A FIVE-STAGE QUALITY RECEIVER

Practical Wireless 9D EVERY MONTH

Editor F. J. CAMM

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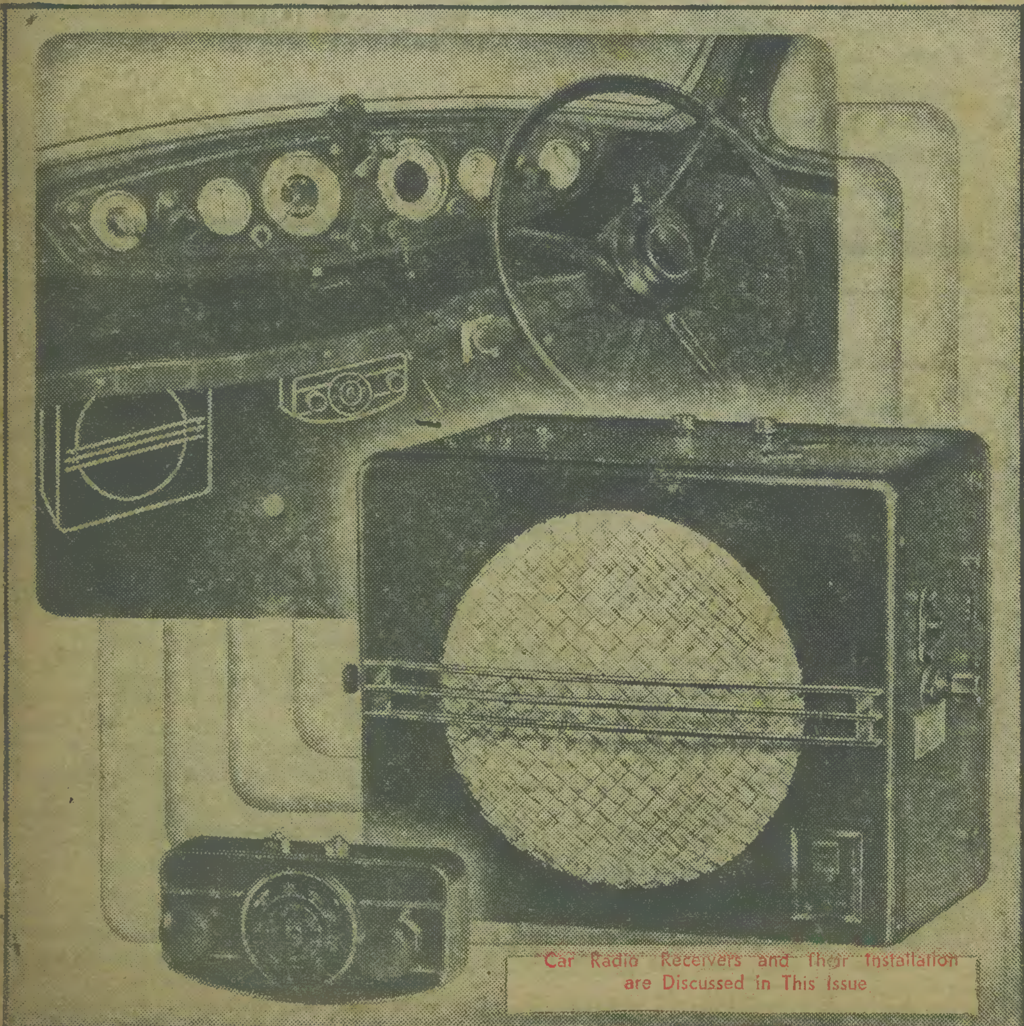

Car Radio Receivers and Their Installation are Discussed in This Issue

Practical Wireless
and PRACTICAL TELEVISION
Editor F. J. CAMM
12th YEAR OF ISSUE
Vol. XX. EVERY MONTH. No. 455. MAY, 1944.

COMMENTS OF THE MONTH BY THE EDITOR

Imported Radio Sets

THE Board of Trade has announced that a small number of domestic radio sets, bought on Government account in the U.S.A., will shortly be placed on the market for purchase by civilians, and as they become available they will be released to the trade through the British radio manufacturers and the pre-war importers, and will reach the public through normal trade channels.

Efforts are to be made to secure an even distribution throughout the country, and each set will have been tested on arriving here, although they are to be sold without guarantee. Why, therefore, waste time testing them?

The sets are of many types, but they have been classified into four price groups and an Order—The Imported Wireless Receiving Sets (Maximum Prices) Order, S.R. and O. 1944, No. 200—has been made by the Board of Trade in consultation with the Central Price Regulation Committee fixing the following maximum prices as follow:—

	Wholesaler (excluding Purchase Tax) £ s. d.	Retailer (excluding Purchase Tax) £ s. d.	Public (including Purchase Tax) £ s. d.
Group I ..	5 17 0	6 16 0	11 14 2
Group II ..	6 15 0	7 17 0	13 10 0
Group III ..	7 13 0	8 18 0	15 5 10
Group IV ..	8 11 0	9 19 0	17 1 8

The maximum prices for sales to wholesalers and retailers, respectively, are subject to a minimum cash discount of 2½ per cent. on payment within the calendar month following that of despatch. All the prices are inclusive of delivery charges.

The Board of Trade has also made the Imported Wireless Receiving Sets (labelling) Order, 1944 (S.R. and O. 1944 No. 201) which provides that every set shall bear a label showing the title of the Order, the American manufacturers' catalogue reference for the set, the serial number of the set, and the maximum retail price, including purchase tax. Our readers are advised that it will be an offence for any trader to acquire or supply any of these sets until its proper label is attached. It is also an offence to remove or deface the label. For compliance with the requirements of the Price Controlled Goods Order, invoices for these sets should include the American manufacturer's catalogue reference and the serial number of the set (if it has one).

The Radio Manufacturers Association recently issued a statement on this matter to correct erroneous impressions which may have been gained as a result of the publication in a Sunday newspaper of an article which was full of misstatements. They say that it is expected that the work of testing the first 10,000 imported receivers and of making them suitable for the British market will be completed by the time this issue is on sale. A further 20,000 sets will become available during the next three months.

Distribution

A QUARTER of the sets will be distributed through pre-war importers, and the remainder through British set manufacturers. These imported sets will be followed later in the year by a number of civilian wartime receiving sets which are being made to a standard design by the British radio manufacturers with the approval of the Government. The prices of these sets will be covered by maximum price orders.

We hope that these American sets will be adjusted to eliminate the troubles which have been experienced with American sets hitherto sold to the British public. All American sets are made to suit the standard American voltage of 110 volts, and the usual method of doing this is to use a resistance cord between the mains and the set. This is by no means satisfactory. They overheat, the resistance does not remain constant, with the result that the valves become overloaded and soon blow. There are other and more satisfactory means of making 200/250-volt mains suitable for 110-volt receivers.

It is also to be hoped that replacements will be imported so that receivers which become damaged can be serviced. We also hope that the receivers will be accompanied by adequate service instructions for dealers. There have been many complaints of the ignorance of dealers dealing with American receivers.

Car Radio

DEFENCE Regulation 8 (3A) which provides that apart from certain authorised exceptions, no person should use or have in his possession or under his control any receiving apparatus stored in a road vehicle, has been revoked by an Order in Council. Wireless receiving apparatus may now be carried on road vehicles without a special permit, apart from the ordinary 10s. receiving licence where required under the usual conditions.

An owner of a receiving set which was impounded from a vehicle by the police in 1940 should apply to them for the return of his set.

Readers' Queries

OWING to the shortage of staff, we ask for the indulgence of readers and request them to refrain from submitting queries until further notice. Readers will agree that our first duty is to produce the journal, and the demands made upon the clerical staff by the Services leaves us with no alternative but to restrict our query service until the situation changes.

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

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

ROUND THE WORLD OF WIRELESS

Imported Radio Sets

THE retail prices of the radio sets purchased recently from the United States have now been fixed by the Board of Trade. They range from £11 14s. 2d. to £17 1s. 8d., including purchase tax. Every effort will be made to ensure even distribution throughout the country, and sets should reach the shops shortly.

B.B.C. Staff

MR. ROBERT FOOT, new general director of the B.B.C., stated in London recently that to meet war needs the B.B.C. had increased the staff from something like 3,500 to 11,500.

They had the greatest difficulty at the time of Munich in finding people who could send out Mr. Chamberlain's speeches in French, Italian and German. They had no foreign language programme.

Now they were broadcasting in 47 different languages, a tremendous expansion that had "certainly got their administrative side rather knotted round."

I.E.E. Meeting

AT a meeting of the Institution of Electrical Engineers, held in the Lecture Theatre of the institution at Savoy Place, Victoria Embankment, London, W.C.2, on March 2nd, a lecture on "Internal Discharges in Dielectrics, their Observation and Analysis," was given by A. E. W. Austen, Ph.D., and Miss W. Hackett (Associate Member).

Radio for U.S. Troops

DURING the coming invasion of the Continent, American troops will have their own radio entertainment.

Plans are being made for a regular service to be sent out over the American Forces network from studios established in Mayfair.

Programmes in many ways will follow the pattern of the B.B.C.'s General Forces Service—entertainment, news, educational and religious presentations and morale-building features.

Empire Radio Talks

A BRITISH Commonwealth and Empire Conference was held in London recently to study wartime advances in radio development regarding its bearing on post-war civil aviation.

P.O. Appointment

THE Director-General of the Post Office (Sir Thomas Gardiner) has appointed Miss C. Kennedy to be his private secretary in succession to Miss M. G. Brown, who has returned to her former department, the Assistance Board, on promotion.

B.I.R.E. Meeting

AT a meeting of the British Institution of Radio Engineers (London Section members) held at 11, Upper Belgrave Street, London, S.W.1, on February 24th, a paper on "A Review of Wide Band Frequency Modulation Technique" was read by C. E. Tibbs, A.M.I.E.E., an associate member.

A.T.C. Broadcasts

LISTENERS may remember hearing A.T.C. Cadet Frank Budd, of Bude, the boy soprano who starred in the last A.T.C. broadcast, "First Flights," on Saturday, February 19th (Forces programme).

He was one of the "talent finds" by Billy Cotton and Miss Joan Clark, of the B.B.C., and his singing of "I'll Walk Beside You" and "Smilin' Thro'" in "First Flights"—unfortunately the last of the series, owing to the new General Forces programme—created quite an impression.

As a result he had been asked to sing as guest-artist at a big B.B.C. concert for the Merchant Navy Rest Home in Surrey on Easter Monday (organised by John Neill).

It is also interesting to note that the pipe band of No. 497 (Motherwell) Squadron, which has already been on the air in the A.T.C. broadcast "First Flights," is taking part in "Scottish Half Hour" (General Forces) on April 12th.

Light Music Special

THE biggest thing that the Light Music Section of the B.B.C. has yet attempted was broadcast on March 10th. This was the first of a new series of programmes which will involve two orchestras—one of 45 players under Charles Williams, and the other Primo

An R.A.F. observation post on the summit of the Cheops Pyramid in Egypt

Scala's Accordion Band. In short, nearly 60 musicians will be employed in a fresh and more vivid presentation of light music. The two orchestras will play in markedly contrasting styles the best kind of light music, ranging from Strauss to Eric Coates. This new feature has been conceived and sponsored by Fred Hartley, light music supervisor, who is constantly seeking fresh fields for exploration and new methods of giving light music the right place in the artistic and entertainment schedule.

"The Night Has Eyes"

CHARLES WILLIAMS is already well known for his broadcasts, and has done much to popularise the good light music, especially in some brilliant arrangements. It will be remembered that he was the composer of the attractive music for the film, "The Night Has Eyes," and he has conducted the music of many English films with marked success.

Primo Scala's Band is one of the best-liked bands contributing to "Music While You Work," and is directed by Harry Bidgood, who is responsible for the music of many British films to-day.

Listening Time Round the Clock

WHEN it is 8 o'clock British Summer Time in the evening in Britain it is 1.30 a.m. in India, 10 p.m. in Iraq, 7 p.m. in Gambia, and so on.

These variations between clocks in Britain and clocks overseas are important to Home listeners who are linked by the new General Forces programme with their relatives and friends overseas. The link is provided, of course, by shared experience, by listening to the same B.B.C. programme at the same time. "At the same time" is the operative clause—8 p.m. for Mrs. Smith, of Surbiton, is not 8 o'clock for Private Bill Smith in Ceylon.

Peak Listening Hours

BECAUSE the evening is normally the time when most people are off duty, the peak listening hours in any part of the world can be taken as the period between 7 and 10 p.m. Men and women serving overseas will probably have scant time for listening except in the evening. So listeners in the Home Country, wishing to share their listening with their folk overseas, may like to tune in at the time in Britain equivalent to the evening hours in the area in which their special interest lies.

As a guide to these clock variations, here are the British clock time hours equivalent to 7–10 p.m. local clock time in six major centres of war activity:

	In Great Britain
India and Burma (14th Army) ..	1.30–4.30 p.m.
Iraq and Iran (P.A.I. Forces) ..	5–8 p.m.
Egypt and Near East (M.E.F.) ..	6–9 p.m.
Italy and Sicily (C.M.F.)	7–10 p.m.
North Africa, Gibraltar, Malta (B.N.A.F.)	7–10 p.m.
West Africa (B.W.A.F.)—	
Gambia	8–11 p.m.
Gold Coast	7.30–10.30 p.m.
Nigeria	7–10 p.m.
Sierra Leone	9–12 p.m.

The Institution of Electrical Engineers

PROGRAMME of Future Meetings of Cambridge and District Wireless Group: April 17th, at 5.30 p.m., at the Cambridgeshire Technical School (tea at 5 p.m.), Mr. B. J. Edwards: "A Survey of the Problems of Post-war Television."* May 1st, at 5.30 p.m., at the Cambridgeshire Technical School (tea at 5 p.m.), Mr. C. R. Stoner B.Sc.(Eng.), and Mr. R. W. Wilson: Discussion on "Training for the Radio Industry." May 11th, at 8.15 p.m., at the University Engineering Department, Mr. E. B. Moullin, M.A., Sc.D.: "The Contribution of Cambridge to Radio Engineering."

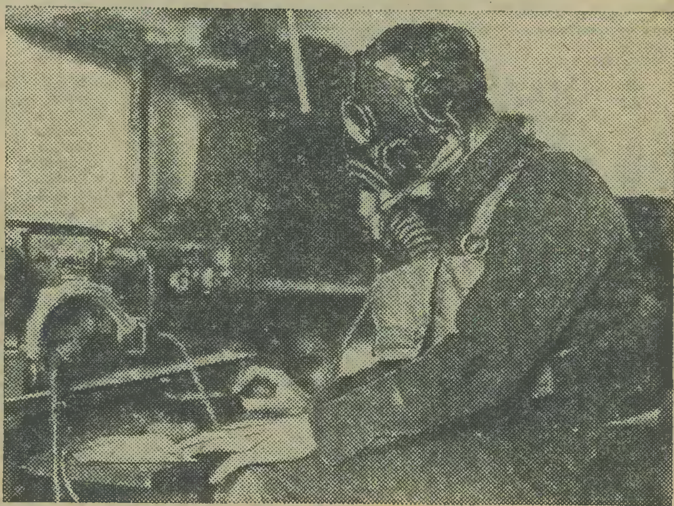
* Advance copies of this paper will be available on application to the secretary.

B.B.C. Feature Producers for America

UNDER a new rota system the B.B.C. is sending one of its feature producers to work in America for several months. A resident B.B.C. feature producer there means that the B.B.C. can call on him, as it can on men of its own regions, for feature programmes dealing with the area in which he is stationed.

The first man to be sent was Geoffrey Bridson. He went for six months, and stayed nine. Bridson, who is both producer and author—his "Aaron's Field" is considered an outstanding example of poetic radio drama—had produced a variety of programmes during his visit and travelled widely throughout Canada and the U.S.

His Dominion Day programme, broadcast in Toronto, recorded and subsequently heard over here, was his first production there. Other features have been "An Englishman Looks at Chicago," "An Englishman Looks at San Francisco"—in which Herbert Marshall appeared—and later on "An Englishman Looks at Brooklyn."



An A.A. gunner in Cyprus, learning how to use a wireless transmitter during a gas alert.

His programme on the making of the Alaska Highway was widely approved in Canada, and he was also in charge of the North American contributions to the B.B.C.'s Christmas exchange programme.

C.B.S. and Transatlantic Call

BRIDSON'S work, all of which has been broadcast in America, recorded and later broadcast in Britain, has been well received by United States and Canadian radio critics, and throughout his stay he has received close and friendly co-operation from broadcasting authorities in America. He has been the link between the Columbia Broadcasting System and the Features Director in Britain, Laurence Gilliam, over the series of weekly exchange programmes, "Transatlantic Call."

It is the task of the broadcast producer visiting another country to paint a vivid aural picture of that country for his compatriots. Norman Corwin, star producer from America, did this in 1942, when he produced six memorable feature programmes showing life in Britain at war.

Five-stage Quality Receiver

P. R. DYMOCK Describes a Receiver Possessing Several Good Features, Which He Designed and Constructed to Secure High-fidelity Reproduction

THE circuit (Fig. 1) consists of one H.F. stage, a diode detector, two L.F. stages, a phase-splitting stage, and a "PX4" push-pull output.

I have used a "straight" circuit because of its great simplicity and superior performance for "quality" reproduction, when compared with superhets, although the general sensitivity is of a relatively low order.

After considerable experiment with two H.F. stages, I found that stability was so difficult to obtain that the final gain was not appreciably greater than that derived for one H.F. stage; but in previous sets reaction was taken from the screen with very satisfactory results, giving far greater gain but an unfortunate decline in fidelity—hence reaction was abandoned in this receiver.

To obtain negligible distortion, a diode detector must receive a strong signal, and this is only obtainable from really local stations with this receiver.

The coils are iron-cored and screened, the switching being effected with a Yaxley switch. The "top end" band-pass capacity C15 is obtained by twisting two short lengths of "pushback" wire together—say about four times. This is a very convenient method, because it allows easy adjustment to be made and has a low capacity to earth.

Optimum results are obtained from a diode only when the total shunt impedance across the diode load is, at least, four times as great as the diode load itself. These conditions are approximately complied with in my circuit if R4 is four times R1+R2, and the values I used satisfy these requirements. The highest permissible value of R4 naturally depends on the valve in use. Since R2 is also the volume control, when the slide contact is near the earth end of R2, as it is normally, the shunt impedance is further reduced.

The value of the diode load condenser C1 must also be small for the same reason, and incidentally a small value does assist in passing transients.

The H.F. stage does not permit of effective A.V.C. Returning again to the position of the volume control, it will be noted that since it is passing current a "noise" will be heard when moving the control, but this affords very little annoyance and is quite worth while ignoring, since greater fidelity results.

The value of anode load R5 is governed by the H.T. available, and the loss of high frequencies if it is too high. I have used 100,000 ohms. These factors affect all the L.F. stages.

A phase-splitting valve was used because it obviates the necessity for a transformer with its consequent distortion. A drawback of this method is that the cathode of the phase-splitting valve is about 80 to 100 volts positive relative to the cathode, but although

COMPONENT VALUES

R1	25,000 ohms.	R10	100,000 ohms.	R20	100,000 ohms.	C7	0.25 mfd. treble lift above 1,000 cs.
R2	0.25 megohm volume control.	R11	0.25 megohm.	C1	.00005 mfd.	C10	4 mfd.
R3	1,000 ohms.	R12	25,000 ohms.	C2	.02 mfd.	C11	8+8 mfd. electrolytic.
R4	1 megohm.	R13	1,000 ohms.	C3	25 mfd.	C12	
R5	100,000 ohms.	R14	25,000 ohms.	C4	.02 mfd.	C13	.0003 mfd.
R6	20,000 ohms.	R15	200,000 ohms.	C5	.05 mfd.	C14	0.1 mfd.
R7	0.25 megohm.	R16	200,000 ohms.	C6	0.1 mfd.	C16	0.1 mfd.
R8	1,000 ohms.	R17	5,000 ohms.	C8	1.0 mfd. bass boost below 200 c/s.	L1	300 ohm speaker field (or choke).
R9	250 ohms.	R18	400 ohms, 5 watt.	C9	50.0 mfd.		
		R19	400 ohms.				

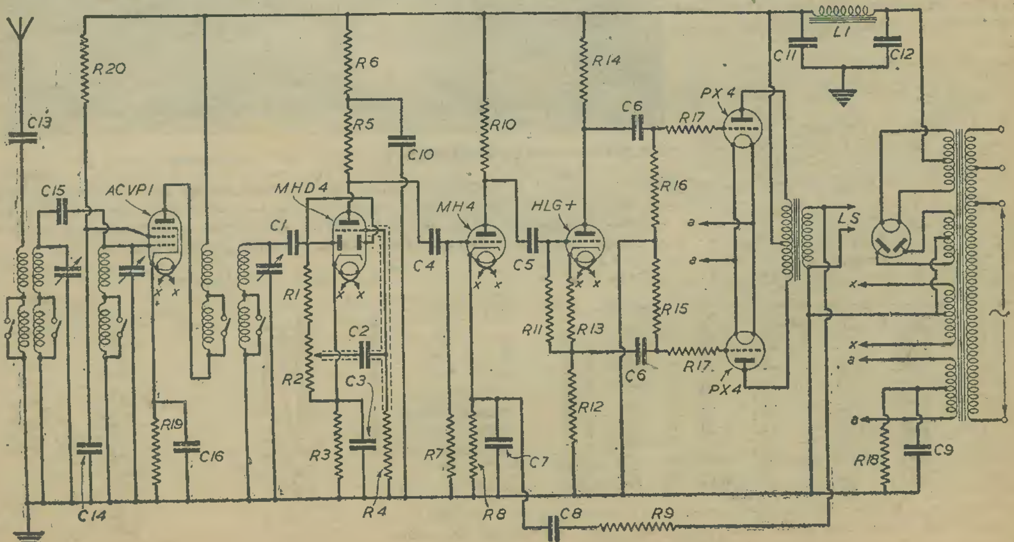


Fig. 1.—The theoretical layout of the complete receiver.

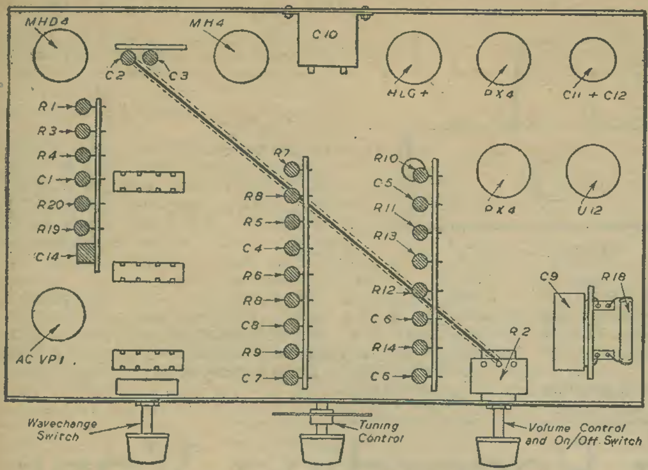


Fig. 2.—Layout of underside of chassis showing use of component panels.

this cannot be a good thing for the valve insulation, no trouble has been experienced in the past two years with the same valve. The Tungsten HLG+ is designed to withstand this voltage.

The push-pull stage is normal, and although I never experienced any parasitic oscillations, the "stoppers" R17 of 5,000 ohms were included and soldered direct to valve-holder pins. Readers may be interested to hear that I discovered, quite by accident, that a good way of detecting parasitic oscillation is to hold a flash-lamp bulb across the output transformer secondary—as it will light up if oscillation is taking place. Smoothing is obtained with a choke of 300 ohms resistance, and an 8+8 electrolytic condenser C11 and C12.

Bias for the output valves is taken from a common resistance R18, which must have, at least, a 5-watt rating.

Negative Feedback

Negative feedback is of very great importance in this receiver. The values of components used give extreme bass boost below 200 c/s and extreme treble lift above 1,000 c/s. The employment of negative feedback has the most pronounced effect of improving quality, as it reduces, virtually, all forms of distortion. It can be applied over any reasonable number of stages, and can, in theory, reduce their normal gain to unity. In practice, however, if it is taken too far back in an amplifier, phase change results, and the feedback becomes in phase, and oscillations are generated. In this amplifier I found that stability was not obtained if the feedback was taken to the cathode of the valve MHD4. The total gain of the last three stages is not very large, but is ample for quite large rooms.

The resistance R9 is used to limit the amount of feedback to the maximum stable quantity. R9 must not be too large, say, above 1,000 ohms, because if it was it would impair the feedback of transients.

Condenser C8 gives bass boost because it offers a large impedance to low-frequencies relative to R8, and so prevents this being fed back. Condenser C7 gives treble boost because it shunts the feedback load R8, and at high-frequencies above 1,000 c/s it will bypass them and prevent their being fed back.

The modification of values of the condensers C7 and C8 provides a very interesting basis for the control.

Great care must be taken to ensure that the feedback is connected correctly to the secondary of the output transformer. If regeneration occurs it may not actually cause oscillation, but quality will certainly be ruined.

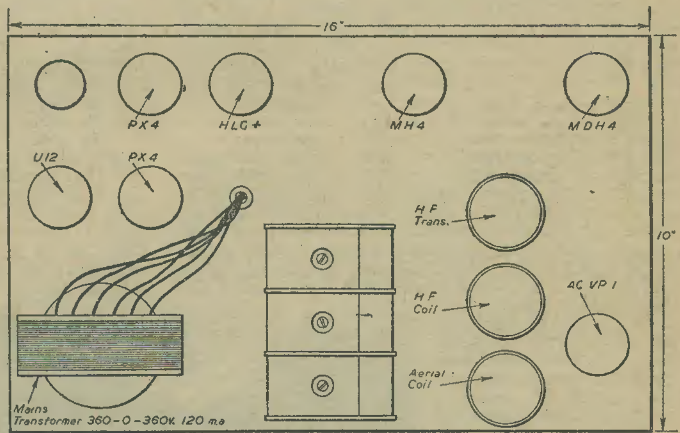


Fig. 4.—Plan view of chassis. A neat and symmetrical layout.

Construction

The method of construction is one which I invariably follow in all normal radio apparatus. As can be seen by Figs. 2 and 3, all possible resistors and condensers are mounted on paxolin strips in the manner shown. The strip is bolted to the chassis with small brackets.

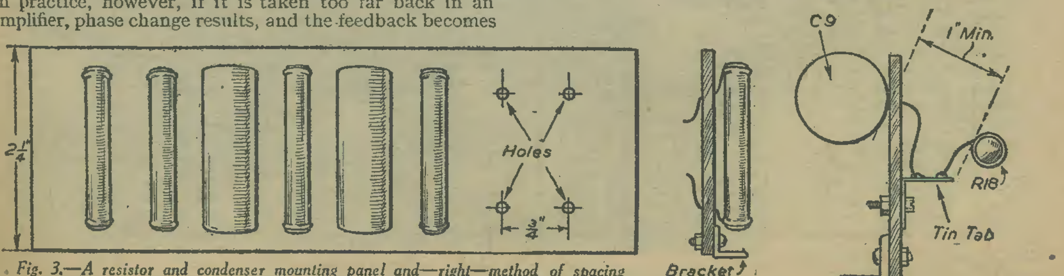


Fig. 3.—A resistor and condenser mounting panel and—right—method of spacing R18 from C9.

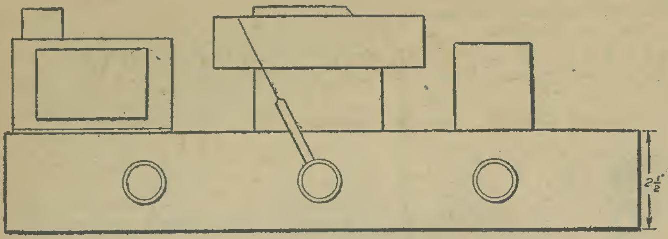


Fig. 5.—Front view of receiver. Note only three controls.

The disadvantage of this method is that leads are rather longer than usual, but the great advantage is that it allows of great flexibility in making circuit changes; and, above all, the general appearance is very neat.

It is most convenient to fix the ready-drilled paxolin strips into the chassis and to mount the resistors, etc. in as required. Care must also be taken to avoid "shorting" of adjacent resistors, and cooling must be considered also. The layout of the upper side of the chassis and the controls are shown in Figs. 4 and 5.

All the components are normal, and do not require any comments beyond those already given. I might say in passing that no bias smoothing condenser is required across R13, since the general effect is negligible. The PX4 bias condenser C9 is 50 mfd. capacity.

There is plenty of scope for very interesting modification in this circuit. Pentodes instead of triodes will improve "top" response quite possibly, and there are infinite possibilities for fitting tone controls around the feedback circuit. I am hoping to try some of these in the near future.

B.B.C.'s New Recording Vans

THE B.B.C. have recently put into service some vehicles for recording eye-witness accounts of fighting, etc., in the actual battle zones, the discs being used on the return to base for broadcasting. Needing a real "go anywhere" performance, as well as a fairly roomy body, the B.B.C. engineers' choice fell upon a vehicle which had already won its spurs in the field—the Humber army ambulance. Fitted with four-wheel-drive and 27 h.p. engine, it fully complied with requirements as to performance, while the body, minus ambulance fittings, provided room for the special equipment.

The recording equipment is of B.B.C. design and consists of three main units, namely, the turntable, the amplifier and the power supply. The turntable unit is very sturdily constructed and has proved itself efficient under many difficult conditions—it has even been used in aircraft and tanks when on the move. Discs up to 13in. diameter can be accommodated, and the turntable is driven by a motor of controllable speed, normally adjusted to 78 r.p.m. The power supply is obtained from a 12-volt battery, usually of the nickel-iron type, which can be charged when necessary from a special dynamo driven off the engine.

A "mixer" enables the output from up to three microphones to be brought in at any desired relative strength. A pick-up is also carried and the recording turntable, amplifier and loudspeaker (normally used for monitoring purposes) can be employed for playing back the discs. In addition, a lightweight disc reproducer is carried as an extra, so that when required a disc may be re-recorded (or "dubbed").

Not only does this roomy vehicle accommodate the whole of the necessary equipment for recording, but also provides space to "board and lodge" two persons. The bulky and weatherproof part of this impedimenta is stowed on a luggage grid fitted to the roof, but inside the body and driving cab there is proper housing for personal belongings and cooking apparatus. Provision is made for attaching a tent to the rear of the vehicle, which not only forms an extension to it, but provides a shelter for two people sleeping on camp beds.

Already these recording vans have given good service in the field. The B.B.C. have recently received from one of their recording engineers in Italy a report which reads as follows:

"In approximately fourteen days I have covered 2,500 miles over blown-up roads, through rivers, in the mountains, etc. Any ordinary recording truck would not have taken such a heavy ordeal, but this truck has been most excellent in every respect and I have 100 per cent. confidence in same—in fact, it is a pleasure. I find that every Army transport depot carries all Humber spares. This vehicle is very common in the field."

One of the B.B.C.'s recording vans as used in Italy and elsewhere by their war correspondents.

Royal Signals "Golden Arrow"

The Army's Largest Mobile Wireless Station

"GOLDEN ARROW" is a name which immediately suggests speed, and, consequently, efficiency. In pre-war days it was so aptly applied to the famous London–Paris boat train, and it seems rather strange to find it now linked with a train of vehicles whose purpose is vital to the satisfactory prosecution of the war. The Royal Signals wireless station, "Golden Arrow," is virtually a mobile adaptation of the normal type of small fixed commercial radio-telegraph station, and, while providing the traffic-handling capacity of such a station, is fully mobile, and can be set up or dismantled in three or four hours. The complexity and bulk of the station necessarily restricts its use to the main arteries of communication, such as those between Army H.Q. and G.H.Q., or between a mobile G.H.Q. overseas and a fixed station in the U.K. Fortunately, it is only on such a main artery that the amount of traffic rises to figures that cannot be disposed of without resource to automatic working. Each "Golden Arrow" can transmit and receive 30,000 words a day over considerable distances. Several "Golden Arrows" have been allotted for future operations on the Continent. Their role will be to provide communication from the armies in the field back to the United Kingdom. The despatches of newspaper correspondents will be among traffic handled in this way.

The "Golden Arrow" and its crew of 22 is completely self-contained, and carries its own collapsible mast gear, spare valves, power supply and administrative stores. The cook with his portable petrol cooker is naturally a most important member of this little community. As far as possible the equipment has been rendered capable of operating in any climate from sub-arctic to tropical, and this has already proved of great value, as sets are now in service in places as far apart as Italy and Bengal.

The first "Golden Arrow" in Sicily went ashore late one evening from a landing-craft. By 9 o'clock next morning it was hard at work carrying messages to and from the War Office, 1,200 miles away. The erection of a fixed station of this type, involving the design and erection of a number of buildings, would, under peacetime conditions, take six to 12 months.

Details

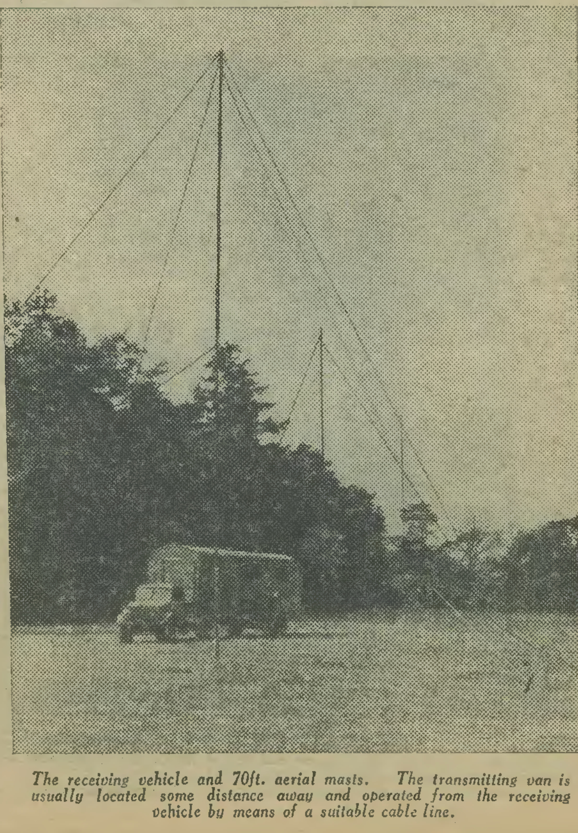
When large quantities of traffic are to be handled normal morse operating at 20 or 30 words per minute is inadequate, and automatic transmission is employed on a duplex basis, i.e., both transmission and reception take place simultaneously on different frequencies. Consequently it is necessary to separate the transmitter and receiver physically in order to avoid the former "blotting out" the weak signals received by the latter. In the "Golden Arrow" the majority of the crew work in the receiving vehicle, which also houses the automatic transmitting "head" and the automatic receiving equipment. The transmitter, in its transmitting vehicle, is driven to a suitable site 400–800 yards away, and the transmitted signals from the transmitting "head" are sent as D.C. impulses over a cable pair to the transmitting vehicle, where a relay controls the transmitter itself. Consequently, the man on duty in the transmitting vehicle has little to do beyond "keeping an eye" on the transmitter, clearing any faults that may occur and changing frequency when requested. A telephone is provided between the transmitting and receiving vehicles, so that instructions may be passed to the former when, for instance it is necessary to change to another frequency.

Power Supply

The power supply for the station is a matter of interest, because it is the factor which limits the size of the plant as a whole, a very large generator being an awkward thing to handle. A diesel generator was chosen as being more reliable than the normal petrol-driven plant.

The 4-cylinder engine is direct coupled to a 27 KVA generator giving a 400/230 volt 3-phase 4-wire output, while a mechanical governor and automatic regulator control the frequency and voltage of the output to very fine limits; in fact, the power supplied is often far steadier and more reliable than the public supplies available in isolated places overseas.

The generating set is mounted as a trailer, and is towed by a 4-wheel drive lorry, which carries part of the crew and their kit when the station takes the road, but as power must be available for 24 hours a day, a duplicate generating set is provided as a standby to the first, and is drawn by another similar type of lorry. A 4-core heavy cable is unrolled on site, and interconnects the generators and the transmitting and receiving vehicles—the last-named probably about 600 yards away from the others.



The receiving vehicle and 70ft. aerial masts. The transmitting van is usually located some distance away and operated from the receiving vehicle by means of a suitable cable line.

The Transmitter

The transmitter itself is carried in a large semi-articulated vehicle, and is of about 3KW aerial rating. The layout of the final P.A. circuits and the interchangeable tank coils of the transmitter are of considerable interest. The anodes of the high-power valves are cooled by a blast of air from a blower. Facing the transmitter is the cubicle which contains the main transformers and mercury vapour rectifiers for supplying power to the transmitter and the overload and time-delay relays, which protect the transmitter from damage due to faults or incorrect operation. Behind the power supply cubicle there is a special resilient stowage for the carriage of spare power valves.

The aerial gear is all carried in or on the vehicle (the mast sections are slung below the trailer chassis), and when erected provides two dipoles on 70ft. masts—one being used for the day (high) frequency, and the other for the night, or lower frequency.

Receiving Vehicle

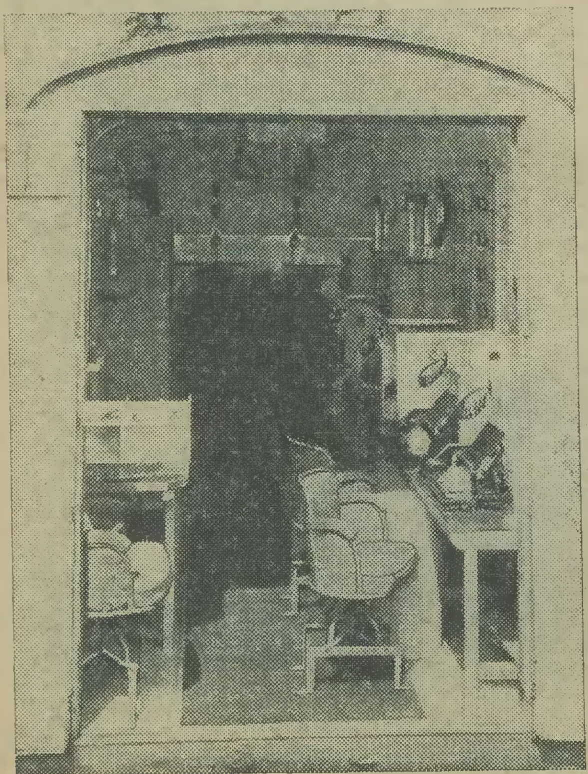
The receiving vehicle is of similar shape to the transmitter vehicle, but contains a very complicated installation as it forms the traffic office in which the majority of the crew work. The forward end of the vehicle is divided off, and contains an air-conditioning equipment which supplies a current of cool dry air to the operating room through a duct slung below the ceiling. As the air intakes to this plant are covered with filters the interior of the vehicle is kept free of dust, sand and (last, but by no means least) of flies and mosquitoes. In order to assist in keeping the vehicle interior cool the "skin" of the vehicle and the floor is "lagged" with glass wool. Not only does this air-conditioning prevent the unbearable conditions otherwise inevitable in a small crowded vehicle standing in a tropical sun, but the exclusion of sand reduces the wear on the delicate instruments within. In cold climates a 3 KW heating element in the air intake replaces the cooling compressor, and the vehicle is consequently ventilated and warmed in a pleasant manner.

The vehicle contains a long operating bench on the offside, which carries two keyboard perforators, a receiving undulator, a Wheatstone transmitter, hand key and a spare undulator. The wireless receivers themselves, which are high-grade "communication" receivers, are carried on resilient mountings on a shelf above the undulators, together with a "Recording Bridge" which converts the interrupted audio-frequency note from the receiver into direct current to operate the undulator. It was found necessary to fit interference suppressors to key contacts and motors in the vehicles in order to prevent the production of "man-made static."

The receiving aerials are similar to those for the transmitter, except that a coaxial feeder is employed between the "dipole" itself and the receiver.

Operation

When a message is to be sent it is first handed to an operator who, by typing it out on the keyboard perforator, produces a paper tape bearing holes corresponding to the morse characters. This tape is then run through the Wheatstone transmitter, which "keys" the radio transmitter automatically at speeds up to 150 words per minute.



View of receiving vehicle. Reading right to left are two perforating positions, one undulator with receiver and bridge above, one Wheatstone transmitter, then second undulator with second receiver above and two tape reading positions. Desk on front left is the superintendent's desk.

At the receiving terminal the signal is recorded by the undulator as a wavy line on a paper tape which is then drawn slowly across in front of a typewriter, while a specially trained operator transcribes the message and types it out in its original form. The typewriters and the "tape pulling" machines are installed at the front of the vehicle. In the near-side rear corner a small desk is provided for the superintendent and for a message clerk, who accepts and delivers messages through a small "letter-box" in the side of the vehicle.

Production Team-work

One of the most interesting things about this equipment is the fact that from the production point of view it is an enormous piece of "team work" by British factories. Three firms share the building of the vehicles, while two others share the fitting. The transmitter itself, the Wheatstone transmitter, the keyboard perforator, the masts, the aerial equipment, the typewriters, the telephones, the air conditioning equipment and even the mechanics' tool kit all come from different factories scattered all over England to be assembled at a point near London, and taken over by the crew, who will make the vehicles their home and workshop overseas.

The Crew

In normal times, it takes three to five years to train a man before he becomes an operator in a commercial station, capable of handling high-speed automatic transmission and reception. During wartime, the Royal Signals have to think in terms of months, and it is for this reason that they "hand-pick" their men who, if selected for this vital work, receive every encouragement and consideration, particularly during their training period. The Signals are always on the look out for keen and intelligent young men—preferably between the age of 18 to 21 years—who possess any knowledge of the work involved or have a natural aptitude for morse, wireless, electricity, etc.

YOUR SERVICE WORKSHOP—13

Servicing Receivers

Locating Faults Stage-by-stage Testing. By STANLEY BRASIER

(Continued from page 202 April issue)

IT is proposed to discuss servicing and the methods by which faults may be located by means of some of the instruments already described in this series.

In all receivers, except crystal sets, we have to deal with two parts, the radio circuit and the power supply. The radio circuit is basicly the same according to the valve sequence, and so, for that matter, is the power supply, in that its purpose is to supply, by some means or another, the correct L.T. voltage to the valve filaments or heaters and the correct H.T. voltage to the anodes and screens. But the method by which this is achieved varies according to the source from which the power is drawn.

It is, therefore, dependent upon the power supply and/or the symptoms exhibited by the offending receiver as to which method of attack may be adopted.

Let us assume that we have a set to service which is absolutely dead. Let us also assume that by methods which will be explained later we have traced the trouble to the power supply and found that no H.T. exists at the main distribution point. This point is shown in Figs. 1, 2 and 3 at X, considering a battery set, an A.C mains set and an A.C./D.C. set respectively.

Lack of H.T. at this point may be caused by an open circuit, a short circuit, and, in the case of Figs 2 and 3 a faulty rectifying valve, or in Fig. 1, a run-down H.T. battery.

Testing Power Supply

The battery is easy to deal with, for having taken a voltage test of the H.T. battery it is only necessary to examine the lead or leads to the receiver for open or short circuits. Do not forget, however, the possibility of a fuse having blown. This is almost invariably in the H.T. neg. lead and is sometimes incorporated in the wander plug itself, otherwise it is usually found on or under the chassis. If a condenser is included in parallel with the H.T. battery, this must also be suspected of breakdown.

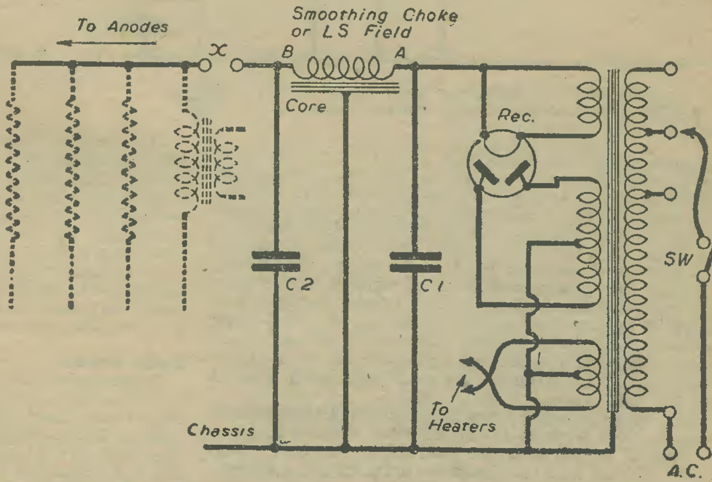


Fig. 2.—A typical arrangement of a power supply for an A.C. operated receiver.

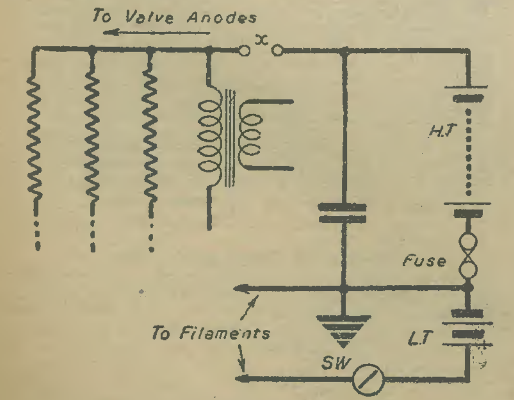


Fig. 1.—In the case of battery-operated receivers, the power supply takes the simplest form as shown here.

Power supply also includes filament power, but with batteries this only amounts to checking the accumulator and its leads, and faults such as these are usually very obvious and easy to deal with.

The power supply section of an A.C. receiver—a typical arrangement of which is shown in Fig. 2—is not quite so easy, for there are more possibilities of breakdown. Remembering that no voltage exists at point X, we would connect the "ohms" range of our Universal test meter between the earth line and X, and with the set switched off, test for a short circuit.

(Although a Universal test meter has not, as yet, been described in this series, a specification of such an instrument was outlined in Your Service Workshop (1).)

A reading of zero ohms would indicate a breakdown of C2 or a short circuit between terminal B of the choke (or loud-speaker field) and core, or, which amounts to the same thing, chassis. A reading on the ohmmeter of the resistance of the smoothing choke or L.S. field would tend to prove that C1 is shorting or that a short exists between terminal A and chassis. If no short-circuits are found, the L.F. choke or speaker field and all wires should be tested for continuity and the rectifying valve for emission. If these are in order, the absence of voltage can now only be due to trouble in the mains transformer such as a break in the primary winding or the leads thereto, or a blown fuse. This however, would have been spotted before because in such a case neither the valves nor pilot lamp would light and we would immediately check the primary for continuity by joining the ohmmeter across the mains plug. The switch must of course be on, and a reading of some 30 to 60 ohms

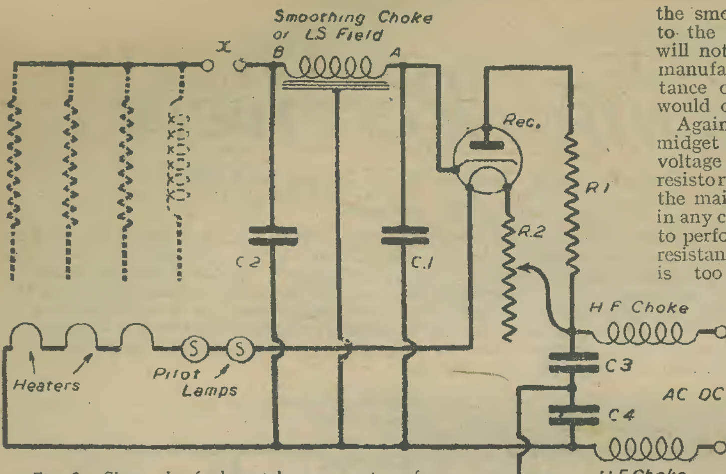


Fig. 3.—Shows the fundamental power system of an A.C./D.C. receiver. Care should be exercised when testing.

at least should be obtained if the primary winding is in order. Remaining troubles in the transformer would be due to a short or break in the rectifier filament winding or its leads (this would also have been evidenced before) and to similar conditions in the H.T. secondary winding. A short here would, no doubt, cause the transformer to overheat badly. An open circuit would probably affect only one-half of the winding so that some voltage would be obtained unless a break existed in both halves or between the centre tap and chassis. Resistance tests between the secondary winding and chassis would prove this, and readings of approximately 200 to 500 ohms should be obtained for each half, both sections reading the same.

Any trouble would by now have been found unless there exists a short between any transformer winding and core or chassis, or between the individual windings. This can be checked with the ohmmeter or better still a megger, if available.

A.C./D.C. Circuits

The power circuit of a typical A.C./D.C. receiver (Fig. 3) is usually similar, so far as the smoothing section is concerned, to the A.C. arrangements, therefore preceding remarks regarding testing rectifier apply also to Fig. 3. Also, if C1 or C2 develops a short-circuit, it invariably destroys the rectifying valve, so this should be checked. If, on the other hand, all is in order, it only remains to check the circuit from the anode of the rectifier through to the appropriate mains input lead. R1 is a current limiting resistor which is often included; a usual value being approximately 100 ohms.

If trouble is suspected in the heater circuit we could check this by applying an ohmmeter test to the pins of the mains plug. A reading of rather more than the resistance of the mains dropper R2 would prove that this component and also the continuity of the valve heaters are intact, also any fuses and mains H.F. filter chokes, if included. C3 and C4 should, of course, be checked for open or short circuit.

Apart from these normal power circuits one must always be prepared (if the service sheet is not available) to find more uncommon arrangements such as the smoothing choke or L.S. field being joined in the H.T. negative lead. Or the field coil may be tapped so that the voltage drop along part of it may be used to bias the output valve.

Midget sets often provide some rather unusual smoothing arrangements. Sometimes, for example, the output valve is not smoothed at all, its anode being joined via the speaker transformer to rectifier cathode. Thus only the earlier valves are affected by the smoothing with the result that, due to the lower current, the speaker field will not drop so many volts or, for the manufacturers' convenience, the resistance of the field may be higher than would otherwise be possible.

Again, the rectifying valve in some midget receivers takes an anode A.C. voltage of only 125 and a dropping resistor has to be inserted between it and the mains. However, since one is used in any case for the heater circuit, it is made to perform a dual purpose. Then, if the resistance value for the heater circuit is too great for the correct voltage drop to the rectifier, a tapping is taken at some point along its length with the result that the linecord (for such it usually is) will have three leads emerging from the set end and two from the end which connects to the mains. This is liable to be a little confusing to anyone not familiar with the system, especially when fitting a new cord. The leads are best identified with the aid of an ohmmeter.

D.C. receivers have similar smoothing arrangements to Fig. 3 and there is, of course, no rectifier to bother about. This fact, however, may be a worry in itself, because if at any time we are required to service a D.C. set on A.C. mains it will be necessary to provide rectification for the H.T. supply. So for this reason it is a good idea to keep handy a Westinghouse metal rectifier type H.T.10, which can be temporarily connected to the D.C. set. It should be wired between the smoothing choke and mains so that rectifier negative goes to mains and rectifier positive to choke.

Radio Circuits

Assuming once again that a dead receiver confronts us, it is first necessary to decide in which stage of the circuit the fault lies. Most sets are provided with sockets for connections to a gramophone pick-up and this forms an ideal and ready-made point from which the L.F. amplifier may be tested. After switching to "gramo" and turning up the volume control, a rough check may be made by touching the pick-up sockets with the fingers.

(To be continued.)

PRIZE PROBLEMS

Problem No. 455

WALTERS had a three-valve battery-operated receiver using a variable-mu S.G. valve, a triode detector and a pentode output valve. The variable-mu properties of the S.G. valve were not made use of, however, and zero bias was being applied to this valve. He decided to fit a grid-bias potentiometer volume control, using a component having a value of 50,000 ohms with a .1 mfd. by-pass condenser joined between the earth end of the grid coil and earth terminal in the usual manner. He was surprised to find that sensitivity dropped after this modification had been made. He tested the by-pass condenser and checked the wiring and found both to be in order. What was 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. 455 in the top left-hand corner, and must be posted to reach these offices not later than the first post on Friday, April 14th, 1944.

Solution to Problem No. 454.

Jones overlooked the fact that he was using a metal panel and a reaction condenser whose moving vanes were common to the operating spindle and, likewise, the fixing bush. When he made the alteration to the reaction circuit he connected the anode to the fixed vanes; the moving vanes to one side of the reaction coil, and the other end of the coil to earth, but owing to the points mentioned above, the moving vanes were at earth potential, therefore the reaction coil was short-circuited.

The three following readers successfully solved Problem No. 453 and books have accordingly been forwarded to them: G. A. Grundy, 2, Bracken Place, Fenham, Newcastle-on-Tyne; P. W. Barnett, Station House, London Road, St. Albans; L.A.C. Turner, R.A.F., Norfolk.

Some Applications of Thyratrons in Radio Engineering

A Paper Read Before the Institution of Electrical Engineers

By A. J. MADDOCK, M.Sc., Associate Member

SOME of the principal applications of thermionic gas-filled triodes (thyratrons) in the field of radio engineering have been selected for description in summarised form. Certain applications described belong to that field of power engineering peculiar to radio, such as H.T. supply sources, whilst others describe instruments used in ancillary capacities.

The paper is limited as the field already covered is very wide and would take much space to describe; consequently many of the more obvious applications have been omitted. Likewise no detailed descriptions

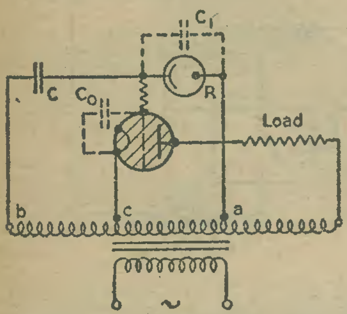


Fig. 1.—Circuit for progressive increase of anode current with increase of illumination.

are given of thyratrons and their characteristics, or methods of effecting control of the passage of current through such valves.

Introduction

Gas-filled valves with thermionic cathodes may be said to have become a practical possibility around 1928 when Hull announced that, based on work by Hull and Winter, and Kingdom and Langmuir, any activated cathode can be operated in a gas or vapour discharge, provided that the cathode potential-drop is not allowed to exceed a certain value designated the "disintegration voltage." Ions which have a velocity less than that associated with the disintegration voltage do not cause damage to or de-activation of the cathode, but at higher voltages rapid disintegration occurs, principally by active material being knocked off by the bombarding ions. Different gases have different disintegration voltages, e.g., 27 v. for neon, 25 v. for argon and 22 v. for mercury vapour, and it is fortunate that the disintegration voltage is always higher than the ionisation potential of the gas so that a reasonable working range can be obtained. The practical significance of this is that the instantaneous current in the discharge must never exceed the full emission of the cathode, otherwise the voltage drop across the valve will rise above the disintegration value.

It was immediately evident that a wide field of use was opened up by such valves, not only in diode form when they are used principally as rectifiers, but also in triode form when control of arc current becomes possible owing to the inclusion of a grid element. It is the purpose of this paper to review some of the applications that have been made in the radio field of gas-filled thermionic valves having three or more electrodes. No pretence is made to completeness and, on the score of space alone, the more obvious applications have been omitted, but it is hoped that such applications as are given will illustrate the various ways in which these devices may be operated, and that interest in possible other uses will be stimulated.

Gas-filled thermionic triodes and tetrodes have been called "thyratrons" by their originators, and as this word has now come into general use in scientific circles it will be used throughout this paper since it forms a conveniently short and descriptive title for such valves

Thyratron Characteristics

Thyratrons in which the atmosphere is one of the inert gases are reasonably free from temperature effects since the gas pressure is dependent primarily on the pressure at which the valves are filled, and only to a small extent on the ambient temperature or the increased temperature brought about by passage of the discharge; for this reason such valves are used where constancy of characteristics is required without the necessity of temperature control. However, the current and voltage capacities of these valves are low in comparison with those of valves employing mercury-vapour filling, and in most of the applications discussed in section dealing with the applications of thyratrons in radio engineering, it is the latter type of valve that will be considered unless special attention is drawn to the use of a gas-filled valve. For simplicity of nomenclature the word "gas" will be taken to embrace vapour also.

Due to the low arc drop and high emission efficiency of the cathodes, particularly when the latter are of the indirectly-heated, heat-shielded type, the power losses are small. In the larger sizes, efficiencies of 1–1.25 A of peak emission per watt of cathode heating power are obtainable, and cathodes rated at 600 A peak emission (100 A average) are in use. On the continent, valves with a peak emission of 1,000 A have been made, but for practical purposes a limit of 200 A is usual. The maximum peak inverse voltage, for normal operation of

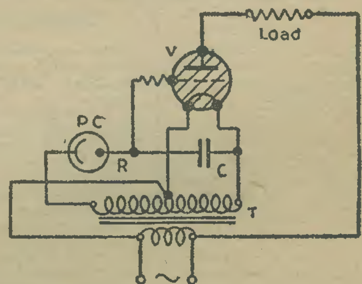


Fig. 2.—Circuit for sudden change from zero to full conduction with decrease of illumination

valves designed for high inverse potentials, varies from 30 to 15 kV for valves rated at 5 A and 150 A peak emission respectively.

The amount of power required in the grid circuit to control large powers in the anode circuit is very small—a photocell will control even large thyratrons directly without the use of further amplifiers—but in some types of thyratron a second grid (shield-grid) has been added which reduces still further the amount of power required and a reduction to about 1/100 or even less of the value in a triode may be obtained. At the same time more rapid de-ionisation is obtained owing to the closer spacing of this shield-grid to the anode, the shield-grid being either connected to the cathode, and so at zero potential or having a suitable bias potential applied to it. With such valves series resistances up to 5 MΩ can be employed in the grid circuit—a higher value than can be used with many vacuum valves.

The shield-grid can also be used to alter the characteristics of such a thyratron between a negative- and positive-control type, e.g., in a particular valve described +5 volts on the shield grid gives a negative-control type, whilst —3 volts converts it to a positive-control type.

It is to be noted that, in all types of thyratrons, the grid current before and after initiation of the discharge is very different. Before initiation the grid current consists of a flow of electrons to the grid, as in a vacuum valve, and is very small (a few microamperes) unless the grid is positive with respect to the cathode. When the arc is struck, the grid current increases considerably in magnitude (many milliamperes) and reverses in direction since it now consists of a flow of positive ions to the grid when the grid is negative; but it again reverses if the grid is made sufficiently positive, increasing rapidly, and if the grid potential reaches the ionising value an arc discharge to the grid will occur. Thus the power required to control the thyratron before the arc is initiated is very small, amounting to only a few microwatts even in the larger sizes, and high-impedance grid circuits can be utilised; once the arc is struck the question of power is of secondary importance since the controlling circuit has then performed its function. Furthermore, the time factor enters into consideration, as the controlling voltage need be applied for a time only sufficient for ionisation to take place.

As the general characteristics of thyratrons and the basic methods of control are becoming more generally known, further details will not be given here. A useful summary of considerations to be taken into account when using gas-filled valves and the treatment such valves should be accorded, has recently been published.

Applications of Thyratrons in Radio Engineering

Analysis into groups of the applications to which thyratrons have been applied is somewhat difficult owing to the diverse nature of these applications and the wide field already covered, but an attempt has been made in Table 1, making a division into four groups,

Table 1

ANALYSIS OF APPLICATIONS OF THYRATRONS IN THE RADIO FIELD

General class of application	Examples of application
Relays, i.e., amplification of power	Amplifiers with light-sensitive cells— e.g., measurement of power in lamp load, switching-on beacon transmitter, power control on occurrence of flashover. Timed operations, e.g., delays on switching sequences. Peak voltmeter, overmodulation indicator and overload relay. Frequency meter
Instantaneous switches, i.e., control of power	Pulse and oscillation generators, e.g., single and multiple pulses of square waveform; peaked-pulse generators; relaxation oscillators; and frequency divider Frequency comparator
Current and voltage regulators	Torque amplifiers, e.g., remote operation of tuning devices; position-locating devices
Commutating devices	Rectifiers

and some of the principal uses in the radio field are also summarised therein. A more detailed description of these applications and specialities of the circuits is given in the Sections that follow.

Relays: Amplifiers with Light-sensitive Cells

A very wide field of applications already exists in the combination of thyratron and light-sensitive cell, covering all branches of industry and research. Applications in the radio field are not so numerous, but the possibilities are indicated and methods of control illustrated, by three examples: (a) switching-on of beacon transmitters during hours of darkness or fog, (b) switching-off a transmitter on occurrence of a flashover, and (c) estimation of power dissipated in a lamp load.

Measurement of Power in a Lamp Load.—Normally this is performed by means of a light-sensitive cell exposed to the illumination from the load dissipating the radio-frequency power, the cell current being read on a sensitive microammeter. Comparison is then carried out with direct current or alternating current of power frequency to obtain the same illumination, as indicated by the meter, whence the power may be

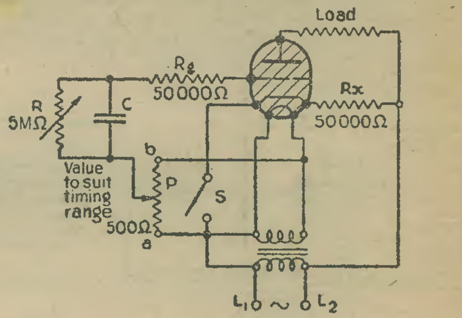


Fig. 3.—Basic time-delay circuit

determined by ammeter and voltmeter readings in the D.C. or A.C. circuit.

The same principle is used when a thyratron is employed in conjunction with the light-sensitive cell, but now the indicating meter, which is connected in the anode circuit of the thyratron with a suitable load resistance, may have a range of, say, 200 mA instead of microamperes and so be considerably more robust. The circuit employed is that of Fig. 1, the resistance R of the light-sensitive cell and the capacitance C of the condenser forming a simple phase-shifting circuit; thus decrease in the resistance of the cell, brought about by increase in the intensity of the incident light, causes the anode current of the thyratron to increase progressively since the phase of the grid voltage is advanced, with respect to the anode voltage, from the anti-phase position.

The thyratron current is made more nearly proportional to the illumination the greater is the capacitance of condenser C compared with the stray capacitance C_1 of the photocell. However, in the comparison method as above, the linearity of response is unimportant since identical conditions exist in the two measurements.

Switching-on with Decrease of Illumination, and vice versa.—For this the circuit of Fig. 2 is used. With the cell illuminated, the grid voltage is in anti-phase with that of the anode and no current flows, but when the illumination falls below a certain value, producing an increase of R, the phase becomes sufficiently retarded for sudden change to full conduction to take place and the resulting anode current may be utilised to operate relays or contactors to switch on the equipment, e.g., a beacon transmitter. This sudden change occurs no matter what the relation between the value of C and the stray capacitances. This circuit may also be employed to switch-off a transmitter momentarily should a flashover occur across suitably disposed spark-gaps which are "watched" by the photocell; when the flashover ceases the thyratron will again pass current and the transmitter power be reapplied.

Timed Operations

One useful delay circuit for providing delays on switching sequences, etc., is given in Fig. 3; it forms a basis on which multiple time-delays can be built up if desired. The delay interval occurs from the instant of closing switch S, and its duration is controlled by the magnitude of *R* and *C* and the setting of potentiometer P. In the diagram an indirectly-heated thyratron is employed and use is made of the heater voltage to provide a bias supply without the necessity of separate or extended transformer windings.

The principle of operation is as follows: With the alternating voltage applied to L_1 L_2, current will pass between cathode and grid, whenever the latter is positive, through the resistor R_x so that condenser C will become negatively charged. When S is closed the cathode is connected to L_1 and no alternating potential now exists between grid and cathode but the full line voltage appears across the anode-cathode circuit. However, as the grid is negative by virtue of the charge on C, no anode current flows until this charge leaks away through R and finally brings the grid voltage to the critical value when the arc strikes and continues to do so until S is opened—thus cutting the anode circuit—and the cycle may then be repeated. The time of charging—which determines the time that must elapse before the circuit can again function correctly—can be reduced to a few cycles by proper choice of *C*, *R*, R_x and R_g. P is so connected that when L_2 is positive, end "b" is negative, the movement of the slider towards "b" increases the negative component of alternating grid voltage so that the condenser C must discharge to a lower voltage before the critical potential is reached; hence movement of the slider towards "b" increases the time interval.

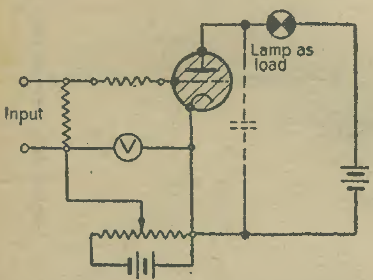


Fig. 4.—Peak voltmeter.

Peak Voltmeter, Overmodulation Indicator, Etc.

The circuit (Fig. 4) is similar to that of the slide-back voltmeter utilising hard valves, and the peak value of the applied voltage is the difference between the grid bias just sufficient to stop conduction as measured by the voltmeter V and the critical bias, i.e., the bias when the thyratron is just triggered, the applied impulses being absent. As distinct from the hard valve, however, the thyratron anode current is either zero when the impulses are less than the predetermined amount or full value when they are greater, the value of anode current being determined by the (constant) load in the anode circuit. Indication that the valve has been triggered may be obtained from its characteristic glow, or a lamp may be used as the load. If a relay is operated by the anode current, the circuit can be extended for use as an alarm to indicate voltages in excess of a predetermined value. As a D.C. supply is used for the anode source, current will continue to pass once the valve is triggered until the anode circuit is opened.

To overcome the disadvantage of the circuit working once only until the anode supply is switched off, a condenser may be inserted, as shown, dotted so that the voltage falls periodically to zero (if the grid impulses render the tube conducting) owing to the condenser discharging through the thyratron. A pair of headphones may be inserted in the negative return to the anode supply, and a click will be heard in them each time the condenser discharges. The point at which the thyratron is first struck is indicated by a slow clicking; on one side there is silence and on the other the clicking merges rapidly into a buzzing sound. The critical potentials with and without the applied input voltage may then be readily determined without the need for switching-off the anode voltage.

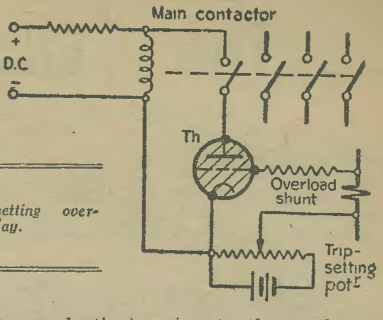


Fig. 5.—Self-resetting overload relay.

Extension of this circuit for use as an overload relay is evident. A convenient means of making the circuit self-resetting for this type of application is to arrange that the device operated by the thyratron also opens the anode circuit of the valve and so allows the grid to regain control. The thyratron may operate a relay in its anode circuit or it may act more directly, e.g., to trip the main contactor of an equipment by virtually forming a short-circuit across the operating coil, this contactor having the necessary auxiliary contact to open the anode supply to the thyratron. A typical circuit is given in Fig. 5.

Since the measurement here depends on the actual value of critical bias, a valve should be chosen in which this varies only slightly with temperature, or means should be taken to ensure that the air temperature around the thyratron is maintained reasonably constant.

If the applied voltage impulses have a much lower frequency of recurrence than the usual power-supply frequency, an A.C. supply may be used on the anode when the circuit becomes self-resetting, and repeated indication will then be given on, say, the lamp forming the anode load of voltages occurring in excess of the value predetermined by the setting of the potentiometer. This method is used in overmodulation indicators when modulated radio transmissions are being monitored.

Frequency Meter

An ingenious and simple circuit for extinguishing the arc when a D.C. supply is utilised was described by Hull, and is widely used. A condenser charged to the voltage difference between the supply and thyratron anode voltages enables a negative impulse to be applied to the anode for stopping purposes.

This basic circuit is here extended to be driven by steady frequencies to act as a frequency meter and, whereas with ordinary meters the wave shape may have considerable influence on the indicated value, in this scheme the shape of the input wave is practically immaterial, its function being to release, alternately, two thyratrons which give constant output for passing to the indicating meter.

(Courtesy of the Institution of Electrical Engineers.)

(To be continued.)

The "Economy" DX Three

An Inexpensive Short-waver Requiring Few Parts. By F. G. RAYER

THE advantages that can be claimed for this receiver are: it is easy to build and operate; it is inexpensive, both in initial cost and upkeep; it is not too critical as regards its operating conditions and it can provide good DX results.

The Circuit

This is shown in Fig. 1, where it will be seen that an H.F. stage is employed, and that it is untuned, and although such a stage is not absolutely necessary, it is well worth while in many respects. It does not provide much amplification, but it does remove the unwanted effects so often introduced when the aerial is connected to the detector stage, and therefore it increases the overall efficiency of the circuit. Among these unwanted effects may be included body-capacity, dead spots in the tuning range, fading caused by the aerial swaying and having a varying capacity to earth, and difficulty in obtaining accurate logging due to a series-aerial condenser having to be adjusted to different values when using different coils. A tuned H.F. stage would overcome these defects and also provide slightly greater gain and selectivity, but it would introduce complications. Band-spreading is necessary in any receiver to be used for real Dx work, and it would be necessary either to have two band-spread condensers ganged or to have the H.F. stage with band-set only and flatly tuned. The former calls for careful layout and construction, the latter loses most of the advantages a tuned stage can offer over an untuned one. Separate band-spread condensers could be used, but operating them together, while keeping the receiver in a sensitive condition by means of the reaction condenser, soon proves very tiresome. It was decided, therefore, that an untuned stage was to be preferred for many reasons. In practice the results fully justified its use.

The detector stage is of the normal leaky-grid type. The band-set condenser is of .0001 mfd. capacity; the band-spread condenser, as supplied, has a capacity of .000015 mfd. This is rather high and was reduced by putting small washers between the fixed plate of the condenser and the metal sleeves bolted to the frame of the condenser, an item which should not be overlooked. A maximum capacity of about .000005 mfd. should be aimed at, as this will allow the tuning range of a coil to be covered in 25 bands (allowing a little for tuning overlap) and will give two or three degrees between stations instead of two or three stations between degrees.

A valve of the detector type is used in the L.F. stage, and although this is R.C.-coupled, it will give ample gain for use with 'phones. A high amplification pentode valve, and, say, transformer coupling, would enable speaker operation on many stations, but it would have a higher background noise level. It seems better to rely on a really efficient detector stage and not too much L.F. amplification.

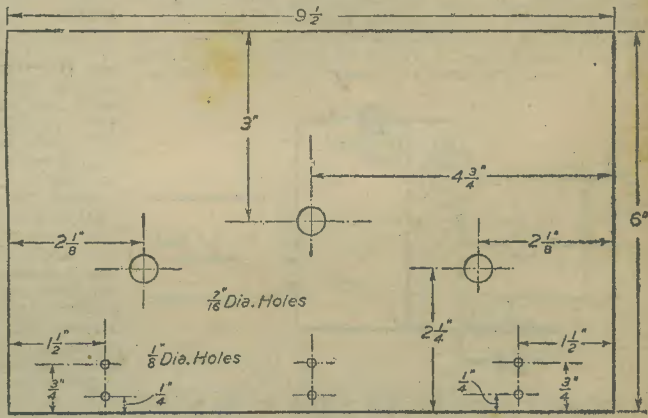


Fig. 2.—Panel and drilling dimensions.

Construction

A wooden panel 6in. by 9½in. is used, backed by a piece of perforated zinc slightly smaller. The baseboard is 9in. by 6½in., to which the panel must be rigidly fixed. Supporting brackets can be used, but in the set made by the writer the baseboard was 1in. thick and the panel was screwed to it with three pairs of screws, one above the other, as shown by Fig. 2.

The coil-holder, which is of the chassis type, is mounted 1in. above the baseboard by means of long screws and ebonite sleeves of appropriate length. The coil connections will be seen on the wiring plan, Fig. 3. The wiring should be as shown, and the coil-holder mounted with the key-way towards the panel.

Wiring was carried out with 18 s.w.g. tinned copper wire, insulated sleeving being used where necessary. A solid wire was also used for the connection to the anode cap of the H.F. valve. The resistors and condensers are held in place by their wire ends; they should be connected so that they cannot move about and spoil the extremely accurate logging which is possible with the band-spread condenser. A small piece of ebonite, equipped with two terminals, is used to hold the L.F. coupling condenser and its associated resistors accurately.

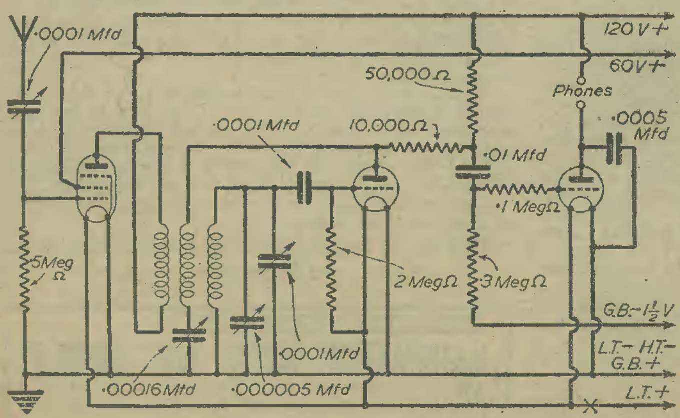


Fig. 1.—The simplicity of the circuit is emphasised by this diagram.

A wood-screw in the baseboard anchors the G.B. minus lead and the .3 megohm grid leak for the L.F. valve.

The output connector was made from an old two-pin coil holder, the socket going to H.T. plus and the plug to the L.F. anode. This is convenient if the 'phones are similarly equipped and other receivers in use are fitted with the same output arrangement.

The band-set condenser should be fitted with a knife-edge pointer and dial. A 4in. diameter knob, with 0-180 degree dial, is used on the band-spread condenser.

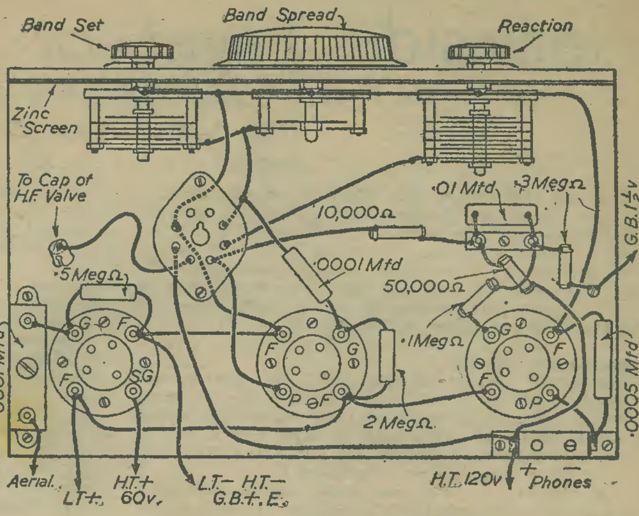


Fig. 3.—Component layout and wiring plan.

Operating Notes

The best coil to insert for the first trial is the 22-47-metre one. Owing to the good layout, this coil will tune to below 19 metres with the band-set fully opened.

With the band-set condenser set at minimum capacity, and the reaction advanced until a slight breathing sound shows that the receiver is in a sensitive condition, slowly turn the centre dial, and when a signal is heard make final adjustments to secure loudest results. Towards evening, many American stations will come in at "'phones on the table" strength.

The H.T. lead from the screen of the H.F. stage should be tried in various sockets of the H.T. battery to determine which voltage is most satisfactory for the valve in use. The pre-set aerial condenser should also be adjusted for best results; a capacity of about .00005 will probably be found best, but this will depend in some measure upon the aerial being used.

An on/off switch can be fitted in the L.T. lead at the point marked X on Fig. 1, if desired.

The construction of the receiver will be found to be justified by the results obtained. Even at the present time, when the sun-spot cycle is supposed to make conditions at their worst for 11 years, the set has received a great number of stations from all corners of the earth.

It is advisable, with a simple set of this type, to pay a reasonable amount of attention to the aerial and earth sections of the installation, as on these depend to a great extent the efficiency of the set, particularly from the point of view of DX results.

COMPONENT LIST

Variable condensers: .000015 mfd., .0001 mfd. and .00016 mfd. All-brass, ball-bearing trolitul short wave.

6-pin coils (Premier): Type 06B and 06C, for 19-90 metres tuning range. (Other coils, if required: Type 06, 9-15 metres; 06A, 12-26 metres; 06d, 76-170 metres.)

Coil-holder: Octal type.

Resistors: 1 each of 10,000 ohms, 50,000 ohms, 100,000 ohms, 300,000 ohms, 500,000 ohms, 2 megohm.

Condensers: .0001 mfd. (mica), .01 mfd., .0005 mfd.

Pre-set condenser: .0001 mfd.

Valve-holders: three 4-pin baseboard type.

Large knob for band-spread condenser. Two small knobs for reaction and band-set condensers.

Zinc for screen. Connecting wire and sleeving, etc.

Valves: Cossor 210 VPT for H.F. stage; Mullard PM2HL for detector stage; Osram HL2 for L.F. stage (or similar types).

Servicing Notes

Oscillation in a Superhet

RECENTLY a complaint was received of oscillation accompanying all signals in a modern superhet of well-known manufacture. It was assumed that the oscillator volts had risen, owing to the anode resistor decreasing in value.

The set was placed on the service bench and switched on. To my surprise, the oscillation had ceased, and reception appeared to be normal, and remained so for some eight hours. Even so, extensive tests were made to find out the cause of the original trouble, but the oscillator anode resistors and the associated decoupling condensers were correct, and, eventually, the receiver was returned to the owner as being in perfect condition.

Some weeks later, however, the complaint was again received, and, deciding that it was a job to be done on the spot, I took my service kit with me.

The receiver was on a small table in the corner of the room and oscillation was forming a background to the programme. After turning the set round carefully, the back was removed, when the real cause of the trouble was apparent, and a small amount of cotton wool and insulating tape did the trick.

The rectifier valve was oscillating at a frequency somewhere in the region of 1,500 c.p.s., and a tap of the cabinet cured the trouble, evidently by displacing the valve, or its component parts, very slightly.

This explained how the oscillation had disappeared by the time the set reached the service bench, and why, after having been reinstalled it had remained satisfactory until the housewife moved the cabinet.—(J. W. Bower.)

Checking the Polarity of 'Phones

OCCASIONALLY it is desired to use 'phones and moving-iron speakers from which the leads have been disconnected, and which have no markings to show the correct polarity of the connections.

Having a first-class pair of 'phones from which the leads had been removed, and being unable to find any markings either inside or outside the case, a method to determine the polarity was needed. This appeared almost impossible until the following method was tried.

A milliammeter of the moving-coil type was connected to the 'phones (any instrument of not more than 10 mA's. full-scale reading is suitable and the ebonite cover removed from the 'phones. Pulling the diaphragm off with a swift movement produced a current which caused the meter to show a momentary deflection. If the needle moves in the wrong direction, reverse the leads; when properly connected the 'phone polarity is the reverse of that shown by the plus and minus of the meter. Speakers may be tested by moving a piece of iron rapidly *from* the magnets. The accuracy of this method can easily be proved by applying it to a speaker or 'phone of which the polarity is known.—(F. G. Rayer.)

Heaviside Layer or Ionosphere?

The E and F Regions. Critical Penetration Frequencies.

By CAMPBELL BEGG, M.Sc.

(*Continued from page 188, April issue.*)

IT is for this reason that these frequencies are the worst for long distance reception. As the primary purpose of broadcasting is to provide a reliable, steady, fade-free service, the range is limited to the area between the transmitter and the point where the first wave reflected from the ionosphere is returned to earth. Reception beyond this point, being subject to fading, is only of secondary importance.

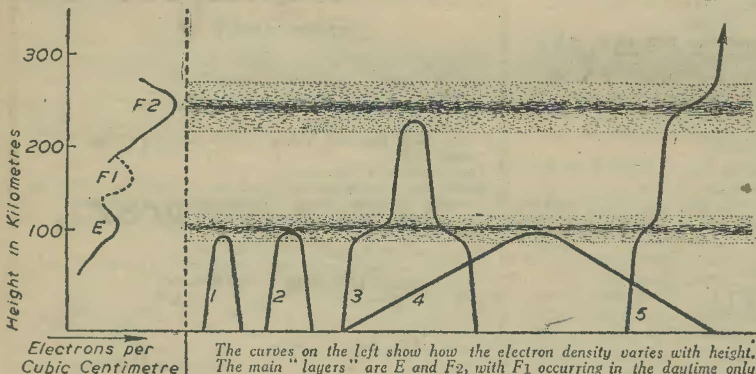
"Long-wave" Band

For lower frequencies than this, i.e., the normal "long wave" band, the region of the free electrons in the upper atmosphere acts as a conducting screen which reflects the waves back to earth like a mirror. These waves hardly penetrate the ionised region at all, so that there is very little attenuation.

Now we can see why the longer waves were used exclusively in the early days of wireless. For the waves going along the earth's surface, the longer the wavelength the greater the range, i.e., the longer the wavelength the less the attenuation of the "ground wave." The sky wave, too, suffers very little attenuation at the reflecting surface of the ionosphere, due to the small penetration at these frequencies. As the wavelength is reduced the ground wave is more attenuated, and so is the sky wave, due to great absorption in the ionosphere, until the gyro frequency, corresponding to about 230 metres, is reached. No one, therefore, bothered much about wavelengths shorter than this. These short wavelengths, in fact, were given to amateurs to play with, and soon there were more surprises when their tiny powered signals were clearly received at great distances.

But before talking about the short waves there is one more effect of the earth's magnetic field that should be mentioned. To get the maximum signal in the receiving aerial, the aerial wire should lie in the direction of the electric field of the wave. The effect of the vibrating electrons in the ionosphere being pulled out of their straight line paths by the earth's magnetic field is to change the direction of the electric field of the wave, so that in the downcoming wave after its adventures in the ionosphere, the electric field may be in any direction, and, in fact, will be constantly changing. There is therefore, no point (other than for minimising local noise) in having the receiving aerial in any particular direction. This effect also tends to upset direction finding by radio.

In the diagram below we can examine the particular structure of the earth's ionosphere, and see how knowledge of this is used for practical short-wave communication.



The curves on the left show how the electron density varies with height. The main "layers" are E and F2, with F1 occurring in the daytime only and mainly in summer.

Curves 1, 2, 3, 4 and 5 show possible paths assumed for waves of different frequencies. 2 is higher in frequency than 1, and so penetrates farther. 3 is sufficiently higher in frequency to penetrate the E region completely. 4 is the same frequency as 3 but owing to its oblique incidence the bending is sufficient to turn it back to earth. 5 is still higher in frequency. At the angle of incidence shown the ionisation of either region is insufficient to bend the ray back to earth.

Now that we know something of how the radio waves are affected when they meet with free electrons, let us see how these electrons are distributed in the atmosphere of the earth.

From observations it was soon realised that the main ionising agent was something radiated in straight lines from the sun, and the conclusion is that it is the ultra violet radiation. This radiation is rapidly absorbed by the atmosphere, so that it is strong at the outer edge of the atmosphere and weak near the earth. But at the outer edge of the atmosphere where the ionising radiation is strong, the air is rarefied, i.e., there are not many atoms to be broken up. Near the earth there are plenty of atoms, but the ionising radiation is weak. The consequence is that there is a maximum ionisation at some intermediate height. The ionosphere has been defined as that part of the upper atmosphere which is sufficiently ionised to affect the propagation of wireless waves.

Up at the height of the ionosphere (about 80 to 400 kilometres) the air consists mainly of nitrogen in molecules and oxygen in atoms, and as there is no wind at these heights to cause mixing, these gases tend to separate into layers according to their weights. As the different gases require different intensities of ultra violet radiation to break them up into their ions, there are likely to be two heights at which the density of electrons is large. Actually even in the same gas the atoms may be in different states requiring different intensities of ultra violet radiation to ionise them. The result is then that we expect the upper air to be ionised to a greater or less extent, and that there is not just one height where the ionisation is specially intense (large density of electrons), but several.

We can see now what will happen to a radio wave on entering the ionosphere from below. Its path will get bent a little at first, then more and more as it penetrates to heights of greater electron density. It may get bent sufficiently to turn it right back and out the lower edge back to earth again.

Two Main Regions

Investigations have shown that there are two main regions where the ionisation is a maximum. The lower one, which keeps pretty steady at a height of about 100 km., is called the "E region" (or layer), and the upper one, which may be anything between about 220 and 350 km. in height, is called the "F region"—or layer. The ionisation of the F region is about five times

(*Continued on page 239.*)

as intense as that of the E region, so a wave may often be insufficiently bent in the E region to be returned to earth, but on reaching the F region will be turned back. Again, the ionisation of *either* region may be insufficient to turn the wave back, so that the wave goes right through the ionosphere and is lost in space. The diagram shows the ionisation and the wave paths.

If a wave enters the ionosphere at a very flat angle it will obviously require less bending to bring it back to earth than a wave entering nearly vertically. Thus, whether a wave is returned from the sky or not, depends also on the angle it enters the ionosphere.

We saw earlier that the amount of bending depends upon the frequency of the wave, and it is found that the E regon is always sufficiently ionised to return the lower frequencies (long and medium waves) to earth, but normal short wave communication is carried out mostly by reflections (from what we have seen above, "reflection" is not a very good word), from the F region. For his experiment in 1901 Marconi used a wavelength of about 1,300 metres, so that the Heaviside layer is identified with the E region. The existence of the F region was a later suggestion by Appleton in 1927 and this is often called the Appleton Layer. For short wave communication using the F region we see therefore that the Heaviside Layer is just a hindrance causing unwanted attenuation of the signals.

In the summer during the day, i.e., when the sun is at its strongest, the F region seems to acquire a lower shelf at about 150 km., called the F_1 region; the main F region becomes then the F_2 region. The F_1 region disappears at night, and is rare in the winter.

Critical Penetration Frequencies

As there is a definite relationship between the amount of bending, the density of the electrons, and the frequency of the wave, the electron density of a region can be measured by finding at what frequency a wave sent vertically upwards will just go right through the region and not be returned to earth. Measuring these "critical penetration frequencies" at different times shows how the ionisation varies with the time of day and the season of the year, etc. Results show that the ionisation of E and F_1 regions follow closely the variation of the sun, i.e., the ionisation is a maximum at noon and greater in the summer than in winter. There is one strange thing though. During the night there is ample time for all the ions to recombine into neutral atoms and molecules by collision, and yet the ionisation never completely disappears. There must be some nocturnal ionising agent, perhaps charged particles from the sun deflected to the dark side of the earth by the earth's magnetic field, or possibly thunderstorms over a wide area, or meteors.

The F_2 ionisation is not quite so simple in its variations. Winter noon ionisation is actually greater than for summer noon, and when the sun sets, the decay of ionisation is suddenly checked. This, it seems, is not due to a nocturnal ionising agent, but is because the rarefied air at the height of the F_2 region quickly cools and shrinks, so that the actual density of the electrons (the number in a cubic centimetre) is not reduced. In summer during the night there is a gradual decay of the F_2 ionisation because then at heights of 250 km. the sun never sets.

The sun itself waxes and wanes in activity over a cycle of about eleven years, so that the electron density also depends upon the year.

Fade-outs

Every year there are many occasions when the long distance signals suddenly fade out completely for a time, then more gradually come back again. Has the ionosphere suddenly evaporated? Well, that seems most unlikely, especially as the electron density immediately after the fade-out is usually the same as just before it. The most likely explanation is that a sudden burst of intense radiation is emitted from the sun, sufficiently intense to cause ionisation at a very low level where the air density is such that the many collisions completely absorb the energy of the radio wave.

The ionisation in the ionosphere is continually fluctuating and is not even evenly distributed along a layer; in the lower levels for instance there are "clouds" of ions which cause scattered radiation of the radio waves. Also magnetic storms have a marked effect on the ionisation. The E, F_1, and F_2 regions, varying with time of day, season and year, are regular features, and much data, constantly being collected, allow useful predictions for the state of the ionosphere at a particular time to be made. These predictions, before the war, were published monthly by the I.R.E. of America in the form of curves giving the maximum usable frequency for the coming month for different distances. These applied to frequencies higher than the gyro frequency, i.e., the normal short wave band. The "maximum usable frequency" is listed because it will be remembered that the higher the frequency the less the attenuation; but if the frequency is too high, the wave will penetrate the ionosphere completely and be lost forever in space. This maximum usable frequency has to be given for different distances because whether or not a wave completely penetrates the ionosphere also depends upon the angle at which it enters the ionosphere. In practice, to make allowance for changing conditions, a frequency about 80 per cent. of the published maximum usable frequency for the required distance and time is used.

Conclusions

The upper air is ionised, mainly by ultra violet radiation from the sun. Due to the density gradient in the atmosphere, the gravity separation of the gases, and the different states of the atoms and molecules, the ionisation is not evenly distributed but has several regions of specially intense ionisation. There are often abnormal conditions, but the regular features are:—

E region—Fairly constant in height at about 100 km. and following the sun in ionisation intensity, i.e., maximum when the sun's activity is maximum, and at noon on a summer day.

F_1 region. About 150 km. in height and occurring only during the day, and not often even then in the winter. Like the E region its ionisation intensity follows the sun.

F_2 region. Varying considerably in height between about 200 km. and 350 km., present day and night but not following the sun in the times of its maximum ionisation (maximum ionisation in the winter).

It would also be normal to expect some irregular clouds of electrons at about the level of the E region.

The effect on the radio waves is:—(a) To bend their paths away from the level of maximum ionisation. The amount of bending depends on the electron density and the frequency of the wave, being less, the higher the frequency. The angle of incidence of the wave on the ionosphere will determine whether the bending is sufficient to return the wave to earth. (b) To attenuate the wave by absorbing energy from it. For frequencies higher than the gyro frequency, this attenuation decreases rapidly as the frequency increases. The attenuation is very great at the gyro frequency (about 1,300 kc/s—230 metres) and is fairly uniformly large in the medium wave broadcast band. In the long wave band the penetration into the ionosphere is small, and consequently the attenuation is small and almost uniform over the band. It may be noted here that long waves are going out of fashion, not because of their propagation characteristics, but because of the extremely inefficient aerial radiating systems it is possible to make for these wavelengths. "Atmospherics" too are bad at these frequencies.

(c) To alter the direction of the field (i.e. "polarisation") of the wave.

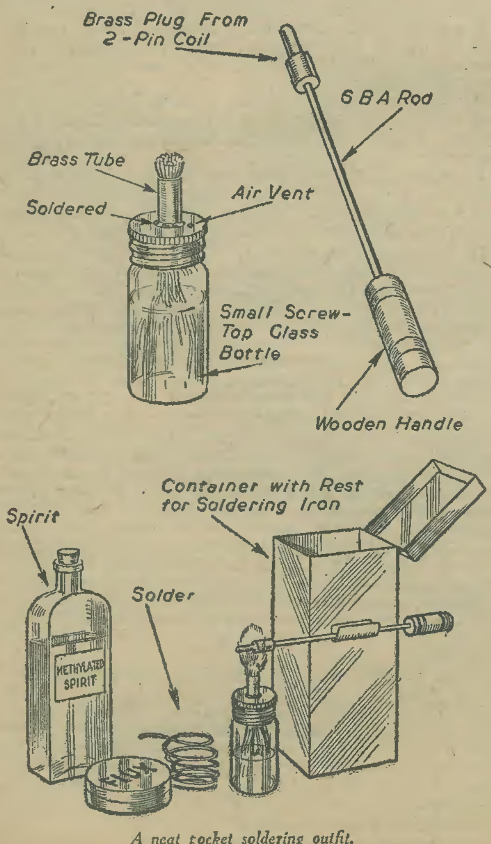
As a result of all this it is clearly best to use the highest possible frequency for short wave communication. This means knowing the likely state of the ionosphere, therefore investigations are constantly being made, and from the data obtained useful predictions as to the best frequencies to use for given times and distances are regularly published. Frequencies higher than about 40 mc/s under normal conditions will always completely penetrate the ionosphere.

Practical Hints

Pocket Soldering Set

THE soldering set here described was originally made for use when mending receivers where there was neither gas nor electricity, or, in the summer, any fire or means of heating an iron for soldering. The soldering iron is very small, as a large iron is difficult to heat with a spirit lamp. It is made by fixing a wooden handle upon one end of a length of 6 B.A. rod, and the plug from an old two-pin coil to the other. The lamp is made by soldering a length of brass tube to the metal cap of a screw-top bottle. The wick is made from lengths of wool, as many being threaded through the tube with a needle as is possible. A small piece of tin, bent channel-shaped to hold the iron, is soldered to the side of the containing tin at the correct height.

The iron is not suitable for soldering large pieces of work, as it will not hold enough heat, but it is eminently suitable for radio work, and will be found convenient when wiring up multi-contact switches, and in other places where there is not room to use a larger iron without the danger of burning neighbouring components. Flux, solder, a bottle of methylated spirit, the lamp and iron, are all carried in the containing tin.—H. J. RAYER (Longdon).

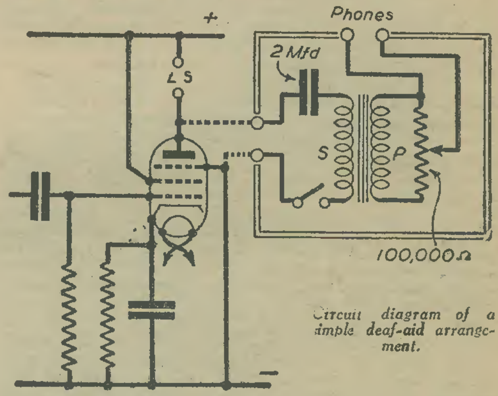


A neat pocket soldering outfit.

Deaf-aid Arrangement

SOME time ago I had to fit a pair of headphones to a commercial receiver for a very deaf person who did not want to annoy other listeners by turning up the volume too far. After trying various arrangements I decided on the one shown in sketch. The transformer, condenser, and volume-control (incorporating the on and off switch) are housed in a small wooden box separate from the receiver.

The output valve of the receiver is a Tungsram APP4c, and there is no loss of reproduction when the unit is switched on. The transformer is an ordinary intervalve transformer reversed, with the volume control connected across the primary terminals. The whole arrangement is very satisfactory and there is no danger of shocks.—J. B. O'KANE (Belfast).



Circuit diagram of a simple deaf-aid arrangement.

Output-filter Circuit

WHEN using an output-filter circuit one common cause of disappointment in the results is the use of an unsuitable L.F. choke. It should be remembered that the choke is in parallel with the speaker transformer; consequently it will have a marked effect on the loading value of the speaker, and, therefore, if any old choke is selected and the speaker matching is not attended to, the valve may be operated with an incorrect load value. The choke should have an inductance in the region of 20 henries when carrying the D.C. current of the output valve. If this current is in excess of that for which the choke is rated, the inductance value will decrease.—R. SIMPSON (Leeds).

Battery-charging

MANY constructors use metal rectifiers in conjunction with a mains transformer for accumulator charging. An important point to be borne in mind in this connection is the current which is permitted to flow, and therefore an ammeter in series with the accumulator should always be used. Some rectifiers are used with a tapping on the transformer, whilst others are used with a variable series resistance, and care should be taken to follow the rectifier makers' instructions regarding the particular circuit adopted, the accumulator makers' instructions regarding the current used during charging, and the hours during which the cell is allowed to remain on charge.—H. WELTON (Watford).

ON YOUR WAVELENGTH

By THERMION

To Readers in Eire

I HAVE received, and I understand the Editor has received, a number of letters from readers in Eire asking for details of communications receivers, short-wave receivers, and transmitters! I, as well as the Editor and the staff of this journal, am compelled to turn a deaf ear to all of these requests. In the first place it is illegal for us, or any other journal, or any other private individual, to send diagrams into Eire. In view of recent disclosures it is even more undesirable that readers in Eire should send requests for such information. I am not suggesting for one moment that the increase in these requests has any sinister connection with international politics or policies, but the fact is that readers in Eire who want this information must understand why we cannot supply it.

This country is at war; Eire is enjoying neutrality, a question I am not at liberty to discuss. All the same, I want to make it quite clear that I, for one, am not prepared to send technical information to Eire at the present time, and thereby risk imprisonment in the Tower. I thought that my very loyal readers in Eire would be glad to hear this from me, and to learn why I must turn a deaf ear to their requests.

My Dear Watson

LANE-NORCOTT, in the *Daily Mail*, recently wrote the following:

Here is a fascinating bit of pure radio entertainment which we have written specially for that hardy old perennial "*Funday Night at Eight*." We have tentatively called the item "*No Advertising for Miss Blandish.*"

SCENE: A studio mock trial. Miss Topsy Blandish, a little actress, enters the witness-box.

Counsel: Are you at present "working" or "resting"?

Miss Blandish: What an absurd question! I am playing the principal role in "Black and Blue," Kale Peter's new revue, presented by Max Mugger, with book and lyrics by Sid Bulger, additional lyrics by Moss Pan, scenic effects by Zegg, and *my* costumes by Mme. Piffler!

Counsel: If it is not a rude question, Miss Blandish, at which theatre is this sensational entertainment to be seen?

Miss Blandish: At the Frivolity, of course! Nightly at six o'clock, matinees Wednesdays and Saturdays at 2.30.

Counsel: I don't want to be too hard on you, Miss Blandish, but before you leave the witness-box I must insist that you entertain the members of the jury by singing one of your delightful numbers from the show, which I am given to understand, is doing record business.

She does so and the scene ends amid unbridled applause from the actress-crazed jurymen.

We sincerely hope that this item won't cause a frown.

One of my contributors comments as follows:

"Watson, my dear fellow, I have made a most interesting discovery."

"My dear chap," I replied, "nothing unusual in that, is there? What is it this time?"

Before replying, Holmes took off his deerstalker cap, put down his pipe, took up his beloved violin, and drew his bow caressingly across the strings.

For a few moments, his whole body vibrant with musical ecstasy, Holmes filled the air with double harmonics and delightful arpeggios, in which, I confess, I became almost as enthralled as he himself.

Then he put down the violin and pointed an accusing and admonitory finger at me. "Watson," said he, "Lane-Norcott of the *Daily Mail*, is a constant reader of Thermion's Page in PRACTICAL WIRELESS."

"Good Heavens! Holmes," I exclaimed. "How on earth do you know that? Do you know Lane-Norcott? Or Thermion? Have either of them told you of this interesting fact?"

"Never met either of them in my life," said Holmes, indulging in an infuriating and enigmatical smile.

"Holmes," said I, "you continue to amaze me! I do not for one moment doubt your word, but, if you do not know him, how can you make such sweeping statements about Mr. Lane-Norcott's literary tastes?"

The enigmatical smile grew wider and wider, until it almost reached from ear to ear, and in a pitying voice Holmes replied: "Simple, my dear Watson. Read Thermion's page in PRACTICAL WIRELFSS, and note his comments on the 'puffing' at Broadcasting House, and then read Lane-Norcott in the *Daily Mail*."

Explained in this lucid and informative manner, the mystery was made clear to me and, beyond all further doubt, I agreed with my friend's solution!

K. T. H.

Our Roll of Merit

Readers on Active Service—Forty-first List.

J. R. Kirkpatric (A.C.1, R.A.F.).
J. Davey (L.A.C., R.A.F.).
L. K. Paddison (Tel., R.N.).
J. Parrish (A.C., R.A.F.).
R. Hawkins (Cpl., R.A.F.).
S. Morris (Spr., R.E.).
S. Astley (Cpl., R.A.F.).
— Hook (L.A.C., R.A.F.).

Recording and Reproduction of Sound

THE Discussion Evening held by the Wireless Section on February 15th, 1944, on the subject "Recording and Reproduction of Sound," aroused much interest.

Dr. G. F. Dutton, in his introduction to the discussion, stated that when industry can turn back after the war to the development and manufacture of gramophones, it would be useful to have a settled line of attack. It was the purpose of this discussion to exchange views regarding the various systems available for the recording and reproduction of sound, bringing out their comparative merits and demerits.

The disc system, in spite of its age, offers a great many facilities for home use and for broadcasting. It is relatively easy to handle; it provides a self-contained and compact unit; processing is relatively cheap; short numbers can be catered for, and the record is accessible for extracting short portions for programmes or educational use.

"THE SOB SISTERS"

[Press Item.—Cockney women crooners who "wail about lost babies" in the General Forces programme cannot be good for the morale of our Second Front troops. This view was forcibly expressed by Earl Winterton in the House of Commons, when he asked: "Is it really necessary to continue the number of female crooners we had before? Their accent resembles no known American accent; it reminds me of the caterwauling of an inebriated cockatoo."]

The most sincere thanks are due,
Most noble lord, from us to you,
Re women crooners caterwauling,
Across the air too often calling.
"Inebriated Cockatoos"—
Oh! what appropriate words to choose.

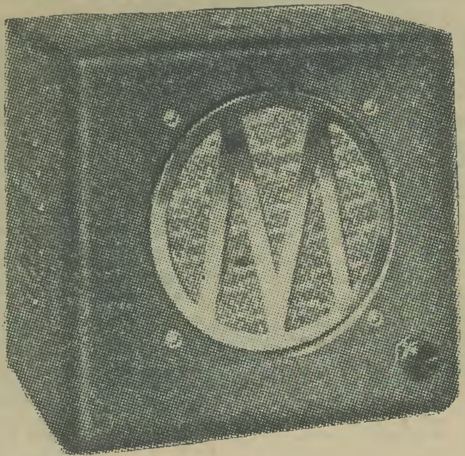
Some insult to our troops is here,
A little thinking makes that clear.
Their taste's not sunk to such low level,
And their comments would shock the Devil,
These "Blue-eyes" of the B.B.C.
Depress our troops with bored "ong-wee."

Their very numbers seem a sin.
Could Mr. Bevin not step in,
Directing them to some new jobs—
Requiring work, instead of sobs?
Surely the girlies would not shirk.
Or would they rather croon than work?

"TORCH."

Car Radi

The Ban on Car-radio Installations Has Recently Been Choice, Installation, and Licensi

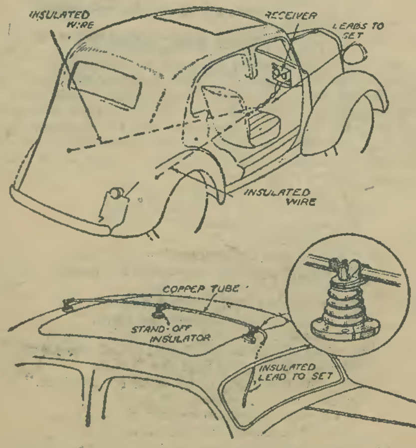


The Masteradio "Roadio Six," a popular pre-war model.

THE recent lifting of the ban on car radio came as very welcome news to those motorists who are still able to use their cars on work of national importance. Although this move had been mooted previously, the raising of the ban came as rather a surprise to most of us. It has already had the effect of raising the prices asked for car-radio sets by those dealers who held second-hand instruments in stock, whilst many of those readers who had a set fitted in their cars before the war have probably forgotten the installation details and will be in rather a quandary. Most radio and car firms are so busy and so short-staffed that they will be unable to undertake installation work—at least for a long time—and we are asked by the makers of the two models shown in this issue, namely, Philips and Masteradio, to make it quite clear that during existing conditions they cannot supply any models.

Licence Essential

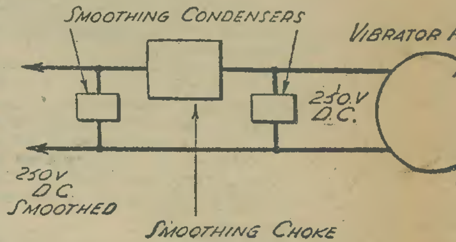
Before proceeding to the more practical aspects, it should be made perfectly clear that it is necessary to have a licence for a car-radio receiver. The licence which is applicable to a "domestic" receiver does not cover the set fitted in a car. In taking out the licence at the post office it is desirable that the clerk should be asked to endorse the licence to show that it does apply to a receiver installed in a car. That would save a good deal of trouble in the event of being stopped by the police and asked to produce the licence; and, in some cases, particularly with Service personnel, a receiver may not be in use at the address stated on the licence.



Showing the location of one form of under-car aerial, and a popular single rod roof type.

Choice of Receiver

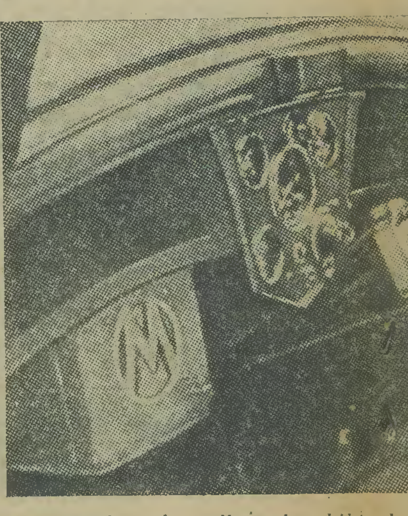
Let us assume first that it is intended to buy a receiver. What points should be watched? Obviously, the physical dimensions in relation to the space available inside the car must be taken into account; it would be foolish to buy one of the largest sets if it were to be installed in an Austin "Seven." In addition, there are many largish cars in which it is difficult to fit a medium-sized receiver without encroaching unduly on the leg-room available for a front-seat passenger.



A schematic diagram of the fundamental c

Next there is the question of the supply voltage available. Most British-built car-radio sets were made in two types, for 6 and 12-volt operation, but many of the American receivers were made in 6-volt models only. In the latter case it is necessary to fit a voltage-dropping resistor if the receiver is to be fitted in a car having a 12-volt supply. Do not attempt to connect the set between one side of the battery and a tapping; there are objections to this, and they will be referred to later.

The use of a voltage-dropping resistor is perfectly satisfactory, provided that the resistor is mounted in such a position — say under the bonnet —that there is a free circulation of cooling air around it. This method of feeding the receiver has one rather serious disadvantage,



A typical car radio installation, the model being the cover was produced in pre-war c

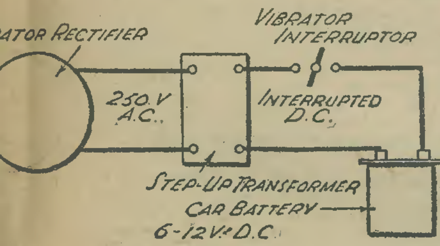
dio Again

Been Lifted. Here is Some Sound Advice on the Licensing of Car-radio Receivers

however, which is that the power consumption from the supply is double the power actually taken by the set. The average 6-volt car radio takes between 3.5 and 5 amps.; a 12-volt set usually takes between 2 and 3 amps. Consumption is dependent to a fair degree on the circuit arrangement in the receiver.

Circuit Details

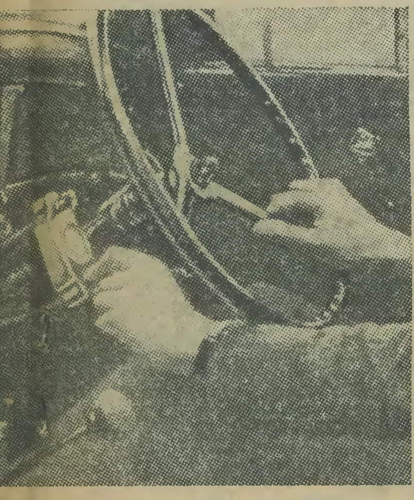
Practically every car radio uses a superhet circuit, but whereas the simpler types of set have only four valves, others have six or seven. In general, the greater number of valves is to be preferred, because this means that there is a pre-frequency-changer H.F. stage. This gives increased amplification, and also, in general, better A.V.C. In some cases the vibrator used for stepping up the car battery voltage for H.T. is of the self-rectifying type, whilst in others the vibrator acts merely as an interruptor; in the latter case a valve is required for rectification.



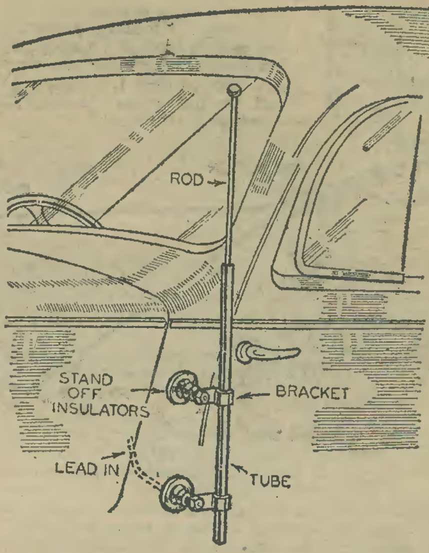
amental arrangement for the power supply.

Positive or Negative Earth

Apart from the voltage from which the set is designed to operate, there is a question of polarity to consider. As readers will be aware, the negative pole is earthed on some cars, whilst positive earthing is used on others. The metal case of a car radio is generally earthed, earth-bonding being obtained through the mounting bolt or bracket employed. It is generally possible to modify a "negative-earth" receiver to "positive-earth," and vice versa, but if possible it is far better to obtain a set with an earth system appropriate to the car into which it is to be fitted. Sometimes, the system of earthing can be reversed by withdrawing the vibrator unit and replacing after turning through about 90 degrees; this is by no means standard, however, so if a change is to be made, each individual set should be considered on its merits if the makers' instructions are not available.



being the "Roadio Six." The receiver shown on the pre-war days by Messrs. Philips.

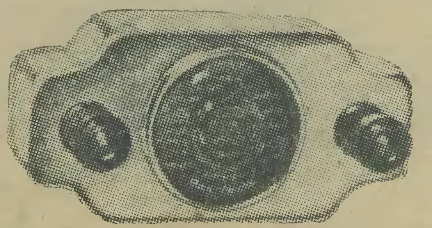


A popular form of car-radio aerial. It is known as the "fishing-rod" type.

Aerial Types

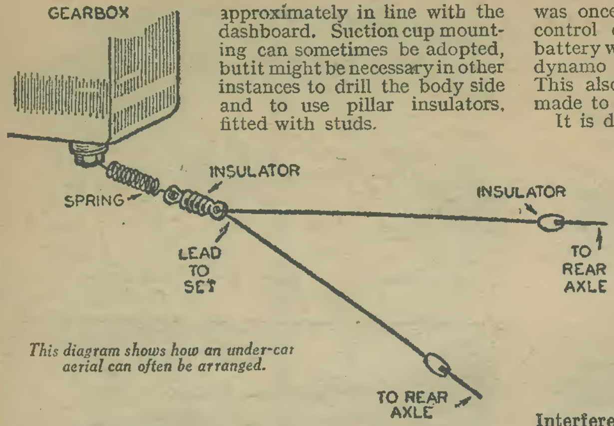
Assuming that the above points have been satisfactorily cleared and a set is available for fitting, the question of the installation itself can be considered. It is well to start by deciding on the type and position of aerial to be employed. In the case of a car with a wooden-framed, fabric-covered roof, there is little doubt that a roof aerial is most satisfactory. The single or "V" rod type can usually be fitted by means of the rubber suction cups provided, after applying a suitable adhesive to the insides of the cups. The cups should simply be pressed firmly down on to the metal parts of the roof at the front and rear. Should the roof have a sliding portion the third or centre suction cup may present a difficulty, and it will probably be necessary to omit it, and trust that vibration will not loosen the other two. The alternative is to agree to have the sliding roof permanently closed or capable of being opened only a short way. The best solution is probably to use a "V" type roof aerial, the suction cups of which can be fitted one at each side of the roof.

In the case of a car with all-metal roof, a "fishing-rod" or "hinge-pin" type of aerial is generally found most satisfactory. This can be mounted on the near side



The remote control unit for use with the "Roadio Six."

approximately in line with the dashboard. Suction cup mounting can sometimes be adopted, but it might be necessary in other instances to drill the body side and to use pillar insulators, fitted with studs.



This diagram shows how an under-car aerial can often be arranged.

Should it be preferred that the aerial be "invisible," one of the "running-board" type, which fits under the running board, can be fitted. Aerials of this pattern are often in pairs (one for each running board) and have a matching transformer to feed them into the set. A simpler under-car aerial consists of a length of wire in "V" shape between, say, the base of the clutch housing and the two ends of the rear axle. The point of the "V" would be attached to the forward mounting, and the aerial lead-in would be taken from it. Since the distance between the mounting points will vary as the car traverses every small bump on the road, it is wise to use tension springs to join to the rear anchorages. Although it has not been mentioned, it will be understood that any type of aerial must be properly insulated.

Screened Aerial Lead

The lead from the aerial to the set, regardless of the type of aerial used, should be screened. If not, there will be a danger of ignition noises being picked up, even if suppressors (of which more later) are fitted. So-called co-axial cable is best for this purpose, since it has a low capacity; ordinary screened wire has a comparatively high capacity and higher losses. The screening should be well earth-bonded at as many points as possible.

In most cars it will be found most convenient to mount the set beneath or inside the cubby hole on the near side. The method of mounting will vary according to the receiver used, but in every case care should be taken to ensure that the metal containing case is earthed; this may necessitate the use of a strip of copper or a length of heavy-gauge copper braid of the kind often used for earthing one car-battery terminal.

When a roof aerial is fitted it will be necessary to drill a hole through the front of the roof to allow the lead to be fed through. A rubber grummet should be used, which will be a tight fit in the hole and round the lead-in cable. The lead can then be led along the upper edge of the windscreen and down the near side. Provided that good co-axial cable is used, the extra foot or so required to run the lead neatly will not matter. With a "fishing-rod" aerial the lead-in will probably be no more than 18in. long if the set is mounted in the position previously mentioned. That being so, a length of ordinary screened wire may be used without introducing any appreciable loss. In the case of an under-car aerial, the lead-in can normally be brought through a hole near the forward edge of the footboards and run up the inside of the bulkhead.

Supply Connections

The precise method of picking up the 6-volt or 12-volt supply will vary with different cars, but it is important that connection should *not* be made directly to the battery. This was once done on a car with a compensated-voltage-control charging system, with the result that the battery was run down in one day, despite the fact that the dynamo and voltage regulator were operating correctly. This also explains why a 6-volt tapping should not be made to a 12-volt battery.

It is desirable that there should be a fuse in circuits and many car-radio receivers have one included in either the set itself or in a supply lead. If not, a fuse should be fitted. Connection can then be made between earth and the terminal marked "AUX" on the fuse box. This terminal is in series with the "auxiliary equipment" fuse, and generally supplies the direction indicators, screen-wiper motor and electric horn. There may be a danger of this fuse being overloaded with the extra drain; in that case, connection should be made to terminal "A," which is connected to the ammeter (when provided) and to the other side of the auxiliary-accessories fuse.

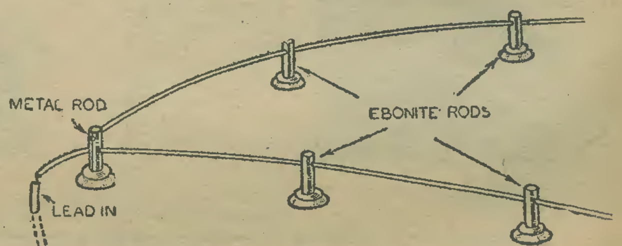
Interference Suppression

It remains only to consider the question of interference suppression. In general, it can be expected that some interference will be picked up from an unmodified ignition system, but this does not always follow. It has often been found that the fitting of interference-suppression resistors in the sparking-plug and main H.T. ignition leads is totally unnecessary. In other instances it has been found that interference persists in spite of these precautions.

It is therefore a good plan to check the operation of the receiver, with the engine of the car running, before fitting suppressors. If ignition noise is present—a form of "crackle" which varies markedly in frequency as engine speed is changed—plug suppressors are probably required. These were made as standard components, but 10,000-ohm carbon-rod type resistors can be used. The suppressors should be fitted right on the plug terminals. A similar suppressor may also be required in the lead entering the centre of the ignition distributor; this, also, should be as close as possible to the terminal.

In rare cases it will be found that the dynamo causes interference, but try the effect of cleaning the commutator and checking the brushes before jumping to conclusions! If necessary, a .1 mfd. suppressor condenser can be fitted between the field terminal and earth. Suitable condensers are made, and have a mounting bracket for attachment to an earthed bolt, and a "pigtail" lead for connection to the dynamo terminal.

If crackles of a spasmodic nature are heard, it is probably an indication that some earth bonding is required between parts of the chassis or bodywork. As an example, a wing may be partly insulated from the rest of the body by a strip of felt and the mounting bolts may be rusty. As a result, intermittent contact takes place, with consequent "static." Removal of rust and the making of good electrical contact between the two parts will put an end to the trouble. Another similar trouble can arise due to loose running boards or even loose body-holding-down bolts. These items should receive attention whether they cause radio interference or not!



One type of "V" aerial fixed to the roof of the car by suction pads.

Radio Examination Papers—29

Another Random Collection of Interesting Questions, With Appropriate Answers, by THE EXPERIMENTERS

QUESTIONS

1. *What steps would you take to ascertain the cause of a sudden falling-off in both sensitivity and selectivity of a superhet receiver of usual design?*
2. *Explain the purpose and principle of an electron multiplier.*
3. *Describe a method of eliminating "birdies" from superhet reception. Assume that there is no pre-selector stage.*
4. *What points would you look for in checking the earth-bonding of a short-wave mains receiver which was found to be unstable and prone to reproduce mains hum?*
5. *If a high-gain output tetrode in a newly-built receiver were found to be unstable, what simple circuit modifications would you try?*

1. Loss of Selectivity and Sensitivity

IN the event of both sensitivity and selectivity showing marked signs of deterioration, it would be reasonable to commence an inspection by checking the connections to the coils and I.F. transformers. An open-circuit in any of the windings could cause the effect described, whilst a defective trimming condenser could also be responsible.

If a calibrated signal generator is not available, it is not wise to tamper with I.F. or oscillator trimmers, but there should be no harm in observing the effect of adjusting them—each in turn—if the original settings are first carefully noted and marked, so that they can later be duplicated if necessary. After marking, tune in a steady signal, preferably after replacing the normal aerial by a short length of wire and disconnecting the A.V.C. supply, if this is provided. The effect on signal strength can then be noted by slowly turning each trimmer in turn, starting with that across the secondary of the final I.F. transformer.

Should it be found that adjustment of any condenser does not have any effect, it may be tentatively assumed that either that trimmer or its associated winding is defective. If, on the other hand, each trimmer has the effect of altering (probably reducing) signal strength, the fault is elsewhere. We state "*probably* reducing" signal strength because in some superhets the tuning of the I.F. coils is "staggered" in order to give a deliberate band-pass effect. Thus, it may be found that reception is improved in both respects when one of the trimmers is adjusted; in that case, it might be desirable to make the new setting permanent, but reproduction will probably suffer at the upper end of the audio register.

Should the fault remain undiscovered it is a good plan to check the valves; if possible by replacement. Although probably least suspected, the double-diode-triode second detector is as likely as any to give the effects mentioned if it is becoming soft. Such a valve loads the secondary of the final I.F. transformer too heavily. If its emission is failing, detection is impaired.

The I.F. valves, and H.F. valve if provided, should not be overlooked. If the frequency-changer were defective there would probably be symptoms other than those stated in the question. In fact, it would probably fail to oscillate properly, rendering the set "dead" over certain parts of the tuning range.

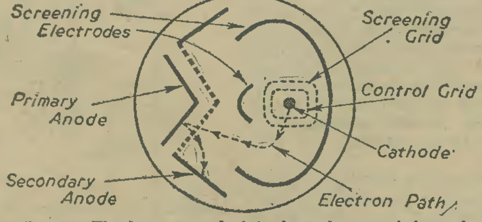
2. The Electron Multiplier

Seldom used for normal radio reception, the electron multiplier was developed primarily for television use. It is a form of valve the purpose of which is to obtain a much higher mutual conductance than can possibly be obtained by any normal type of valve. The principle of the device is that of directing the electron stream from the cathode on to an anode at comparatively low potential. When these primary electrons strike the anode at high velocity they cause a greater number of secondary electrons to be liberated; these are attracted to what might be termed a secondary anode, at higher potential than the first.

The form of construction for a tetrode type of electron multiplier is shown diagrammatically in Fig. 1, where it will be seen that in addition to the normal cathode, control grid and screening grid, there are two screening electrodes and two anodes. Actually, the primary anode is often described as a secondary cathode, since it is from this that secondary electrons are liberated.

The final or secondary anode is in three parts; the two "wings" are made from plain sheets of metal, while the V-shaped section joining them is in the form of a gauze mesh which will allow the passage through it of both primary and secondary electron streams. Electrons liberated by the normal cathode pass through the control and screening grids, and are deflected away from the large curved screening electrode. They are then attracted to the primary anode in the ordinary manner, their course being regulated by the small screening electrode. They strike this anode at high velocity, and so cause secondary electrons to be "knocked off." Due to the higher potential of the final anode, these secondary electrons are attracted to it. And, since the number of secondary electrons is greater than the number of primary electrons, the final anode current is greater than that of a normal anode surrounding the screening grid. More accurately, the variation in final anode current for any given variation in control grid voltage is greater—hence the increased mutual conductance.

It would appear that this electron-multiplication process could be carried on indefinitely by deflecting the electron stream from one anode to another, using any number of anodes. In practice, it can be carried to several stages, but every additional anode involves the use of a higher H.T. voltage, since it is normally found that each successive anode must have a positive



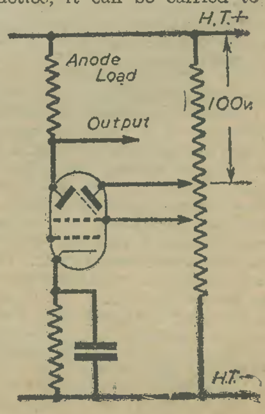


Fig. 1.—The diagram on the left shows the general form of construction for an electron-multiplier. On the right are shown the connections to the valve electrodes.

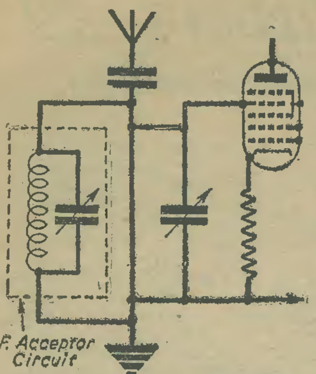


Fig. 2.—An I.F.-tuned acceptor circuit connected between aerial and earth terminals of a superhet to prevent "birdies."

potential of about 100 volts in respect of that preceding it. For most purposes, therefore, only one primary and one secondary anode is used.

The principle of electron-multiplication has been applied to photo-electric cells, using a light-sensitive cathode and up to 12 anodes. The advantages of electron-multiplication for this purpose, where the primary cathode current is very limited, are obvious.

3. Eliminating "Birdies"

It might be well to commence this answer by explaining that the term "birdies" is applied to second-channel whistles. These can be caused by various defects in design, as has previously been explained in this series. In general, however, they are caused by the tuning circuits of the receiver accepting frequencies close to the intermediate frequency. The most obvious method of effecting a remedy is therefore by increasing general selectivity. But this is not always a practical proposition, especially when the aerial feeds directly into the first detector. In that case, the simplest course is to connect an efficient acceptor circuit between aerial and earth. This circuit must tune to the intermediate frequency, and commercial versions of the acceptor normally consist of a small coil or choke, across which is wired a pre-set condenser; connections are indicated in Fig. 2.

The correct method of tuning the pre-set is by connecting a signal generator tuned to intermediate frequency between the aerial and earth terminals of the set and then adjusting the condenser until the output as indicated by speaker reproduction is nil or at a minimum. If a generator is not available, the condenser can be set by trial-and-error methods, leaving the aerial and earth leads connected to the receiver and finding the setting at which the "birdies" disappear.

Another method of eliminating "birdies" which often proves successful consists of winding one or two turns of insulated wire round the oscillator coil and including these in the cathode circuit of the frequency-changer valve. In order to find the correct "sense" for this winding it may be necessary to reverse the connections to the added small winding. The object of this arrangement is to cancel out the unwanted signals by applying them to the frequency-changer valve in reversed phase.

4. Earth-bonding

The whole object of earth-bonding is to avoid the presence of a reactive circuit between points in the receiver and earth. Should there be such reactive—or even resistive in some cases—circuits there is always a probability that an H.F. or audio-frequency voltage may be developed across them. Any voltages developed can well be applied to subsequent valves along with the required signal voltages, with the result that they appear in the reproduced output. This applies particularly to audio-frequency voltages such as are produced by A.C. or pulsating D.C.

In some instances H.F. voltages are developed across reactive circuits in the low-frequency-amplifier portion of the circuit; this may result in the application of H.F. voltage to the L.F. valves, which causes a form of instability and, generally, distortion. Where screening is employed, lack of good earth bonding between the screens and the earthed chassis can be very serious in its effects. Eddy currents may be set up in the screen, with the result that inductive coupling may take place between the screen and other components, or other unearthed screens. Thus, positive feedback may occur, in H.F. circuits; the obvious consequence would be instability.

It will now be seen that the points to watch in connection with earth-bonding are that all screens, including the screening of leads, are well connected to the chassis; that the chassis is connected to a good earth connection; and that all so-called earthed leads are actually earthed by being properly connected to the chassis by means of low-resistance wires. Where a steel chassis is employed it is easy to make a bad soldered connection to it, either because the chassis has been inadequately cleaned or because too small a soldering iron is used. To avoid this trouble it is often better to fit earthing bolts with soldering tags, making connections to these. Where good earth-bonding is in doubt, a check can be made by joining together the earth connections with earthing braid or stout stranded wire. This is especially desirable when using a metallised wooden chassis.

5. Output-valve Instability

Due to the very high gain provided by the modern output tetrode especial care must be taken in decoupling the electrode circuits. In some cases it is also necessary slightly to reduce the available gain by one method or another.

With regard to decoupling, the inclusion of a resistor having a value up to about 50,000 ohms in the grid lead, as shown in Fig. 3, is helpful. At the same time, a small fixed condenser between the anode of the preceding valve and earth is of value in by-passing any H.F. which manages to break through; this also reduces the tendency toward parasitic oscillation. Another form of decoupling which is to be recommended, either in addition to or as an alternative to the grid stopper, consists of including a fixed resistor of between 50 and 100 ohms in the screen lead. This is also shown in Fig. 3.

The most effective and satisfactory method of reducing the gain of the tetrode stage is by the application of negative feed-back. This can be arranged by omitting the by-pass condenser normally fitted across the cathode-lead bias resistor. Another method is to connect a resistor having a value between .5 and 1.0 megohm between the anode of the tetrode and the anode of the preceding valve. This form of feed-back tends to give emphasis to the higher audio frequencies, and it is very convenient to wire a .0002-mfd. variable condenser in parallel with the resistor, for use as a tone control. All the modifications described are illustrated in Fig. 3, although in most cases only one or two of them would be used at the same time.

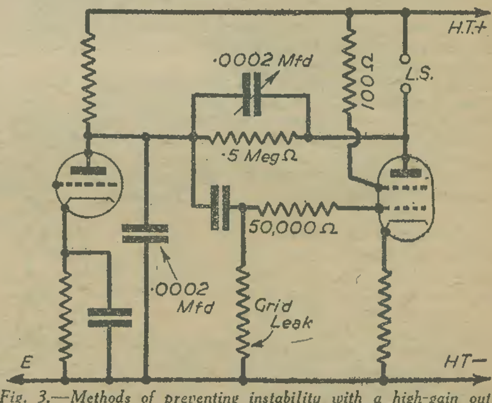


Fig. 3.—Methods of preventing instability with a high-gain output tetrode. They include: the use of a grid stopper; screen decoupler; current feedback, by omission of cathode by-pass condenser; and voltage negative feedback, by connecting a resistor between the anodes of the output and penultimate valves.

Elementary Electricity and Radio—16

By J. J. WILLIAMSON

(*Concluded from page 207, April issue.*)

TO ensure that the polar diagrams of straight and loop aerials respectively show equal amplitudes great care in the design and adjustment of the circuits concerned is essential.

Referring to Fig. 105 it is seen that a phase difference of 90 deg. exists between straight and loop aerial voltages, giving a response of the type shown in Fig. 106, which is

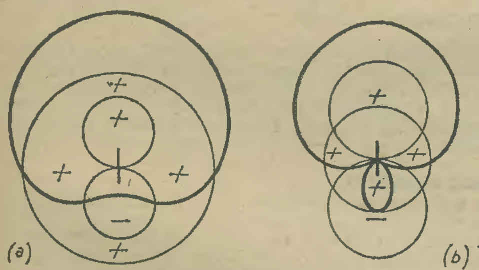


Fig. 104.—Loop voltages smaller (a) and greater (b) than the straight aerial voltages.

obviously useless for sensing purposes. This phase difference may be connected by the use of suitable condensers in the circuits of the straight and loop aerials, although great care must be taken in their adjustment

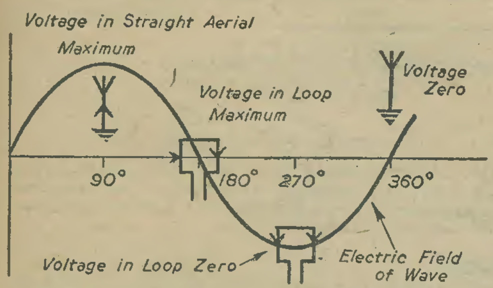


Fig. 105.—Phase difference between loop and straight aerial voltages.

if a pure cardiod is to be obtained and reversal of sense is to be avoided. A better method of phase correction utilises a resistance in the straight aerial circuit, which also enables changes of phase caused by tuning and other things to be corrected easily.

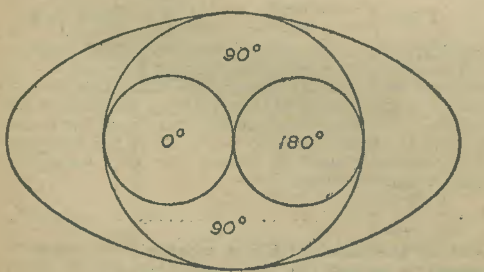


Fig. 106.—Effect of combining loop and straight aerial voltages having a phase difference of 90 deg.

Errors in Direction Finding Aerial Effect

If the loop aerial is not electrically symmetrical or is unbalanced in any way by attached circuits, then the effect upon its polar diagram is the same as the addition of a straight aerial response (Fig. 107), resulting in displaced minima, and if the phase of the voltages due

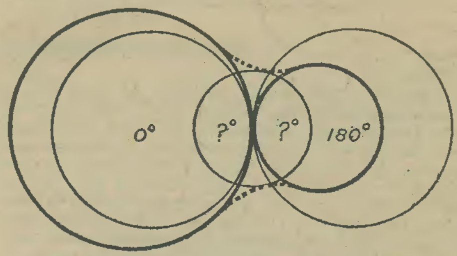


Fig. 107.—Aerial effect produces resultant polar diagram depending on relative phase of loop and aerial voltages.

to aerial effect is not exactly in or out of phase with the loop voltages—a poor minima, e.g., dotted lines of Fig. 107.

By careful matching of the loop connections, push-pull amplifiers, etc., aerial effect may be made negligible.

Direct pick-up of signals by the receiver coils and

Fig. 108.—Formation of quadrantal error.

connections will cause the same type of error as aerial effect, but may be avoided by complete screening of the apparatus.

Quadrantal Error

Referring to Fig. 108, the piece of metal receives energy from the transmitted radiation and re-radiates it. It can be seen that if the metal is in line with transmitter and the loop, then no error is caused; similarly, when the loop is flat-on to the metal no voltages are picked up from the metal's radiation; thus, if the metal is on the axis of the aircraft, ship,

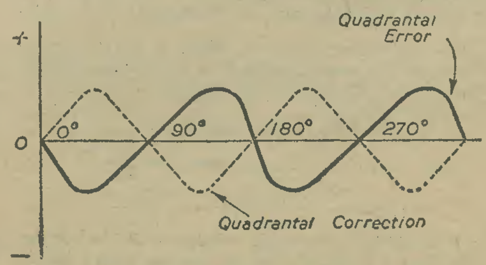


Fig. 109.—Quadrantal error and correction curves.

etc., in which the loop is mounted then zero occurs at 0 deg., 90 deg., 180 deg. and 270 deg., and maximum error at 45 deg., 135 deg.: 225 deg. and 315 deg. on the D.F. scale. The position of zero and maximum errors will be governed by the relative position of the metal. See Fig. 109 for quadrantal error curve.

Quadrantal error may be corrected by adding or subtracting to the loop scale reading the opposite sign of the degrees error existing See the dotted lines of Fig. 109, i.e. quadrantal correction curve. A regular displacement of zero errors from 0 deg., 90 deg., etc., may be corrected by adjustment of the loop's axis.

Fig. 110.—An example of figure of eight distortion due to night effect.

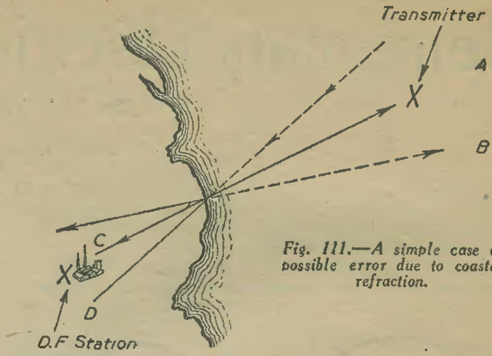


Fig. 111.—A simple case of possible error due to coastal refraction.

Night Effect

Normally polarised waves striking the loop (waves with their electric fields vertical and their magnetic fields horizontal) will induce voltages, that act around the loop, in the vertical wire only, but, if the plane of polarisation of the wave changes then voltages that contribute to the resultant loop voltages are induced in the horizontal wires also, giving effects similar to those shown by Fig. 110 and resulting in poor minima, often displaced, and other faults making bearings taken with the loop completely untrustworthy. As explained in Article 13, a sky-wave of low medium frequency entering the "E" layer (Heaviside-Kennelly) suffers great attenuation during the day but may permit long-distance reception during the night; also, the plane of polarisation of the wave is twisted upon reflection from the ionosphere, hence it can be seen that the sky-wave component received by the D.F. station may be negligible during the day but of serious consequence during the night, maximum errors being caused when ionospheric disturbance is greatest, e.g. at sunset, sunrise and during magnetic storms; it must not be taken that "night" effect does not occur during the day, as many errors due to change of the plane of polarisation of the wave have been recorded during the daytime.

Coastal Refraction

A wave passing over the coast at any other angle than 90 deg. will suffer refraction because of the change of media over which the wave is travelling. This alteration of the direction of travel of a wave is analogous to the refraction of a ray of light entering water, etc.

It may be seen that the shore station (Fig. 111) will obtain a bearing showing the transmitter to be in direction "B" instead of direction "A"; similarly, a D.F. station at "A" will obtain a bearing upon a transmitter "C," as direction "D."

Correction charts and a careful choice of D.F. station sites can make coastal refraction errors negligible.

Voltmeter Errors

The Importance of Using a High-resistance Voltmeter is Proved in This Article

By C. HEYS

WHEN taking voltage measurements during the repairing of receivers, it is desirable that the circuit constants should change as little as possible. This can only be achieved by using a first quality voltmeter having a resistance of, at least, 1,000 ohms per volt. As a voltmeter is connected across the points of the circuit to be measured, it must necessarily draw a certain amount of current from the circuit, therefore the voltage of that part of the circuit will be altered by the inclusion of the voltmeter. The following simple calculations will help in deducing the correct voltage that exists across any two points of a circuit taking into account the resistance of the voltmeter.

Consider the circuit of Fig. 1, where V is the voltage to be measured across BC, and E is the voltage across AD, R_m is the resistance of the meter. E the E.M.F. at the source will be:

$$E=IR+IR_m=I\,(R+R_m)$$

but as I (the current flowing) $=\dfrac{V}{R_m}$

$$\therefore E=\frac{V\,(R+R_m)}{R_m} \text{ or } V=\frac{ER_m}{R+R_m}$$

Now E would be the voltage existing at BC before the voltmeter was connected, and it can be shown below that for V to be 99 per cent of E, R_m must be 99 times R.

Let $E=100$ then V has to equal 99.

$$100=\frac{99\,(R+R_m)}{R_m}=\frac{99R}{R_m}+99$$

$$1=\frac{99R}{R_m} \text{ or } R_m=99R$$

The difference in the value of V when using, say, a meter with (a) a resistance of 250 ohms per volt, and (b) a resistance of 1,000 ohms per volt, can best be shown in the following example:

Example

Let R of Fig. 1 be 20,000 ohms and the E.M.F. E at AD, 100 volts, using the 250 ohms per volt meter on the 100 volt range, $R_m=25{,}000$ ohms.

$$\therefore V=\frac{100\times 25{,}000}{20{,}000+25{,}000}=\frac{2{,}500{,}000}{45{,}000}=55.55 \text{ volts.}$$

Using a 1,000 ohms per volt meter on the 100 volt range, $R_m=100{,}000$ ohms.

$$\therefore V=\frac{100\times 100{,}000}{20{,}000+100{,}000}=\frac{10\times 10^6}{12\times 10^4}=86.66 \text{ volts.}$$

The difference in voltmeter readings is rather surprising unless one has definitely used the two types of instruments and seen this difference, the maxim is then to obtain a true reading of the voltage, the higher the resistance in ohms per volt of the instrument the nearer you come to obtain the true voltage. If the resistance of the voltmeter used is known, the true voltage E of Fig. 1 can be found by—

$$E=\frac{V\,(R+R_m)}{R_m}\quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Consider the circuit of Fig. 2, where the voltage to be measured is across the load resistance R_1 which in actual practice might be the resistance of a triode valve.

From (1) above we have that the voltage V across BC, i.e., across the load resistance R_1, is given by—

$$V=\frac{E\,R_1}{R+R_1}$$

R_1 the load resistance is substituted for R_m, the voltmeter resistance.

When the voltmeter with a resistance R_m is connected across R_1 the voltage will change to V_1 or the voltmeter reading, but it is possible to find the true voltage V as follows:

I the current flowing $=\dfrac{E}{R+\dfrac{R_1\,R_m}{R_1+R_m}}$ (Ohm's Law).

$$\therefore E=I\left(R+\frac{R_1\,R_m}{R_1+R_m}\right)$$

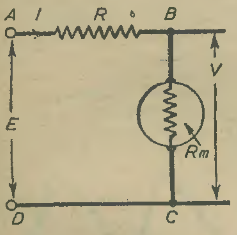


Fig. 1.—In which the voltage across B.C. is being measured.

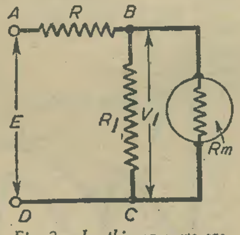


Fig. 2.—In this case we are concerned with the voltage across the load R1.

but I can also be found by $\dfrac{V_1 \text{ (the voltmeter reading)}}{\dfrac{R_1\,R_m}{R_1+R_m}}$

$$\therefore E=\frac{V_1\left(R+\dfrac{R_1\,R_m}{R_1+R_m}\right)}{\dfrac{R_1\,R_m}{R_1+R_m}}$$

$$=\frac{V_1\left\{\left(R_1+R_m\right)\left(R+\dfrac{R_1\,R_m}{R_1+R_m}\right)\right\}}{R_1\,R_m}$$

Now as V (the true voltage) $=\dfrac{E.R_1}{R+R_1}$

$$\therefore V=\frac{V_1 R_1\left\{\left(R_1+R_m\right)\left(R+\dfrac{R_1R_m}{R_1+R_m}\right)\right\}}{(R+R_1)\quad R_1\,R_m}$$

$$=\frac{V_1(R\,R_1+RR_m+R_1\,R_m)}{R_m\,(R+R_1)}=\frac{V_1\left\{R_m\,(R+R_1)+R\,R_1\right\}}{R_m\,(R+R_1)}$$

$$=V_1\left(\frac{R\,R_1}{R_m\,(R+R_1)}+1\right)$$

Therefore for V_1 to be 99 per cent. of V the resistance of the meter R_m must be $99\left(\dfrac{RR_1}{R+R_1}\right)$, that is, it has to be 99 times greater than R and R_1 in parallel.

An Application

A triode valve with an anode impedance of 20,000 ohms is fed through a 50,000 ohm resistance. A voltmeter is connected across the triode and reads 50 volts on the 100 volt range. What is the true reading using (a) a voltmeter of 250 ohms per volt and (b) 1,000 ohms per volt?

$$V=V_1\left(\frac{R\,R_1}{R_m\,(R+R_1)}+1\right)$$

(a) using the 250 ohms per volt meter—

$$V=50\left(\frac{20{,}000\times50{,}000}{25{,}000\times70{,}000}+1\right)$$

$$=28.55+50=78.55 \text{ volts.}$$

(b) using the 1,000 ohm per volt meter—

$$V=50\left(\frac{20{,}000\times50{,}000}{100{,}000\times70{,}000}+1\right)$$

$$=7.14+50=57.14 \text{ volts.}$$

The above examples show that there is a very large error when using the low resistance voltmeter as compared with a very small error when using the high-resistance voltmeter.

Transcription Service

Notes on a Little-known Side of B.B.C. Activities

THE London Transcription Service issues recordings in 19 different languages. These recordings are never heard in this country, and the work of the service with its staff of 120 people is little known here.

The recordings are processed and pressings made on a virtually unbreakable material called vinyl. They are then sent to 450 broadcasting organisations in 85 different territories, and broadcast to local audiences on a medium wavelength.

The London Transcription Service's largest language output is six hours a week in English. As copies of the recordings go to very many countries, this provides a known total of some 45,000 hours of broadcasting time per year in English from stations overseas. Next largest language output is in Spanish and Portuguese, for Latin-America, with other languages some distance behind.

Eighty per cent. of the programmes in English are taken from transmissions already broadcast on either the Home Service or General Forces Programme, but nearly all recordings made in foreign languages are specially designed for the London Transcription Service and produced and recorded in its own studios.

From the beginning of the war the London Transcription Service has issued transcriptions concerned, both directly and obliquely, with the war effort of Britain and other members of the United Nations. The English transcriptions have also included serious music, poetry and programmes stressing Britain's eminence in the fields of science and invention.

Entertainment has not been forgotten, although it has filled a smaller place in the service. It has been financed by subscriptions from the Dominions and Colonies under the name of the Empire Subscription Catalogue. The Service has tried to provide in the restricted time of four hours per quarter year allotted to it, the most outstanding among short broadcast plays, light music and entertainment.

Last autumn pressing demands were received from parts of the Empire for entertainment programmes of British origin; it became of the highest political importance for these needs to be met. Substantial additional funds were provided by the Treasury and the output of entertainment rose to six hours weekly. Some 30 broadcasting organisations made urgent requests for this entire output to be supplied to them regularly in order to meet the fierce competition of transcriptions sent from other countries.

The London Transcription Service is in no sense a sideshow, but an integral part of B.B.C. Overseas broadcasting, and an important complement of the various Overseas Services, to which it is closely linked for direction and policy.

Cathode-ray Tubes—5

Power Supplies. Hard Valve Circuit. Sensitivity.

By LAURENCE ARTHUR

(Continued from page 190, April issue)

Power Supplies

BEFORE outlining test operations it will be necessary to touch briefly on power supplies, without which the cathode ray tube cannot function, and time bases, which are required for most of the valuable applications of tubes. Both power supplies and time bases are integral parts of test boards. The power unit is primarily a mains transformer the high voltage output of which is rectified generally by a half-wave rectifier. Across the output is arranged a network of fixed and variable resistances which permit of adjustable positive supplies to the accelerating and focusing anodes and a variable negative supply for the grid or modulator. Provision is also made for the application of voltages to the individual deflector plates in order that the spot may be moved in any direction about the screen. Fig. 26 shows a diagram of a simple power unit. It will be noticed that the positive of the H.T. supply is earthed. This is fairly general practice in test boards and oscilloscope equipment as it reduces the effect of external stray fields which might deflect the spot from the centre of the screen. As a consequence of earthing the positive the cathode and grid become at a high potential negative to earth and care must be taken in handling connections to these electrodes when the current is switched on. In specialised apparatus, e.g., oscilloscopes or television receivers, the power unit is designed to give only the voltages required, although provision must be made for some control of the focusing anode voltage and the grid voltage. In universal test equipment, however, all the voltages are variable, the final accelerating voltage for some small tubes being as low as 450, while for certain large tubes it is as high as 6,000.

Time Bases

The time base is a complicated part of almost all equipment using cathode ray tubes. Briefly, it is a means of relating movement of the spot to time. The spot has to be swept across the screen and must then return for another journey, the "fly back" time being reduced to the minimum. The voltage applied to deflector plates increases steadily until a predetermined maximum is reached, when it falls rapidly to zero. This process is repeated indefinitely and the resultant waveform is usually called a saw tooth wave. Fig. 27 shows the reason why. The method of causing this waveform in the voltage applied to the deflector plates is by the rapid charge and discharge of a condenser. Considerable progress has been made in time base design since the period when a neon tube was used for "triggering," as shown in Fig. 28. Here the voltage from a source of

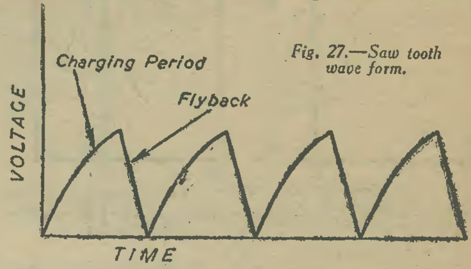


Fig. 27.—Saw tooth wave form.

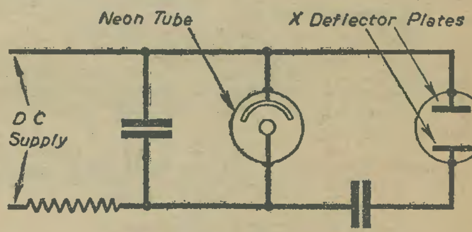


Fig. 28.—Neon tube time base.

supply charged a condenser through a fixed resistance. When the voltage across the condenser reached the striking voltage of the neon tube a virtual momentary short circuit occurred and the condenser discharged. This process was repeated indefinitely. A later development—which still has valuable applications—was the use of a gas-filled thyratron valve. This is a triode valve, generally filled with argon, across the anode and cathode of which is connected the time base condenser. The valve has a purple glow when in use. When the voltage of the condenser reaches a certain critical value the gas in the valve ionises and the internal impedance falls almost to zero. As the condenser is discharged the ionisation stops and the cycle is repeated indefinitely. Fig. 29 shows a simple form of thyratron time base.

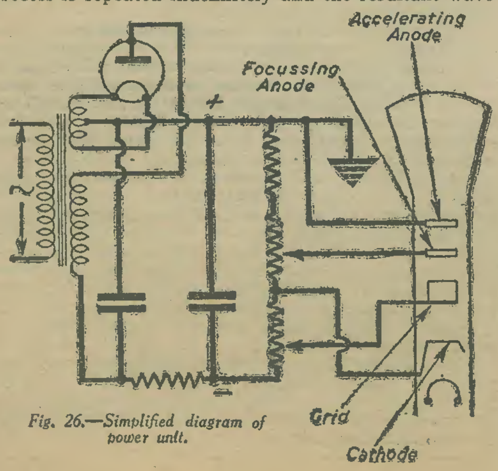


Fig. 26.—Simplified diagram of power unit.

Hard Valve Circuit

A widely used form of time base which gives a more truly linear saw tooth waveform, employs hard valves only and it is particularly valuable when used for very high frequencies. Fig. 30 shows a simplified diagram of such a time base. The sweep is obtained by charging the condenser C through a screened pentode valve V1, acting as a constant current device. The discharge is achieved by the functioning of the hard valves V2, V3 as follows: while the condenser is being charged V2 takes no anode current owing to its being heavily biased by the voltage drop in the resistance R2 in the anode circuit of V3. As the charge increases the voltage across V2 rises until anode current commences to flow. There is now a voltage drop across resistance R1 which is fed through a condenser to the grid of V3. The current through R2 is reduced, the bias on the grid of V2 rises and the anode current increases. The effect is cumulative. When the condenser discharge takes place the current in R1 falls, the cumulative action is reversed and the circuit becomes ready for the next charge. As the spot is swept rapidly across the screen by the intermittent voltage applied to the deflector plates the effect on the eye is to produce a straight line. In test equipment this sweeping effect may be applied to the X deflector plates, giving a horizontal line, or to the Y deflector plates, giving a vertical line. In oscilloscopes the sweep is usually applied to the X plates only.

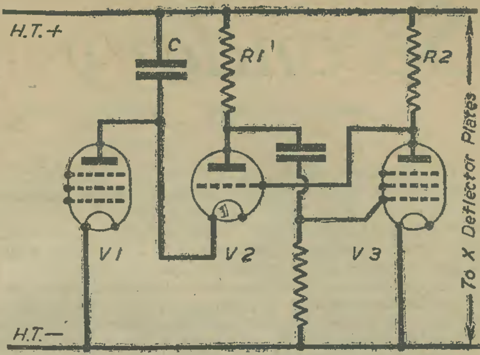


Fig. 30.—A hard valve time base circuit.

Procedure

For the testing operation the cathode-ray tube is placed in a holder inside a cylindrical or cone-shaped shield of mu-metal. As the electron beam is so readily deflected by magnetic fields it is necessary to absorb all nearby magnetism to prevent it reaching the beam. Mu-metal is an alloy having a high permeability and a shield even as thin as $\frac{1}{8}$in. is found to be an effective screen. The heater current is switched on. If the tube is of the indirectly heated type it will previously have been on an adjacent pre-heating unit in order to save time. The heater voltage is set by potentiometer control and the heater current is checked. A majority of modern tubes are rated at 4 volts 1.0 ampere. The normal tolerance of current is from 0.9 to 1.15 amperes. Grid volts are turned up so as to prevent burning of the screen

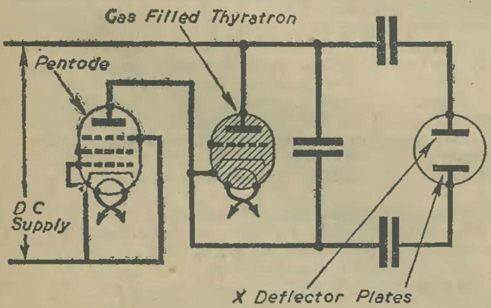


Fig. 29.—The circuit of a thyratron time base.

when the spot appears which is when the accelerating anode voltage has been advanced beyond a critical minimum. The accelerating anode voltage is set at the specification value which may be anywhere from 450 to 6,000 according to the type of tube being tested. A voltage at a frequency of 50 cycles derived from the mains is applied to one pair of deflector plates and the spot is drawn out into a line. Voltage is applied to the focusing anode and the value noted when a sharply focused line is obtained. The value may vary between 50 and 150 volts for a small tube. For a large tube it may be between 350 and 550 volts.

It is important to be able to obtain a certain minimum brightness of the line on the screen at a definite grid voltage and this may be done by direct comparison with a "standard" operating under identical conditions. Owing to practical difficulties it is more usual to measure the brilliancy of the standard under known conditions using a photo-electric light cell and a sensitive galvanometer. One type of light cell consists of a metal disc, coated with cæsium, mounted in a robust housing. Advantage is taken of the "barrier layer" effect of the coating material which produces a very small voltage when subjected to light. The light cell is placed face downwards on the top of the screen on which is a line-trace of a definite length. The voltage—in microvolts—obtained from a check on the standard is regarded as the minimum figure which tubes under test must attain. Brilliancy below standard may be caused by poor emission from the cathode, insufficient activation of the screen powder, excessive thickness or density of the screen, or, occasionally, by light absorption of the thick glass at the screen end of the tube.

The beam current must be measured at standard brilliance. Too high a value would cause burning or fatigue of the screen during operation. In order to measure it, the spot is deflected completely off the screen until it strikes one of the X-plates. A microammeter is inserted between the plate and the cathode, and a direct reading of the amount of beam current flowing is obtained. If the brilliance is adequate the line is returned to the spot and the grid voltage adjusted until the spot just cannot be seen. This cut off voltage is noted, and must not exceed the specification figure. For some tubes this may be as low as 10, for others as high as 80. A check is taken of the resistance between grid and cathode when the latter is hot. This must be a minimum of from 1 to 10 megohms, according to the circuit arrangements in which the tube is to be used.

Sensitivity

The next test is for sensitivity, and it is a direct measurement of the distance the spot is moved from the centre of the screen when a definite voltage is applied in turn to each of the deflector plates. The sensitivity is described as $\frac{S}{E}$ millimetres per volt, where S is the rating figure for the particular tube being tested, and E the voltage on the accelerating anode. For example, if a tube is rated at $\frac{200}{E}$ m.m. per volt and the accelerating anode voltage is 800, the nominal movement of the spot from the centre when 100 volts is applied to one deflector plate would be 25 millimetres. The test specification would probably allow a variation from 23 to 27m.m., which would be expressed as $\frac{184}{E}$ m.m. per volt/$\frac{216}{E}$ m.m. per volt. The sensitivity of both pairs of plates is not necessarily the same, and, in general, it will usually be found that the Y plates have a higher sensitivity than the X plates. Sensitivity is affected by the distance apart of the deflector plates in each pair and by the distance of the plates from the screen, hence the need for accurate jigs when the assembly is being mounted.

(*To be continued.*)

Secondary Batteries—9

Metal Rectifiers. Servicing Cells. By G. A. T. BURDETT, A.M.I.I.A.

(*Continued from page 191, April issue.*)

IN the previous article of this series, three output arrangements were shown for use with two mercury vapour rectifiers, and it was explained that such procedure became necessary owing to the fact that the output from this type of rectifier is not suitable for use with more than one charging circuit.

It will be remembered that the output current is not strictly continuous but *uni-directional*, therefore when more than one charging circuit is required, it is recommended that additional mercury vapour valves are incorporated in the charging equipment.

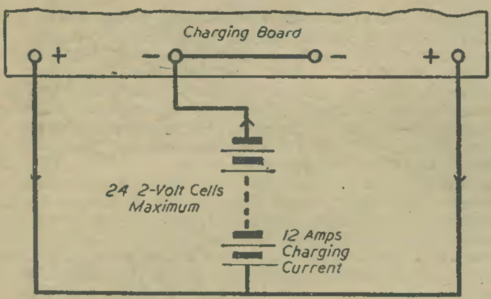


Fig. 1.—An output arrangement, for use with mercury vapour rectifiers, to enable 24 2-volt cells to be charged.

Continuing with suitable output arrangements Fig. 1 shows that the two negative (centre) terminals are again shorted, so providing a maximum of 12 amps. at 75 volts on one single circuit only, which enables two 12-volt batteries to be charged simultaneously.

It will be noted that each outer wire positive does not exceed 6 amps., which is the maximum of each circuit measured on each individual ammeter, while the middle wire does not exceed 12 amps., or the sum of the outer two.

Principles of Mercury Vapour Rectifier

If a mercury vapour arc is started between a mercury electrode, known as the cathode, and a conductor, known as the anode, a current of electricity will flow from the anode to the cathode but not in the opposite direction. Since an alternating current "changes" in direction depending upon its frequency in cycles per second, the mercury arc principle has been adapted to "rectify" the alternation. Therefore, where an A.C. current is applied, Fig. 2, April issue, that half in each cycle which flows in the direction of anode to cathode only will pass through the arc. This system is known as half-wave reactification, since each half cycle of current is "delivered" at the output side of the valve as an uni-directional flow of current, but, by utilising two anodes, as in the diagram, full-wave rectification is achieved. During operation, the mercury vapour which is formed by the heat produced by the arc is condensed in the upper part of the glass bulb. After condensation, minute globules fall from the upper part and form the cathode. The voltage of the incoming supply is not reduced during rectification. In order to obtain a variety of voltages it is usual to insert a transformer in the incoming side of the rectifier. A series of tappings allows the required variety of voltages, and since the losses from a transformer are slight practically the total energy is usefully consumed.

The chief disadvantages of a mercury vapour rectifier are (1) The glass rectifying valve is very fragile and easily damaged. (2) Its normal working life is little more than 1,000 charging hours, after which replacement is necessary. (3) If operated up to and above its rated capacity its life is considerably shortened. Where mercury vapour rectifiers are employed it is advisable to operate them at all times below their rated output.

Metal Rectifiers (Westinghouse) Copper-Oxide

Westinghouse metal rectifiers have now been in use for over 17 years. They are of simple construction, have no fragile filaments, chemicals or moving parts, and are entirely electronic in action. The construction of the original type of metal rectifier, e.g., copper-oxide, is shown in Fig. 2. The operation of this rectifier is due to electronic action at a junction between two metals, copper and copper-oxide. As the resistance to a flow of electricity from copper to the copper-oxide coating is very high, while the resistance from copper-oxide coating to copper is very low, it follows that the tendency is for the current to flow in one direction only, viz., from the copper-oxide coating to the copper. The ratio between the resistances is approximately 1,000 to 1. but for all practical purposes this leakage may be disregarded. An alternating current thus applied will be rectified to direct current, since the path of the current on the reverse half of the cycle will be checked at the junction of the copper and the coating of copper-oxide. As heat will be generated during this operation the cooling fin is incorporated in this design.

Selenium Compound Metal Rectifiers

The copper-oxide rectifier is now largely being replaced by the selenium compound rectifier. The Westalite consists essentially of a steel plate on which is formed a thin layer of special selenium compound. A thin layer of alloy serves to make contact with the selenium compound. The principles of rectification are similar to the copper oxide type. Rectification takes place at the intimate junction of the selenium compound and the alloy since the current flows readily from the compound to the alloy layer, but not from the alloy layer to the selenium compound, due to the very high resistance offered by the bridge in the opposite direction. Fig. 3 shows the sectional view of the Westalite unit, where the rectifier element is clearly illustrated.

The chief advantages of the selenium compound rectifier are: It operates at a higher voltage, anp therefore tends to be smaller for a given output. It can operate safely at higher temperature. Since the efficiency of the Westalite is generally the same as the copper-oxide the higher permissible working temperature of the

(*Continued on page 255.*)

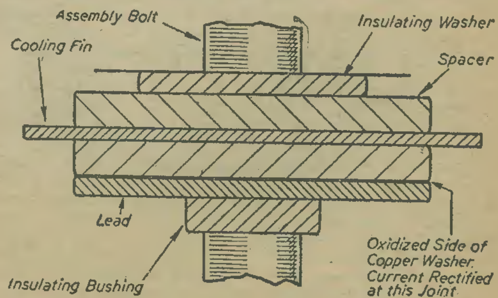


Fig. 2.—A metal rectifier unit assembly.

GALPINS

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MASSIVE GUNMETAL WINCH, complete with long handle, for use with ⅜in. wire cable, weight 50 lbs., condition as new, Price £3, carriage paid.

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TRANSFORMER Cores, will rewind for a 1 kW. Auto, present windings not guaranteed, 22/6.

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Dual ratio epicyclic drives ¼in. shaft and coupling. (Suitable for use with three gang condensers) **5s. 6d.**

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TRANSFORMER PARTS. We offer a few shrouded carcases ready for rewinding. 250 watt size, 27/6. First-class make. If you can cut your own lams out of 6in. Stalloy sheet, we can supply in 38in. lengths at 1/3 each.

WE CAN SUPPLY 100 ohm and 10,000 ohm Wheatstone Bridges, G.P.O. dial switch rheostats 4,000 ohm and 8,000 ohms. Sullivan and Tinsley Mirror Galvos, Meggers Avos, Siemens high speed Relays, 10,000 ohm Raycraft Relays. Incomplete ex-Govt. Wheatstone Bridges less coils, 45/-. G.P.O. vertical Galvos, 35/-.

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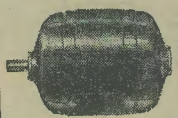

For essential and experimental work, permit free. Fine modern quarter-horse D.C. motors, 200 to 250 volts, enclosed, drip-proof, silent bearings, flange or base fixing, double end shaft, ½in. dia., 1,450 revs. ; size, 7½in. x 7in. ; weight, 35lbs. Compound. We fully guarantee. 1/5th h.p., £3 10s. ¼ h.p., £4. Larger powers in stock.

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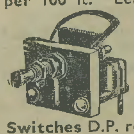
CRYSTAL SETS. Gambrell W/M type with selector switch, tuning condensers and permanent crystal detector, in closed portable case, 55/-. **Victory Pocket type** crystal receiver in bakelite box, 35/-. **Mark III type.** A two-circuit receiver with tapped inductance, variometer, tuning condenser, perikon and catswhisker detectors, in field case 11½ x 10 x 8in., with lid and space for headphones. Govt. model, 85/-. **The Wall Nut.** A superior set for table or wall, new model in polished hardwood case, tapped A.T.I. and variable condenser tuning, 42/-.

AERIAL WIRE. 7/22 bare copper, 5/- per 100 ft. Lead-in wire, 4d. per yard. Aerial insulators, 2d. each.



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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).

Battery Versus Mains

SIR,—Seeing the letter by Mr. Woodward in the March issue of PRACTICAL WIRELESS, on battery versus mains, I should like him to know my opinion of the matter. I agree with him when he says that battery sets will last a lifetime without a breakdown, but I also think a mains set is capable of the same service. A friend of mine has had a mains radiogram since 1928, and it has given good service with perfect tone ever since, without a single breakdown. If care is taken, I think that many present-day mains receivers will be functioning perfectly in fifteen years' time, having required no repairs whatsoever.—G. E. SANDERS (Bedford).

Distorted B.B.C. Transmissions

SIR,—I have been interested in the letters appearing in recent issues of PRACTICAL WIRELESS under the heading of Distorted B.B.C. Transmissions. I earnestly trust that something will be done soon to cure this irritating trouble.

We, in this district, suffer severely after dark from fading and distortion on the Home and Forces programme. It is so bad at times that you have to switch off in disgust. The irony of it all is that a degree or so either side of the above wavelengths the German stations come roaring in at great strength and superb quality without a trace of fading.

It does not matter whether your receiver is a straight set, without A.V.C., or a modern multi-valve superhet with all the latest gadgets. Reception is just the same.—E. JONES (Aberdare).

SIR,—Being a member of the engineering division of the B.B.C., I wish to reply to Mr. Bullock's letter in the March issue of PRACTICAL WIRELESS about reception of B.B.C. programmes in Hampshire.

Firstly, the B.B.C. engineering staff have been taking a great deal of notice of reports of bad reception in this area for a long time, but war conditions make it impossible to rectify this at the moment, and if only Mr. Bullock and the general public knew how much the wartime system of B.B.C. transmitting upsets the enemy trying to use the transmitters as direction beacons for his aircraft, I am sure all these complaints of bad reception, etc., would be tolerated in wartime, and that instead of the public always running down the B.B.C., they might congratulate the B.B.C. on its efforts in overcoming the use of the B.B.C.'s transmitters by the enemy as direction beacons. I can assure Mr. Bullock that the system has worked very well right up to the present time.

In conclusion, I would like to say that Mr. Bullock rather oversteps the mark by saying that reception in Hampshire after dark cannot be relied upon, but if reception is not too good in the area where he lives, I feel sure that a vertical aerial with one or two reflectors pointing in the direction of the nearest station, will very much improve the conditions of reception.

It is funny that some listeners think that an aerial is unimportant because they have a powerful receiver, but after all the aerial is the means of picking up all the signals of transmitting stations, so it is always advisable to have a good aerial, and keep it high, and then most of this so-called bad reception will cease.—J. D. RAMSHALL (Hampshire).

Short-wave Reception

SIR,—In reply to a request from L. H. Cox (N. Wales), C.S.W. is a transmitter of Emisora Naçional, Lisbon, on a wavelength of 30.9 metres approx. There are also two other wavelengths at present in use by Lisbon, to my knowledge, although it must be observed that they transmit different programmes and are not under call-sign C.S.W.; these channels are 27.17 and 47 m. approx.

It may be of interest to know that both Vatican Radio and Radio Naçional of Spain reply, by letter, to all reports sent. The latter's reply is in Spanish, however, but I was fortunate enough to have a friend who knows Spanish !

Another station which has just been received on a new wavelength, is station Lourenço Marques (or similar) which now transmits on a wavelength of 30.4 metres. This is near "Voice of Spain for Europe" (30.45 m.). Lourenço Marques is strongly received in winter months and transmits news in English just before 9 o'clock B.S.T.

Another Spanish station on the short waves which is also quite strongly received is that of Oviedo (?) on 42 metres approx.

A few stations received here include all Ws, PRL8 Leopoldsville, FZ1 Ankara, Tokyo, Helsinki, Andorra (50.2 metres, evenings) and Stockholm. Stockholm in the 31 metre band requests reports to be sent to the Swedish Legation, London.—K. DOBESON (Chichester).

A Reader's Activities

SIR,—I have now been able to make a report on my activities during the last 4 months. I have been constructing the "Fleet Short-Wave Two," and although I had to make one or two slight modifications, I find on giving it a "try-out" that it does all that is claimed for it by other readers who have constructed the set. It is a champion DXer and gives a really remarkable performance. Plenty of stations come in on the phones, and quite a few at loud-speaker strength. My aerial is quite a modest one (inverted-L type), being only about 15ft. high, by about 35ft. long, facing due North and South.

Some of the stations I have logged are :—Leopoldsville, Congo Belge, 25.6 m.; Boston WRUA, 25 m. band; Ankara, T.A.P., 31.70 m.; C.B.S. WOOW, 25.27 m.; Finland, 31 m. band (unable to get call-sign); and Cincinnati, WLWO, 25 m. band.

I am looking forward to some interesting listening in the near future as I am quite pleased with my latest receiver. I can thoroughly recommend this set to the beginner, or to anyone that has a one-valver, and wishes to construct something a little more ambitious. I intend soon to experiment with different aerials, and should like to construct a really efficient di-pole.—F. W. WADE (Wells).

Women Announcers

SIR,—For many years past the B.B.C. has been aware of the fact that women announcers are strongly disliked by many, even by women themselves, but, indulging in its perverse delight in thwarting the wishes of licence holders, the B.B.C. has never ceased its efforts to employ women announcers.

A fresh example of this "female announcer" complex of the B.B.C. is to be found in the new General Forces Programmes under a new ruling which forbids dance band leaders to announce their own programmes. They are "put over" by women announcers instead.

It is not suggested by the B.B.C. that the dance band leaders are in any manner incapable of announcing their own programmes, the reason for the new rule is quite different, and most illuminating.

The B.B.C. says that the change over from Forces to the General Forces programme has greatly increased the number of announcers available. It follows, that if this be true, there must have been a positive glut of them even before any change took place, and, it is equally evident that under no circumstances will the B.B.C. consider parting with their services.

Considering that many thousands of middle-aged women, with homes and families, have been forced to take part-time employment at tasks much heavier than they have ever been accustomed to, may one suggest that Mr. Bevin might well turn his eagle eye on the "greatly increased number of announcers now available," most of whom are not yet too aged to undertake a little war work.

Can it be that, foreseeing a fresh comb-out by the Ministry of Labour, the B.B.C. has instituted this new programme as a measure of some protection for its own female staff and converting them into indispensables as announcers? They seem to be clustered round the mike in the new programme, all waiting their turn to shoot off their own few lines, a hateful state of affairs which can only be escaped by switching off the whole programme. Why not let the dance band leaders continue to announce their own programmes, save the salaries now paid to the women, and find them some war work to engage in?

No one wants these women announcers; even amongst the Forces there are no great numbers of listeners thirsting and hungering to hear their voices. Why must we be forced to endure them? Because we have not sufficient backbone to insist on being masters in our own house, and being properly represented at Broadcasting House. Failing which, the programmes will never reach any higher stage, and the number of silver-voiced announcers shows a continued increase. Our only hope, as listeners, lies in a definite reform of the B.B.C.'s Charter, and us being given a reasonable voice in the control of what we alone have to pay for.—"ANTI BLUE-EYES" (Birkenhead).

An O-V-1 Portable

SIR,—A spell ashore recently induced me to get out my home-made portable and carry out a few experiments. The results have been good and I thought other readers might be interested.

The set is O-V-1, 2-volt valves in series working off a type 126, 4½-volt battery, and a small 45-volt battery for H.T. The detector is decoupled and transformer coupled to a PMIA. Lightweight phones are carried plus a 2in. moving-iron speaker. The set works either on a frame of two basket coils, one in place of an aerial coil and one for a reaction coil. Pick up is excellent and throttle reaction very smooth. The set also contains 25ft. insulated copper wire for an outside aerial and a short length for the earth lead. When working with this array the two frame coils are unplugged and a 65-turn tapped coil with reaction winding is plugged in. By a system of clips two changes of circuit are possible and a wide variation in tuning spread is very easily obtained.

The grid was tapped into the aerial coil as it was found to give greater strength when the gridleak was in parallel with its condenser. Terminals are not used but large crocodile clips are bolted on. This makes for ease in setting up earth, aerial and phone leads. All parts bar frame and coil are mounted on the back of the band, making for short wiring. Though a bad arrangement, the set will receive well with only 10 turns in the secondary and 5 in the primary for the aerial coil.—J. ROYLE (Grimsby).

Sheppey Amateur Radio Club

SIR,—Prior to the outbreak of hostilities your magazine used to publish "club reports" from the Sheppey Amateur Radio Club, sometimes weekly, sometimes monthly.

I would be very grateful if you could publish this letter as I would very much like to get in touch with any ex-members of the club with a view to re-forming it upon a wartime basis, catering for members in H.M. Forces. On my last leave I consulted the hon. treasurer and we spent a very pleasant evening together discussing the club as it was in pre-war days and our hopes for the future of it. Having received your magazine occasionally whilst I was serving overseas, I can vouch for its interest and usefulness, also the fact that it gets into almost every nook and corner of the theatre of war operations, from front-line billets to the Y.M.C.A. at base. And it is through your pages I would like to get in touch with any ex-members of S.A.R.C. and try to form a wartime club of it, most of it by correspondence, of course, but where and when possible by actual meetings if these can be arranged. Both the hon. treasurer and myself will be pleased to receive letters from any members and suggestions as to a "get together."

As most of us are serving with H.M. Forces and have been since the first day of war, all kinds of difficulties present themselves, but I feel sure the life of the S.A.R.C. can be continued if only by the means of correspondence chiefly; and it would likewise help yet further to promote that "Ham Spirit" which all true radio amateurs still strive to keep alive in spite of the war. I hope any member reading this column, be he in this country or overseas, will write to me or the hon. treasurer, and give us his "gen" and any other suggestions.—F. G. MAYNARD (ex-G4OU), c/o 160, Invicta Road, Sheerness, Kent.

Stroboscope Calculations

SIR,—Since PRACTICAL WIRELESS assumed its smaller format, the technical standard of contributions has been markedly raised, and I would like to offer a special word of praise for your April issue.

May I have an opportunity, however, to suggest a few corrections to some of the interesting material in that number? Firstly, in Mr. P. W. Baker's description of his novel turntable speed tester, he mentions (column 1, paragraph 4) that the neon lamp light flickers in and out 50 times per second on 50 c/s A.C. mains. Of course, it actually flashes at *twice* the frequency of the mains supply, because in its illuminating effect the negative half of the waveform is just as effective as the positive half. Then, in column 2, line 3, *et seq.*, the author suggests that 78 equally spaced holes should be punched in the cardboard strip, whereas the correct figure is 77 holes. Using the well-known formula explained in the article on the stroboscope (PRACTICAL WIRELESS, October, 1943), it can easily be calculated that the right number of spokes, segments, or holes, is 77 to the nearest approximation. When reproducing ordinary commercial vocal or instrumental records I doubt whether the aural difference in using a 78 holed stroboscope would be apparent to the average listener, but accuracy is essential when using such constant frequency and frequency-run records as Decca EXP.55 or H.M.V. DB.4033-4037 for test purposes, etc.

Incidentally, it might be worth while to record here that this useful stroboscopic idea was due to Dr. Stampfer, of Vienna, in 1830, although it is usually attributed to Dr. J. Plateau, the Belgian physicist, who apparently invented the same device.

Secondly, regarding Question 4 (page 204) of the Radio Examination Paper, No. 28, dealing with "Fournier's Analysis," I am afraid the Experimenters have confused Fournier D'Albe, the English physicist who invented the optophone and a system of telewriting and telephotography, with the French mathematician J. B. J. *Fourier*, whose theorem proved that a sustained wave is equal to a series of pure sine waves of harmonic frequencies and certain phases, and his integral theorem showed mathematically that a transient or "pulse" waveform is equal to a series of pure sine waves of all frequencies from zero to infinity, and of certain phase, as The Experimenters outlined in their answer.—DONALD W. ALDOUS (Torquay, Devon).

Replies to Queries

Mains Hum with Battery Set

"I have just installed a battery set in the home of my parents, and although this is only of the 'local station' style, I find that there is an awful mains hum. How is it possible to get this from a battery set? I do not even use a mains unit, and I am at a loss to know what to do. Your help would be appreciated."—B. G. (Greenwich).

WE have before had complaints regarding this form of trouble, and we have found that it is nearly always due to the fact that the aerial lead, the earth lead, or the loud-speaker leads are running parallel with mains wiring in the walls of the house. In some cases the house was not even wired for the electric supply, but the next house was, and the set was standing close against the party wall. You must therefore move the set, as well as the leads above mentioned, and you will no doubt find that the trouble is soon cured.

Fuse Points

"In my battery set I have a small fuse bulb in series with the H.T. negative lead. I find when I switch on it lights up quite brightly for a moment and then dies down to a faint glow, but it is glowing all the time and sometimes gives a brighter light with the music. Is this in order, please?"—T. W. (Manchester).

THE fuse glows when you switch on owing to the sudden flow of current, which rises above that normally required for the functioning of the receiver, owing to by-pass condenser, etc. As it glows all the time you are listening it shows that you have chosen a fuse with a rather low rating, and whilst it does not affect results in any way, there is a possibility of it blowing if you get a rather sudden increase in current, due to a very loud passage or other effect, which will not otherwise harm the components. You should fit a larger fuse and the value can be worked out by taking the total filament current rating of your valves and fitting a fuse with a rating just below that value. Remember, for this purpose, that .1 of an amp. is 100 milliamps.

Modifying an Old Set

"I have picked up an old straight three-valve set which I intend to keep for tinkering about. I wonder if I could substitute an S.G. valve for one of the others in the set. If so, would you tell me just what extra components I should require and how to connect them up?"—R. P. (Bournemouth).

FIRSTLY, to what do you refer as a "straight three"? This may be one of several types of receiver, but as you wish to substitute an S.G. valve we imagine you refer to a circuit of the detector and two L.F. type. In this case, an S.G. valve could be used in place of the existing detector, and the only modification would be to remove the lead or leads at present joined to the anode terminal on the detector valve-holder and to fit a flexible lead to those wires. This lead should then be joined to the cap on top of the S.G. valve. A flexible lead fitted with a wander plug should then be joined to the original anode terminal on the valve-holder, and this should be plugged into the H.T. battery at some value between 18 and 36 volts, the best value being found on test. This is the simplest modification.

Push-Pull Output

"I enclose a diagram of the output section of my receiver, from which you will see that two valves in push-pull are used. There are three terminals at the output, two to the anodes and one to H.T. positive, and these are joined to three terminals on the speaker used with the set. I have now obtained a new speaker, but this only has two terminals and I should like to know how to join it to my set. Should I have to get a centre-tapped choke, or another centre-tapped transformer?"—H. K. (Mitcham).

IF you wish to use the new speaker in addition to the speaker at present fitted, the only additional components required will be two fixed condensers. These should have a value of 2 mfd. and one terminal of each condenser should be joined to each of the terminals which are connected to the output valves. The remaining terminals on the condensers should then be joined to the two terminals on the extra speaker. If, however, you wish to use the speaker in place of the present one, you will have to employ either a centre-tapped choke or a push-pull output transformer. It must be remembered, however, that in this case you will have two sources of iron loss, one in the choke or transformer and another in the transformer fitted to the speaker, and thus, although the new speaker may be better than the original model, you may lose the advantage owing to the fact that two iron components will have to be employed. If you communicate with the makers of the new speaker, and send them the transformer now fitted to the speaker, they will, no doubt, supply you with a suitable push-pull component to use in place of it. They will require to know the details of the valves you intend to employ.

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.

Screened Lead and Short-Circuit

"I have made a radiogram for battery operation, but cannot get continuous signals. The leads for the pick-up are screened through the usual metal sleeving, and the pigtail for the S.G. valve is similarly covered. When I was trying to see if any wires were loose I moved one of the pick-up leads and got an interrupted signal. I removed the lead and connected the grid direct to the grid condenser, and the set works. When I put the pick-up lead back I cannot get signals. If I remove the earth connection from the screening lead the signals are clear again. Is this because of the lead being too long, and too great a capacity being made to earth by the grid? If so, is there any way in which I can reduce the capacity?"—W. B. (Stroud).

WE are afraid that capacity does not account for the trouble, but that a much more serious effect is arising. If you carefully examine the lead we think you will find that the actual wire at some point is making contact with the metal sleeving, and thus the grid is being short-circuited to earth. Removing the earth connection enables the valve to function, and thus tends to support the theory of short-circuit. If you are using ordinary flex inside the screening you may find that one strand has broken and has pierced the rubber covering at some point; alternatively, the end of the metal covering is touching the lead or one of the terminals at the ends of the lead.

REPLIES IN BRIEF

The following replies to queries are given in abbreviated form either because of non-compliance with our rules, or because the point raised is not of general interest.

H. C. (Darlington). A variable resistance may be included in the H.T. positive lead for the purpose you mention. A value of 50,000 ohms would be suitable.

J. W. (Weymouth). No, we do not know of any firm who would undertake the work. We suggest that you watch advertisements in PRACTICAL WIRELESS, as you may be able to secure a suitable replacement.

W. L. (Liverpool). We do not recommend the design. For the guitar you will require an amplifier having an output in the region of 3 watts.

E. M. (Manor Park). We cannot offer a blueprint of a receiver using the specified coils. It is very doubtful whether the makers are still in a position to supply diagrams.

C. R. (Sheffield). We advise you to test the coils and make sure that the grid circuit of the first valve is in order.

K. G. (Boscombe). On no account should the valve be operated without grid-bias, otherwise serious harm is likely to be done to the valve, and, possibly, the output transformer.

D. F. (Wimbledon). We cannot identify the circuit from the details provided. We suggest that you study the list of our blueprint designs.

H. B. (York). Try reversing the connections to the secondary of the L.F. transformer. The by-pass condenser could be increased to .001 mfd.

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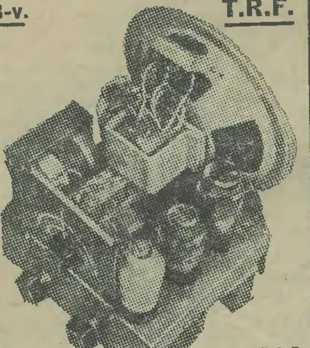

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A.C. Hall-Mark (HF Pen, D, Push-Pull)	—	PW45*
Universal Hall-Mark (HF Pen, D, Push-Pull)	—	PW47*

SUPERHETS

Battery Sets : Blueprints 1s. each.		
F5 Superhet (Three-valve)	—	PW40
F. J. Camm's 2-valve Superhet	—	PW52*
Mains Sets : Blueprints 1s. each.		
A.C. £5 Superhet (Three-valve)	—	PW43*
D.C. £5 Superhet (Three-valve)	—	PW42
F. J. Camm's A.C. Superhet 4	—	PW59*
F. J. Camm's Universal £4 Superhet 4	—	PW60
"Qualitone" Universal Four	—	PW73*
Four-valve : Double-sided Blueprint, 1s. 6d.		
Push Button 4, Battery Model / Push Button 4, A.C. Mains Model	—	PW95*

SHORT-WAVE SETS. Battery Operated

One-valve : Blueprint, 1s.		
Simple S.W. One-valver	—	PW88*
Two-valve : Blueprints, 1s. each.		
Midget Short-wave Two (D, Pen)	—	PW38A*
The "Fleet" Short-wave Two (D (HF Pen), Pen)	—	PW91*
Three-valve : Blueprints, 1s. each.		
Experimenter's Short-wave Three (SG, D, Pow)	—	PW30A*
The Prefect 3 (D, 2 LF (RC and Trans))	—	PW63*
The Band-Spread S.W. Three (HF Pen, D (Pen), Pen)	—	PW68*

PORTABLES

Three-valve : Blueprints, 1s. each.		
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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

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1934 Crystal Set	—	AW444
150-mile Crystal Set	—	AW450*

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One-valve : Blueprint, 1s.		
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*
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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*
All-wave Winning Three (SG, D, Pen)	—	WM400
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65s. Four (SG, D, RC, Trans)	—	AW370
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*
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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
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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.

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PORTABLES

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SHORT-WAVE SETS. Battery Operated

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Roma Short-Waver	—	AW452
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Ultra-short Battery Two (SG, det Pen)	—	WM402*
Home-made Coil Two (D, Pen)	—	AW440
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The Carrier Short-waver (SG, D, P)	—	WM390
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Superhet : Blueprint, 1s. 6d.		
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Mains Operated

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Four-valve : Blueprints, 1s. 6d.		
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MISCELLANEOUS

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