.

AMERICAN Octal Base valveholders, 8d. each, 7/6 doz.

Postage must be included. No. C.O.D.

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RUBBER-COVERED stranded copper wire, 1d. yard. Heavier quality, 1½d. Very heavy quality, 2d. yard. Ideal for aerials, earths, etc. Enamelled copper wire, 24 gauge, ½ lb. reel, 2/-; 1 lb. reel, 3/6; 26 gauge ¼ lb. reel, 1/3. Tinned copper connecting wire, ¼ lb., 1/-. Postage extra.—Post Radio Supplies, 67, Kingscourt Road, London, S.W.16.

SWLs and Ex-transmitters: Exchange Cards! Send your QSL card, replies guaranteed: Pete Craw, Sea Breezes, Harsfold Road, Littlehampton, Sussex.

COULPHONE Radio, New Longton, Nr Preston. New goods only. Tungsram valves. Mains Transformers: 350 v. 120 m.a., 4 v. 8 a.; 4 v. 2½ a., 4 v. 1½ a., 33/6, 350 v. 120 m.a., 6.3 v. 3 a., 5 v. 3 a., 32/6. Celestion 8in. P.M., with transformer, 24/6. Rola P.M., less transformer, 5in., 20/-; 6½in., 22/-; 8in., 24/-; 10in., 28/6. Cored solder, 4/6 lb. Tinned copper wire, 2/3 ½ lb. 2 mm. systoflex, 3d. yd. Barretter resistors, 6/-. Line cord replacement resistors, 800 ohm, 2 adjustable tappings, 6/9. Parafeed L.F. Transformer 4:1, 4/9. 50 mfd. 12 v., 2/-; 25 mfd. 25 v., 2/-. Erie resistors, 1 watt, 9d.; ½ watt, 6d.; ¼ watt, 4d. Pushback wire, 100ft., 6/-. Switch cleaner, 2/3 bottle. Output transformer, 7/6. Bell transformer, 6/6. Valveholders, 1d. per pin. Stanelco electric soldering irons, 21/-. Tubular and silver mica condensers, all sizes. Volume controls with switch, 5/9. Less switch, 4/9. S.A.E. for stock list.

PERMANENT Crystal Detectors Tellurium-zincite combination. Complete on base. Guaranteed efficient, 2/6. Wireless crystal with silver cats-whisker, 6d. B.A. thread screws and nuts assorted, 2/6 gross. Ditto washers, 1/6 gross. Fibre washers, 1/6 gross. Assorted solder tags, 2/- gross. Single earphone, new, 750 ohms, originally made for Air Ministry, 5/6. Reconditioned headphones, complete, 4,000 ohms, 12/6. All postage extra.—Post Radio Supplies, 67, Kingscourt Road, London, S.W.16.

REWINDS—Mains and Output Transformers, Field Coils, promptly executed. Valves—good selection all types. Brand New B.V.A. Send S.A.E. for list.—A.D.S. Co., 261-3-5, Lichfield Road, Aston, Birmingham 6.

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"RADIOLOCATION."—Students of both sexes trained for important war-time Radio Appointments. Also for peace-time careers in all branches of Radio and Television. Boarders accepted. Deferment of Calling-up arranged. Low inclusive fees. College in ideal peaceful surroundings, 2d. stamp for Prospectus.—Wireless College, Colwyn Bay.

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Blueprints, 6d. each.

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The "Junior" Crystal Set	PW94*

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Summit Three (HF Pen, D, Pen)	PW37
All Pentode Three (HF Pen, D (Pen), Pen)	PW39
Hall Mark Cadet (D, LF, Pen (RC))	PW48
F. J. Camm's Silver Souvenir (HF Pen, D (Pen), Pen) (All-Wave Three)	PW49
Cameo Midget Three (D, 2 LF (Trans))	PW51
1936 Sonotone Three-Four (HF Pen, HF Pen, Westector, Pen)	PW53
Battery All-Wave Three (D, 2 LF (RC))	PW55
The Monitor (HF Pen, D, Pen)	PW61
The Tutor Three (HF Pen, D, Pen)	PW62
The Centaur Three (SG, D, P)	PW64
The "Colt" All-Wave Three (D, 2 LF (RC & Trans))	PW72*
The "Rapide" Straight 3 (D, 2 LF (RC & Trans))	PW82*
F. J. Camm's Oracle All-Wave Three (HF, Det, Pen)	PW78
1938 "Triband" All-Wave Three (HF Pen, D, Pen)	PW84
"Hurricane" All-Wave Three (D (Pen), Pen)	PW89
F. J. Camm's "Push-Button" Three (HF Pen, D (Pen), Tet)	PW92*
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Beta Universal Four (SG, D, LF, Cl. B)	PW17
Nucleon Class B Four (SG, D (SG), LF, Cl. B)	PW34B
Fury Four Super (SG, SG, D, Pen)	PW34C
Battery Hall-Mark 4 (HF Pen, D, Push-Pull)	PW46
"Acme" All-Wave 4 (HF Pen, D (Pen), LF, Cl. B)	PW83
The "Admiral" Four (HF Pen, HF Pen, D, Pen (RC))	PW90*

Mains Operated

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A.C. Twin (D (Pen), Pen)	PW18*
Selectone A.C. Radiogram Two (D, Pow)	PW19
Three-valve : Blueprints, 1s. each.	
Double-Diode-Triode Three (HF Pen, DDT, Pen)	PW23*
D.C. Ace (SG, D, Pen)	PW25
A.C. Three (SG, D, Pen)	PW29
A.C. Leader (HF Pen, D, Pow)	PW35C*
D.C. Premier (HF Pen, D, Pen)	PW35B
Unique (HF Pen, D (Pen), Pen)	PW36A
F. J. Camm's A.C. All-Wave Silver Souvenir Three (HF Pen, D, Pen)	PW50*
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A.C. 1936 Sonotone (HF Pen, HF Pen, Westector, Pen)	PW56
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A.C. Fury Four (SG, SG, D, Pen)	PW20
A.C. Fury Four Super (SG, SG, D, Pen)	PW34D
A.C. Hall-Mark (HF Pen, D, Push-Pull)	PW45*
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SUPERHETS.

Battery Sets : Blueprints, 1s. each.	
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A.C. £5 Superhet (Three-valve)	PW43
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The "Fleet" Short-wave Two (D (HF Pen), Pen)	PW91*
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Experimenter's Short-wave Three (SG, D, Pow)	PW30A*
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PORTABLES

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F. J. Camm's ELF Three-valve Portable (HF Pen, D, Pen)	PW65
Parvo Flyweight Midget Portable (SG, D, Pen)	PW77*
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"Imp" Portable 4 (D, LF LF (Pen))	PW86*

MISCELLANEOUS

Blueprint, 1s.	
S. W. Converter-Adapter (1 valve)	PW48A*

AMATEUR WIRELESS AND WIRELESS MAGAZINE

CRYSTAL SETS.

Blueprints, 6d. each.	
Four-station Crystal Set	AW427
1934 Crystal Set	AW444
150-mile Crystal Set	AW450*

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B.B.C. Special One-valver	AW387
Two-valve : Blueprints, 1s. each.	
Melody Ranger Two (D, Trans)	AW388
Full-volume Two (SG det, Pen)	AW392
A Modern Two-valver	WM409*
Three-valve : Blueprints, 1s. each.	
£5 5s. S.G. 3 (SG, D, Trans)	AW412*
Lucerne Ranger (SG, D, Trans)	AW422*
£5 5s. Three De Luxe Version (SG, D, Trans)	AW435*
Transportable Three (SG, D, Pen)	WM271
Simple-Tune Three (SG, D, Pen)	WM327
Economy Pentode Three (SG, D, Pen)	WM337
"W.M." (1934 Standard Three (SG, D, Pen))	WM351*
£3 3s. Three (SG, D, Trans)	WM354
1935 £6 6s. Battery Three (SG, D, Pen)	WM371
PTP Three (Pen, D, Pen)	WM389
Certainty Three (SG, D, Pen)	WM393
Minitube Three (SG, D, Trans)	WM396*
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Self-contained Four (SG, D, LF, Cl. B)	WM331
Lucerne Straight Four (SG, D, LF, Trans)	WM350
£5 5s. Battery Four (HF, D, 2LF)	WM381*
The H.K. Four (SG, SG, D, Pen)	WM384
The Auto Straight Four (HF, Pen, HF, Pen, DDT, Pen)	WM404*
Five-valve : Blueprints, 1s. 6d. each.	
Super-quality Five (2 HF, D, RC, Trans)	WM320
Class B Quadradyne (2 SG, D, LF Class B)	WM344
New Class B Five (2 SG, D, LF Class B)	WM340

Mains Operated.

Two-valve : Blueprints, 1s. each.	
Consoelectric Two (D, Pen) A.C.	AW403
Economy A.C. Two (D, Trans) A.C.	WM286
Three-valve : Blueprints, 1s. each.	
Home Lover's New All-Electric Three (SG, D, Trans) A.C.	AW383*
Mantovani A.C. Three (H.F. Pen, D, Pen)	WM374
£15 15s. 1936 A.C. Radiogram (HF, D, Pen)	WM401
Four-valve : Blueprints, 1s. 6d. each.	
All Metal Four (2 SG, D, Pen)	WM329
Harris' Jubilee Radiogram (HF, Pen D, LF, P)	WM386

SPECIAL NOTICE

THESE blueprints are drawn full size. The issues containing descriptions of these sets are now out of print, but an asterisk beside the blueprint number denotes that constructional details are available, free with the blueprint.

The index letters which precede the Blueprint Number indicates the periodical in which the description appears: Thus P.W. refers to PRACTICAL WIRELESS, A.W. to *Amateur Wireless*, W.M. to *Wireless Magazine*.

Send (preferably) a postal order to cover the cost of the Blueprint (stamps over 6d. unacceptable) to PRACTICAL WIRELESS Blueprint Dept., George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

SUPERHETS

Battery Sets : Blueprints, 1s. 6d. each.	
'Varsity Four	WM395*
The Request All-Waver	WM407
Mains Sets : Blueprints, 1s. each.	
Heptode Super Three A.C.	WM359*

PORTABLES

Four-valve : Blueprints, 1s. 6d. each.	
Holiday Portable (SG, D, LF, Class B)	AW393
Family Portable (HF, D, RC, Trans)	AW447
Tyers Portable (SG, D, 2 Trans)	WM367

SHORT-WAVE SETS. Battery Operated

One-valve : Blueprints, 1s. each.	
S.W. One-valver for America	AW429*
Roma Short-Waver	AW452
Two-valve : Blueprints, 1s. each.	
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Home-made Coil Two (D, Pen)	AW440
Three-valve : Blueprints, 1s. each.	
Experimenter's 5-metre Set (D, Trans, Super-regen)	AW438
The Carrier Short-waver (SG, D, P.)	WM390
Four-valve : Blueprints, 1s. 6d. each.	
A.W. Short-wave World-Beater (HF, Pen, D, RC, Trans)	AW436
Standard Four-valver Short-waver (SG, D, LF, P)	WM383*
Superhet : Blueprint, 1s. 6d.	
Simplified Short-wave Super	WM397*

Mains Operated

Two-valve : Blueprints, 1s. each.	
Two-valve Mains Short-waver (D, Pen) A.C.	AW453*
Three-valve : Blueprints, 1s.	
Emigrator (SG, D, Pen) A.C.	WM352
Four-valve : Blueprints, 1s. 6d.	
Standard Four-valve A.C. Short-waver (SG, D, RC, Trans)	WM391*

MISCELLANEOUS

S.W. One-valve Converter (Price 6d.)	AW329
Enthusiast's Power Amplifier (1/6)	WM387*
Listener's 5-watt A.C. Amplifier (1/6)	WM392*
Radio Unit (2v.) for WM392 (1/-)	WM398*
Harris Electrogram battery amplifier (1/-)	WM399*
De Luxe Concert A.C. Electrogram (1/-)	WM403*
New Style Short-wave Adapter (1/-)	WM388
Short-wave Adapter (1/-)	AW456
B.L.D.L.C. Short-wave Converter (1/-)	WM405*
Wilson Tone Master (1/-)	WM406
The W.M. A.C. Short-wave Converter (1/-)	WM408*

FREE ADVICE BUREAU COUPON

This coupon is available until November 8th, 1943, and must accompany all Queries and Hints.

PRACTICAL WIRELESS, NOV., 1943.

Published on the 7th of each month by GEORGE NEWNES, LIMITED, Tower House, Southampton Street, Strand, London, W.C.2, and printed in England by THE NEWNES & PEARSON PRINTING CO., LTD., Exmoor Street, London, W.10. Sole Agents for Australia and New Zealand: GORDON & GOTCH, LTD. South Africa: CENTRAL NEWS AGENCY, LTD. Subscription rates including postage: Inland 10s. 6d. per annum; Abroad 10s. per annum. Registered at the General Post Office for the Canadian Magazine Post.