A CATHODE-RAY OSCILLOSCOPE

Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

Vol. 21 No. 473 NEW SERIES NOVEMBER, 1945

At Great Malvern College a Radar Instructor Explains the Working of an Air Interception Trainer Panel

Practical Wireless
and PRACTICAL TELEVISION
13th YEAR OF ISSUE
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COMMENTS OF THE MONTH BY THE EDITOR

Television—The Latest

THE news that the Television Development Committee of the Radio Industry Council recently decided to make formal application to the Government for the immediate introduction of a television still pattern picture transmission from Alexandra Palace, is an indication that the trade is getting ready for the development of this newer branch of radio entertainment. The Committee states that it is the intention of the industry to rehabilitate a large number of service men who have been on Radar and Communication work and it will only be possible to do this if a test signal is put on at once in order that facilities are available for training.

They quite rightly say that they are unable to deal with the considerable uneasiness in the minds of television-set owners who have been unable to get their sets overhauled and tested because of the lack of a transmission. It was disclosed that the B.B.C. had already begun to send out test signals on the television sound channel and it was stated that the change in the international position encouraged the whole industry to feel that television programmes should start at an early date. The Lend-lease position has made it imperative that this great spear-head for British export trade should be got under way immediately. The Chairman of the Committee stated that America would have television sets on the market in mass production quantity early in 1946, and that if British industry did not move at once it would be another case of too little and too late. We fear that that is what it will be, in view of the announced policy of the Government to continue controls, and to persist in the Bevin Scheme of Demobilisation. This country was far ahead of America in the development of television, but America has been enabled, by the interchange of technical information during the war, to get abreast of our own developments; and because with typical American alacrity they swept away large numbers of their controls almost overnight, they have certainly been able to steal a march on us from the production point of view. It would seem, therefore, that American television sets will be imported into this country before we are in full production ourselves.

The suggestion has been made that television transmissions should be operated not by the B.B.C. but by another body working independently of, but in collaboration with it. There is much to be said for this proposal, for the B.B.C. if it endeavours to run sound transmissions as well as television transmissions cannot bring an independent mind to bear on the designing of the programmes. It may be the mixture as before. Until the B.B.C. announces its policy in conjunction with a date, it will be impossible for the industry to make preparations and it is here that industry and those responsible for planning the transmissions should get together. A joint management is desirable, for it would enable receiver technique to follow transmitting technique and it would avoid the receiver showing up the inefficiencies of the transmissions and vice-versa.

Television should afford opportunities for leading screen and stage artists to partake of visual broadcasts. Colour television is, we fear, not sufficiently advanced for any large-scale development, but it will come when the necessary encouragement is given.

The home constructor must wait some time before components of a satisfactory quality are available. It must be remembered that a television receiver makes use of very high voltages and that it is not the apparatus with which unskilled amateurs should be encouraged to experiment.

When components are available our readers may rest assured that fully tested designs will be given in this journal.

Several such designs are already in hand, but components are not available except for experimental purposes.

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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.

Query Service Suspended

NOTWITHSTANDING frequent announcements in this journal, some readers are continuing to address technical queries to us. Much as we should like to do so, we are unable, owing to the continuing staff shortage, to deal with them. We hope readers will, therefore, patiently await a future announcement concerning the reinstatement of this service, which we hope will be in the near future.

ROUND THE WORLD OF WIRELESS

Soviet Radio

ACCORDING to a Russian newspaper a giant radio station was erected in the Soviet Union during the war. No details are available as to its power and position, but the aerial masts are stated to be 650ft. in height.

New Television Centre in U.S.A.

IT is announced from the United States that plans for the development of Mount Wilson, the Californian site of the observatory as a centre for television, are being considered. Three of the major broadcasting networks have already entered into negotiations for station sites.

Ship-Shore Radio

SHORT-WAVE radio linking with ships along the 35-mile stretch of Manchester Ship Canal is one of the novelties in a post-war development scheme to

To further develop radar, schools are being set up in various parts of the country, so that the British Navy will be adequately staffed with fully trained radar personnel. The illustration shows an operator checking up on "The Spider Web," the chart which keeps track of all ships and aircraft within range.

cost millions of pounds now being studied by the directors.

Two big estates near the docks which will be developed as rapidly as possible are Barton Dock and Trafford Park. There is plenty of room for expansion.

Ship canal engineers who have recently been to the United States on a special mission have brought back with them the latest scientific methods for handling cargoes. It is intended to replace cranes, wagons, and locomotives over a period of years.

Commercial Sets Soon

ACCORDING to the Radio Industry Council a gradual release may be expected during the next few months of limited supplies of manufacturers' own branded receivers, and a number of firms have already issued preliminary details of their first post-war models. These firms include Ferranti; Ultra Electric, Ltd.; Vidor, Ltd.; General Electric Co., and R. N. Fitton, Ltd., makers of the Ambassador Superhet.

B.B.C. Plans in British Guiana

A B.B.C. engineering representative, Mr. A. E. Barrett, is now in British Guiana carrying out a technical survey for the B.B.C. and the Colonial Office. He states that the B.B.C. plans to establish a high-power broadcast station in British Guiana to cover the whole Caribbean area, also to serve an all-Empire relay station to facilitate the transmission of programmes throughout the Empire.

B.I.R.E. Meeting

AT a meeting of the British Institution of Radio Engineers (London Section) held at the Institution of Structural Engineers, Upper Belgrave Street, S.W.1, on September 20th, a paper on "Engineering Methods in the Design of the Cathode-ray Tube," was read by Hilary Moss, Ph.D. (Associate Member).

New Radio-telephone Service

THE Hon. J. A. Mackinnon, Canadian Minister of Trade and Commerce, and the Hon. J. D. Rankine, Acting Governor of Barbados, held the first conversation over the new direct radio-telephone circuit which was opened between Canada and Barbados on September 1st.

The circuit will be operated by the Canadian Marconi Co. (an Associate of Cable and Wireless, Ltd.) in Canada, and Cable and Wireless (West Indies), Ltd., in Barbados, in co-operation with the Barbados Telephone Co.

Mr. J. A. McNeil, General Manager, Canadian Press, Toronto, exchanged messages with Mr. C. A. L. Gale, Canadian Press Agent and Editor, *Barbados Advocate*, and Mr. A. H. Ginman, President of Canadian Marconi, with Mr. E. A. Way, who deputised for Mr. A. G. L. Douglas, Cable and Wireless Manager in Barbados.

Huge Radio Contract

IT is reported that a £120,000 contract for a complete radio communication system in the Portuguese East African Colony of Mozambique has been placed with Marconi's Wireless Telegraph Co., Ltd. Twelve short-wave telegraph-telephone stations will be built at the company's works at Chelmsford (Essex) and put up at key-points in the colony.

Colour-television Programmes!

TELEVISION programmes in colour will be broadcast from the spire of the 808ft. high Chrysler Building in New York before the end of the year.

They will be run by the Columbia Broadcasting System, which is also to market receiving sets in two sizes.

Mobile Naval Radio Station

THE Royal Navy has already started to restore the great Singapore naval base. In addition to huge floating docks, which were built months ago in India, a mobile naval radio station, complete with office equipment and power supply, manned by more than 100 ratings, and ready to land within twenty-four hours of occupation, was prepared.

Variety Programme Changes

NOW that the "Michael Howard Show" is broadcast on Tuesday evenings in the Home Service, its place in the Saturday programme from 12.30 to 1.0 p.m., is taken by a recorded repeat of "Flotsam's Follies," which has its first broadcast on Mondays from 8.30 to 9.0 p.m.

"Serenade in Sepia," the programme of Negro music featuring Evelyn Dove and Edric Connor, is now heard from 6.30-7.0 p.m. on Sundays, with a recorded repeat on Mondays from 4.45-5.15 p.m. Its place on Fridays is taken by a new radio cabaret show called "Chop and Change," produced by David Porter, in which a different band is heard each week, interspersed with cabaret turns. "Chop and Change" opened on September 14th.

"These Passing Shows," the new Douglas Furber programme that is proving so popular, will be broadcast in future from 9.30-10.0 p.m. on Fridays, with a recorded repeat on Saturdays from 11.03 to 11.30 p.m.

In the Light Programme, "Here's Wishing You Well Again" returns at 8.0 p.m. on Fridays, entailing alterations in timing to John Rorke's "Unusually Yours," now at 8.45 p.m., and "Merry-Go-Round," which will in future be heard from 9.0-10.0 p.m.

Retirement

ON the completion of 45 years' service in the telegraph industry, Lord Pender recently retired from active participation in the Cable and Wireless group of companies. The Hon. Jocelyn Denison-Pender, his son, has been appointed to a seat on the boards of all the companies within the group, and joint managing director of the operating company, Cable and Wireless, Ltd.

Global Radio Record Broken

A NEW record for round-the-world radio transmission was established by the U.S. Army Signal Corps when it sent a nine-word radio-teletypewriter message completely around the earth in 9½ seconds.

In a test to demonstrate the flexibility of Army Communications Service's world-girdling system, the message was transmitted from Washington through automatic relay stations at San Francisco, Manila, New Delhi and Admara, then back to Washington. Regenerative repeaters were used at the relay points.

The transmission was almost instantaneous. Exactly one second after the perforated tape containing the message began moving through a teletypewriter transmitter, a nearby receiving machine started printing the message at the end of its round-the-world journey. The one second represented the time lag in the electrical transmission, the other 8½ seconds the time mechanically required to send the message.—(*Radio-Craft.*)

Radio Telephony for Cars

THE American Telephone and Telegraph Company recently announced that they are ready to manufacture a new two-way car-to-anywhere radio-telephone for U.S. motorists.

This new device, which resembles a walkie-talkie set, will permit communication between a car and telephone number in the United States. Calls from cars travelling along a highway will be picked up by different stations as the car passes from one zone to another. Car-to-car conversations will also be possible.

Each car will have a dashboard 'phone with its own call number. When someone is calling, the 'phone will indicate an audible or visual signal, and all the driver need do then to make connection is to lift the receiver. Similarly, to make an outgoing call he will have only to press a button and give the number he wants. A 15-watt transmitter and the special radio exchange will do the rest.

The American Telephone and Telegraph Company have already applied for authority to instal radio-telephone stations in 13 big cities in the United States, with sub-stations along the principal highways.

Radio Frequencies in Liberated Europe

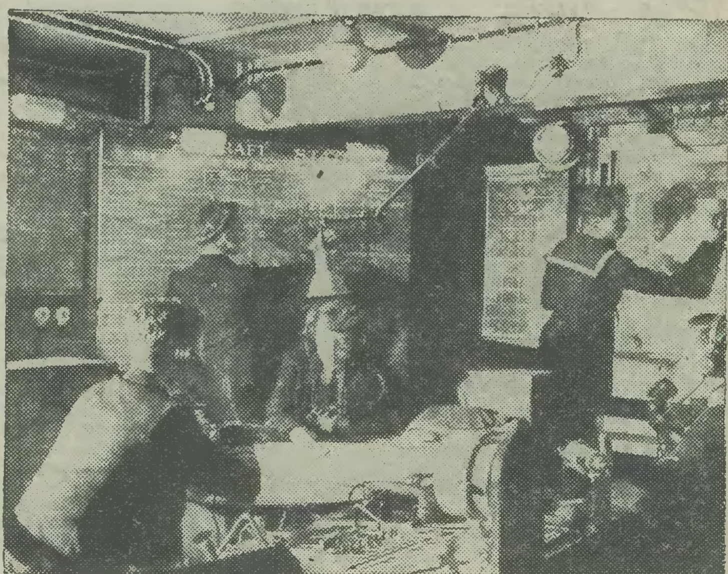
THE Postmaster-General, the Rt. Hon. the Earl of Listowel, recently opened a conference in London to discuss ways and means of assisting the liberated countries of Europe to obtain the wavelengths they need for reopening their civilian radio services.

Under the chairmanship of Colonel Sir Stanley Angwin, K.B.E., Assistant Director-General and Engineer-in-Chief of the U.K. Post Office, delegates from 12 European countries, in addition to the U.K., assembled, and the U.S.A. also sent representatives for the purpose of unravelling the tangle of radio frequencies caused by nearly six years of war and German occupation of European territories.

Use of Codes and Ciphers

THE Post Office and Cable and Wireless, Ltd., announce that all restrictions on the use of codes, ciphers and languages in telegrams exchanged with countries in the British Commonwealth (except India, Ceylon and Palestine) and with the United States of America and Possessions are now removed. As, however, some countries abroad are still maintaining certain restrictions on telegrams it will not be possible at present to restore all the facilities which were withdrawn on the outbreak of the war. Further relaxations will be announced as soon as practicable.

Censorship of telephone calls to Canada, the United States and Kenya has ceased and in consequence the restriction on the use of foreign languages is withdrawn.



In the aircraft direction room of a radar training school. Trainees keeping check on the movements of aircraft.

Radio on the Road

Constructional Details of a Small Set for Motorists

By L. JACKSON

BRITAIN has once again returned to some sort of peacetime conditions, with basic petrol again being used, and many motorists are looking for car radio sets, though they happen to be in very short supply as well as very dear. It is not at all a difficult matter to make a satisfactory set suitable for car use.

Most of the commercial sets have five valves; for conditions in America such a set may be necessary, the U.S.A. has vast distances and one may be a considerable way from a transmitter, but in this country we have a choice of programmes with quite a modest set.

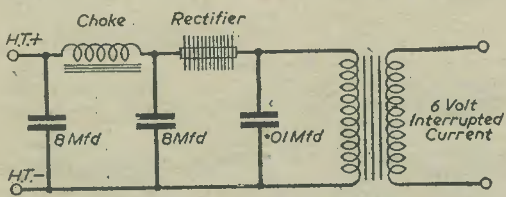


Fig. 1.—Circuit diagram with interrupter omitted.

I have found that a set consisting of S.G. det. and pentode will give good results almost anywhere if provided with plenty of H.T.

That brings us to the difficulty in many cases: providing the H.T. Unfortunately, there is very little published about the subject of getting H.T. from a car battery, in fact many amateurs are very vague about how it is done.

H.T. Supply

A battery supply is interrupted at a fairly rapid rate, and the resultant interrupted current is fed to a transformer, it acts in the nature of an A.C. current and can be stepped up to 150 volts, rectified and used to supply the valves of a set.

The windings of a speaker transformer are often suitable if the speech coil winding is fed with the interrupted current. I have tried several and all have given fairly good results; commercial transformers are generally made centre-tapped to suit commercial vibrators. If you wish to wind a transformer, use a speaker transformer core and bobbin, the heftiest you can get, and put on about fifty turns of No. 22 S.W.G. wire for the primary, the secondary can be of about 3,500 turns of No. 42 S.W.G.; both windings should be centre-tapped.

A choke will be needed and the usual smoothing condensers; there will also be required a .1 mfd. condenser across the output of the transformer—breakdown or absence of this condenser will cause a drop in output volume, so do not omit it. The circuit diagram is given in Fig. 1, the interrupter being omitted.

If you propose to make a conventional unit, then a vibrator may be bought for just over 10s., and connected to the transformer according to the instructions given with it. If it is a self-rectifying vibrator it will be connected like Fig. 2; if it does not rectify then some form of rectifier must be bought.

I prefer a metal rectifier since it needs no current, like a valve, and lasts for ever. There are plenty on the market which are suitable, and may be used as half-wave or in a voltage-doubler circuit.

Interrupters

There are numerous means of interrupting the current to the transformer apart from the vibrator. The vibrator itself is not an easy thing for the amateur to make. As Fig. 2 will show, there are a number of contacts to adjust and this will be found a work of art, but a simple one can be made along the lines of Fig. 3. The centre-tapped transformer is not used for this, since it is only put in series with one of the leads to the transformer, as seen in Fig. 4. The contacts should be of silver, or, better still, platinum, if you can get some. I never could. The simple vibrator should be adjusted to vibrate like a bell and the contacts shunted with a condenser to prevent sparking and also interference in the set. The vibrator itself must be enclosed in a case of sound-proof material; felt is excellent, and I found two layers of thick felt necessary. It must also be enclosed in a metal box, since vibrators are miniature transmitters and can cause interference in the set by direct radiation. The felt is needed to damp out the mechanical interference, since we do not need something rattling like a bell. It may be thought that an electric bell would do for this vibrator, and so it would except for the fact that the resistance of the winding is too great. If you wind the bobbins with about No. 22 S.W.G. wire it should be all right; 20 S.W.G. would be better for six volts.

Many cars are fitted with a Lucas type windscreen wiper which consists of a small motor, the rotor of which opens and closes two contacts, which give it its impulses. The resistance of the windings is low enough to put in series with a transformer without stopping the motor working, the opening and closing contacts then pass the necessary interrupted current through the transformer. I have used an old one of these motors for many months, supplying H.T. to a small set with every satisfaction; the contacts need shunting with a two mfd. condenser, and connections are the same as Fig. 4.

Background noise in the set, I found, was dependent to a large extent on the speed of interruption. If the speed is too low then the speech and music has a wobbly effect, very laughable at first, but one soon tires of it, while if the speed is too great the interference is higher. Speed of the motor may be adjusted by moving the bakelite plate on the top of the motor which adjusts the contacts.

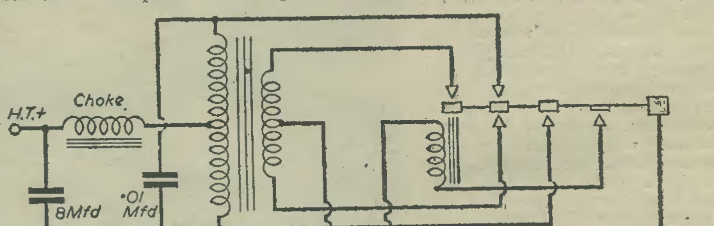


Fig. 2.—Complete vibrator self-rectifying circuit.

For a trial there is no reason why the transformer primary should not be put in series with the car screen wiper motor if it is of Lucas pattern, but for regular use one may be obtained from a car breaker, especially as there is no need for the gearing to be perfect. I removed mine from the wiper.

These motors are not self-starting, since if it stops with the contacts open no current is passing; they must be given a turn to start, that is the only disadvantage. They work excellently as an interrupter, with very little background noise in the set provided the contacts are shunted by a condenser.

All the previous remarks about covering with felt apply here, though I have found that a metal covering is not absolutely essential.

I have also used a wiper motor in another device. This time it was a Bosche self-starting motor. It was used to drive a separate commutator consisting of alternate copper and bakelite strips, which shorted and insulated two brushes alternately. The battery current was thus passed and interrupted a number of times per revolution, the brushes and commutator being in series with the supply. This was an excellent interrupter, background being practically nothing, but it has the disadvantage of needing an extra amp. to drive the motor. The brushes had to be made of copper gauze since the resistance of carbon was too high and reduced the output. The life of each pair of brushes was about 2,000 hours; they were copper gauze rolled round into a cylinder ¼in. diameter.

I also tried a commutator and three brushes, which sent alternate impulses through each side of a centre-tapped transformer, with equally good results.

Making a Unit

My own units have been mounted upon a wood or metal base-plate and placed in a felt-lined cardboard box, this has again been covered with felt and enclosed in a metal box, the size has been roughly 4in. by 8in., including a metal rectifier and choke. The rectifier has no

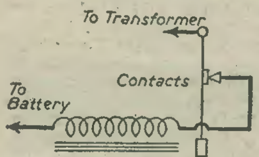


Fig. 3.—A simple vibrator showing contacts.

cooling fins and does not seem to get warm, the absence of fins makes it more compact.

Receivers

Since I do not believe in still further overloading a car battery, I always aim at economy. The battery has to supply lights, starter, ignition, and screen wiper. Another four amps. for a radio is usually made up for by putting up the charge, for if the set isn't used very often the battery is overcharged and the active material drops out of the plates, thus reducing its life.

Mains valves used in many sets take four volts and one amp. each, they cannot be run in series on a six-volt battery, so that the drain of a three-valve set is three amps. for heaters alone, plus some wasted in a resistance. I have never tried American six-volt valves, but at .3 amp. apiece they are more economical. My sets have all used two-volt battery valves and being directly heated I have had slightly more background noise than with indirectly heated valves; when I have reduced this to small proportions I know that on a conventional set the background would be silent.

For a twelve-volt battery I recommend three four-volt mains valves in series for the heaters, they will take one amp. total, which is reasonable enough.

For economy on a six-volt battery I suggest three two-volt valves in series, each valve being of the ·2-amp. type; both screen grids and pentodes may be obtained with this consumption. For the detector I use a small power, such as the Mullard P.M.2, which takes .2 amps. and makes a good detector valve.

It will be appreciated that valves in series must all consume the same current. One end of the filament must be earthed and the detector should be at the earth end followed by the screen grid, the pentode filament will be farthest from earth.

Since three battery valves in series on a six-volt battery allow nothing to spare for a rectifying valve, I always use a metal rectifier, minus its cooling fins and mounted in an old valve base, two of the pins being used for connections, the positive output side of the rectifier being joined to the grid pin of a four-pin base. Mine is a half-wave rectifier.

The Circuit

The circuit I suggest is a simple tuned grid H.F. anode bend detector, with four-volt valves, since it is a little more selective, and R.C. or transformer-coupled pentode. Resistance coupling to the H.F. and pentode make the set more compact and sacrifices very little in signal strength. Selectivity is generally good on the

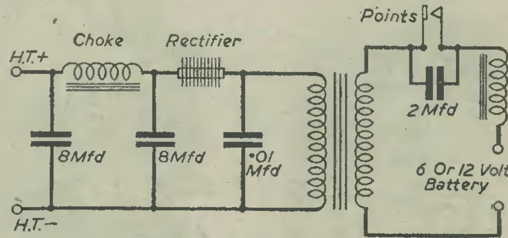


Fig. 4.—Circuit diagram showing contacts for passing the interrupted current.

short aerial possible on a car, unless one is very close to a transmitter.

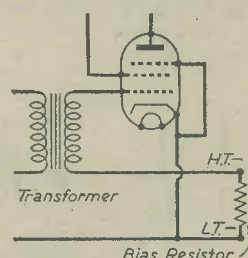
In my own opinion A.V.C. is not essential even in town, there is some loss of strength when passing tall steel-framed buildings, but in London, at least, these are situated in the West End and City where the traffic is most congested and a radio is not likely to be listened to very much. Most listening is done on long runs on the open road, where it helps to dispel the monotony, and fading due to steel-framed buildings does not exist. Railway bridges in some cases cause fading, but for such a brief space of time that the extra complication is not justified.

As regards the arrangement of the set I myself favour making it and its power supply in one unit with direct control, that is, not by means of cables. The speaker is better mounted in the roof of a saloon car; after all we listen with our ears and not our feet. This allows a more compact set, which may be mounted under the dash with knobs and dials showing and handy for tuning.

Aerials

As for aerials, I have always obtained better signal strength from one under the car, the closer to earth the better. The man with a superheterodyne six-valve set would not notice much difference in aerial position, but with the simple sets we have in mind it is worth

Fig. 5.—Diagram of heater wiring and automatic bias for pentode valve.



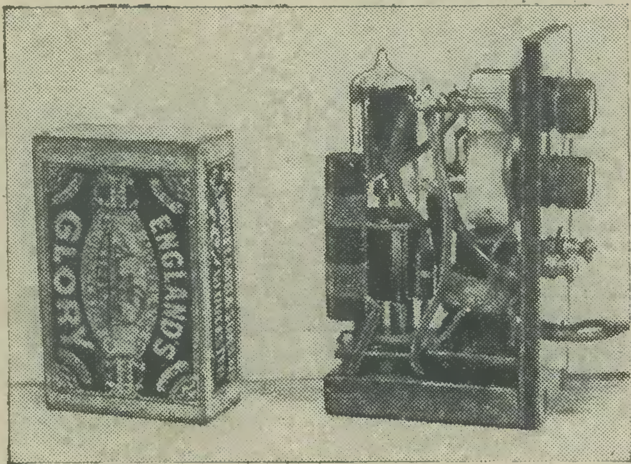
considering and it is fairly simple to try out various positions before making a permanent job.

There are on the market kits of parts to build one of the American type small sets; these lend themselves very well to adapt to car radio.

They have the series arrangement of valves that is desirable together with a metal rectifier plugged into the rectifier holder. Instead of the universal valves the appropriate four- or two-volt valves can be used, with suitable holders, and an automatic bias for the pentode as in Fig. 5, for the battery valves. This drawing shows the heater wiring for two-volt valves.

(Continued on page 513)

A Pocket One-valver



The completed receiver which is not much larger than a matchbox.

Further Details of the "Matchbox" Receiver Mentioned in the Correspondence Pages of our August 1945 Issue

By F. G. RAYER

THE use of a twin trimmer for tuning and reaction purposes is largely responsible for the smallness of this receiver. A Hivac midget valve is also used to further reduce dimensions, and, in consequence, the receiver is very small, as looking at the diagrams will show.

The circuit is shown in Fig. 1. The 5,000 ohm resistor is to smooth reaction and prevent the 'phone leads causing hand-capacity. The remainder of the circuit follows normal lines. The valve type is Hivac XL with 1.5 volt filament, so that a dry cell can be used for L.T. Condensers C1 and C2 are sections of the trimmer, and details of this will be given later.

Fig. 4 shows the panel layout, and the location of the parts will be seen from Figs. 2 and 3. The panel is of ebonite, and the trimmer is secured to it by countersunk 6B.A. bolts. The adjusting screws of the trimmer are removed and replaced with short lengths of screwed rod fitted with insulated terminal heads (such as those on the older type of S.G. valves), as shown in Fig. 3. This enables the set to be tuned by hand.

Below the trimmer two small terminals are fixed—one for the aerial and one for 'phone connection. The positive 'phone connection is taken directly to H.T. plus. No earth terminal is used, for if an earth is available, it can be connected to H.T. minus at the battery.

All the connections except L.T. minus are shown in Fig. 2. L.T. minus is taken to the remaining filament socket, and Fig. 5 should be consulted for the connections to the valve-holder. The large socket is grid, and the three smaller ones are plate and filament, as shown. Note that these connections are for the valve-holder, and not the bottom of the valve.

The resistors and fixed condenser will need to be small components, the former being midget or ¼ watt sizes. The parts are suspended in the wiring, and insulated sleeving should be put over the connections. Short lengths of thin flex are used for the battery connections, there being three only of these. There is no on/off switch, L.T. plus being disconnected to switch off.

The tuning coil fits around the valve, below the trimmer, and is not shown in position for clarity. Numbered connections for the coil will be seen in Figs. 1, 2 and 5. It is a small dual-range type, so that medium and long waves can be tuned for the reception of Light and Home programmes.

The twin trimmer was of the type having a capacity

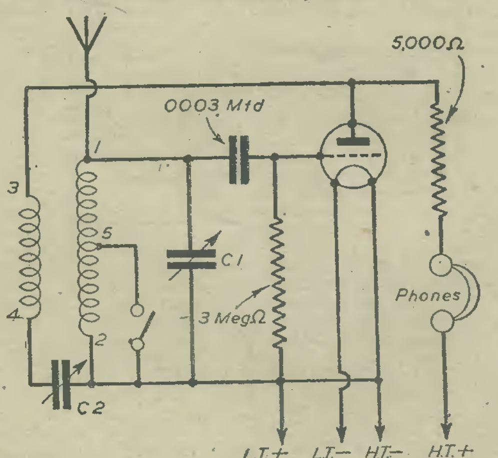


Fig. 1.—Theoretical circuit for the pocket receiver.

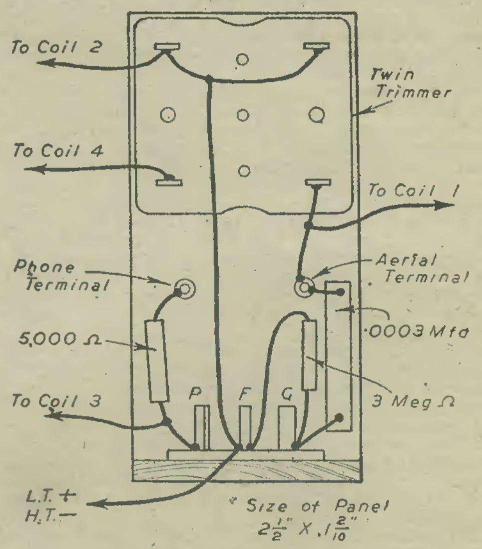


Fig. 2.—View of back of panel showing location of the parts.

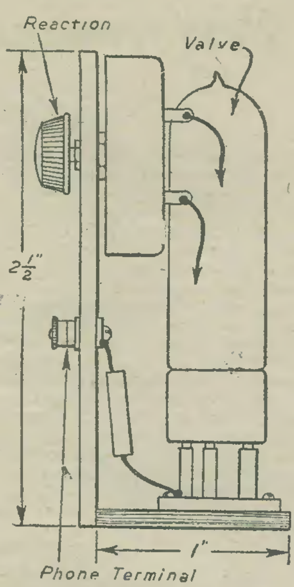


Fig. 3.—Side view (actual size).

of .0005 mfd. each section, but, as the minimum capacity was rather high, some plates were removed, leaving four on the tuning section and three on the reaction section. The capacity used must, of course, be capable of tuning in the stations desired, and also providing proper control of reaction. Because of this it is best to build the set temporarily with no regard for compactness, so that the trimmer may be modified with ease. When the correct capacity has been arrived at the set may then be re-built as shown.

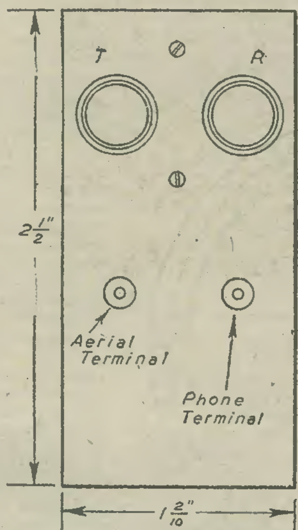
The completed receiver pushes into a small cabinet made from $^1/_{16}$in. thick ply. The wave-change switch is made from a small screw and brass strip, and is fixed to the case.

For L.T. a dry cell is needed, and a small one is suitable as the consumption is only .06 ampere. H.T. can be provided by a special battery or grid-bias batteries About 24–30 volts is sufficient. If listening outside an earth may be provided by a metal skewer pushed in the ground. The aerial is about 15ft. of thin flex hung up as convenient.

With a higher H.T. voltage results are about equal to those from a normal one-valver. With the reduced H.T. results are still very good, and three or four stations can be received at good 'phone strength. After dark numerous foreign stations can also be received.

COMPONENTS

- Twin trimmer.
- Valve: Hivac XL, and holder.
- 5,000 ohm and 3 megohm small resistors.
- .0003 mfd. condenser.
- Small dual range coil.
- Terminals, a few feet of flex, etc.



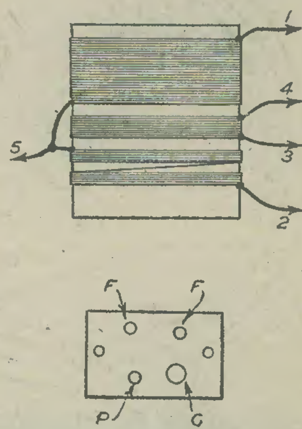


Fig. 4. (Above)—Panel layout. Fig. 5. (Right)—Coil, giving numbered connections and the valve-holder.

Microwaves for Post-war Uses

RADAR and other wartime applications have brought microwave techniques into the practical field. Post-war applications will reach into many branches of electronics.

Experiments have been made with satisfactory results for using microwaves in conjunction with moving railroad trains for control and conversation. Many of the applications are shrouded in wartime secrecy and will undoubtedly be revealed at a later date. Aircraft-to-ground and aircraft-to-aircraft communications should adapt themselves readily to this means, especially where a large degree of privacy is desirable. A few of the valves have already been partially released.

Microwave parts production in the U.S. is increasing. A large post-war market is necessary, or these plants will close. One outlet is the huge "ham" market. The "hams" (amateurs who operate their own transmitting, receiving and experimental equipment) have been responsible to a large degree for the advancement of radio science and will again play an important role when the microwave field opens up. The "ham" will be able to buy those items he needs, which will probably be designed with sufficient latitude to cover an entire ham band, and by adept use of a hacksaw, pipe, sheet metal, and a few other readily available and cheap items, can construct for himself the items he needs.

In the wavelength band between one centimetre and one metre, there is a range of 300,000 to 30,000,000 kilocycles, making available almost 3,000,000 channels for amplitude modulation and 150,000 for frequency modulation. These numbers can be amplified to an almost infinite number when the distance limitations that exist are remembered and that high directivity will permit several stations on the same frequency in the immediate vicinity of one another. (*Radio-Craft.*)

Improving Loudspeaker Performance

By S. O. MAWS

CONSIDER the performance of a conventional moving-coil loudspeaker at very low frequencies. In this frequency range the response of the instrument is largely dictated by the value of the bass resonant frequency, and the value of this is, in turn, determined by the mass of the diaphragm and speech-coil assembly (with a correction due to the additional fluid mass of the air in close proximity to the cone) and the elastic restoring forces which bring the diaphragm to rest once it has been moved. These elastic forces are provided chiefly by the flexible surround of the diaphragm and the centring device. We can, in fact, compare the mass of all the moving parts with the inductance in an electrical tuned circuit and the compliance (i.e., the reciprocal of the stiffness) with the capacitance, and it is also true to say that the value of the bass resonance frequency of a loudspeaker is roughly inversely proportional to the mass of the diaphragm and speech coil assembly and directly proportional to the stiffness of the suspension. Thus, increase of mass or reduction of the stiffness—or, of course, both—will lower the bass resonant frequency. Very broadly speaking, the value of the bass resonant frequency of commercial moving-coil loudspeakers depends on their size. For large models of, say, 12in. diameter it is frequently of the order of 50 c/s.; for midget models of 4in. diameter it may be as high as 150 c/s.; 100 c/s. is an average figure for 8in. models. These figures are of considerable importance, for the response of a loudspeaker falls off quite sharply below the bass resonant frequency. It is of advantage, then, to know how to lower the bass resonant frequency, for an improvement in the reproduction of low frequencies can be obtained by so doing. Clearly there is no point in attempting to improve a loudspeaker which already goes down to 50 c/s. or lower; hence the following applies only to the smaller types and in particular to those 8in. or 10in. diameter models having resonant frequencies of 75-100 c/s.

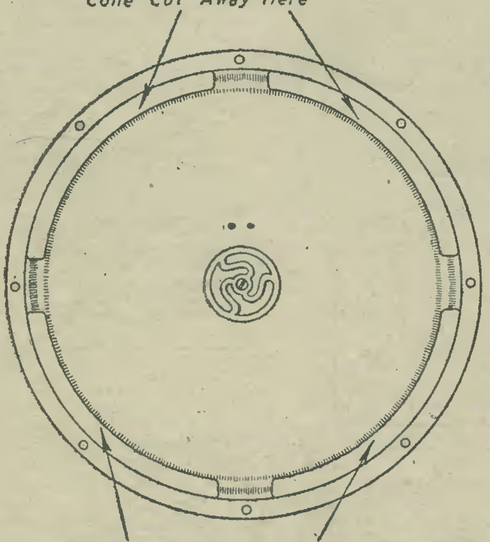


Fig. 1.—Illustrating method of cutting away the surround of a diaphragm in order to lower the frequency of its fundamental resonance.

The Diaphragm

Increasing the mass of the diaphragm by loading it mechanically is not to be recommended as a method of lowering the bass resonant frequency as this usually brings about a fall in high-note response and will possibly reduce the sensitivity, but decreasing the stiffness is easily possible and is frequently well worth while. One way is to cut away much of the corrugated surround, leaving the diaphragm supported at three or four points only as suggested in Fig. 1. Alternatively, the corrugated parts of the diaphragm could be cut away completely, the edge being supported by three or four strips of readily flexible material such as thin chamois leather. Some enthusiasts prefer to use a linen surround supporting the entire circumference of the cone. If the centring is achieved by means of a flexible spider situated inside the speech coil as in fairly old types of loudspeaker, as pictured in Fig. 1, then there seems no obvious way of reducing its stiffness, but if an outside centring spider is employed (as in most modern types, shaped somewhat as shown in Fig. 2, then it is possible to increase the compliance by cutting away one-half of the material as suggested in Fig. 2. By using both of the methods mentioned it is possible to effect a considerable lowering of the bass resonant frequency and a considerable improvement in quality of reproduction results. Parodoxically, one's first impression on listening to a loudspeaker which has been "doctored" in this way is often that there is a lack of bass! This is a direct consequence of the lowering of the bass resonant frequency. Coinciding with this frequency there is a sudden and considerable increase in efficiency, often deliberately encouraged by manufacturers in order to give an impression of a good response at these low frequencies. By lowering the frequency of this peak output, as we do when decreasing the stiffness, we also make the peak less obvious, for the sensitivity of the ear falls off rapidly as frequency decreases at these bass frequencies. Critical listening will show, however, that the bass response is, in fact, better: it is simply that one misses that colouration characteristic of a bass resonant frequency at or near 100 c/s.

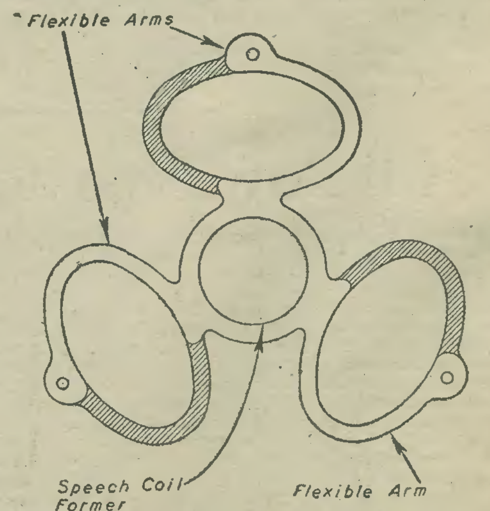


Fig. 2.—A method of reducing the stiffness of one common form of centring spider.

A Free-edge Diaphragm

Possibly the best method of improving the high-note response of a loudspeaker is by the provision of an additional free-edge diaphragm attached directly to the speech-coil former and inside the main cone, as pictured in Fig. 3 (a). This method is the subject of a patent by P. H. A. G. Voigt (Patent No. 413,758). To make a worthwhile improvement in "top" this subsidiary cone should be very light and stiff. Certain types of cartridge paper are suitable for making these "tweeter" cones, but after they have been constructed they should be doped with some form of adhesive which sets hard in order to provide additional stiffness. Experiments seem to suggest that the improvement in "top" caused by doping the "tweeter" cone is greater than that due merely to the addition of the undoped "tweeter" to the main cone. A straight-sided "tweeter" cone such as that pictured in Fig. 3 (a) can be made very simply from a semi-circle of cartridge paper, as shown in Fig. 3 (b). The diameter of the inside semi-circular edge in Fig. 3 (b) will naturally depend on the diameter of the speech coil former to which it has to be attached. The radius of the outside semi-circular edge should be about 2 in. or 3 ins. greater than the radius of the inside edge, so that the final "tweeter" cone should have edges about 2 in. or 3ins. long. The author suggests that the best method of constructing a "tweeter" cone to suit a particular loudspeaker is to make a few trial cones with, say, ordinary notepaper first until a suitable size is obtained by trial and error. Then the real cone can be made, using the final trial model as a template. The effect of adding a "tweeter" cone to a loudspeaker is well illustrated in the response curves given in Fig. 4. From these it is evident that the addition of the subsidiary cone does more than extend the upper frequency limit; it also exerts a damping effect on the main cone and reduces the output in the all-important 2,000 c/s region where the ear has maximum sensitivity and where, unfortunately in the case of so many loudspeakers, there is a marked increase in sound output. Incidentally, the response curve of the loudspeaker given in Fig. 4 is fairly typical of 10in. and 12in. commercial models with single diaphragms. The sharp fall at 6,000 c/s is quite a marked feature of their performance and makes them very suitable for the reproduction of gramophone records, a scratch filter being more or less unnecessary. There is no reason, of course, why a commercial loudspeaker should not be treated in both the ways suggested in this article; the stiffness could be reduced to improve the bass and a "tweeter" cone can be added to increase the "top," and it is possible to produce some very fine quality from loudspeakers treated in this way.

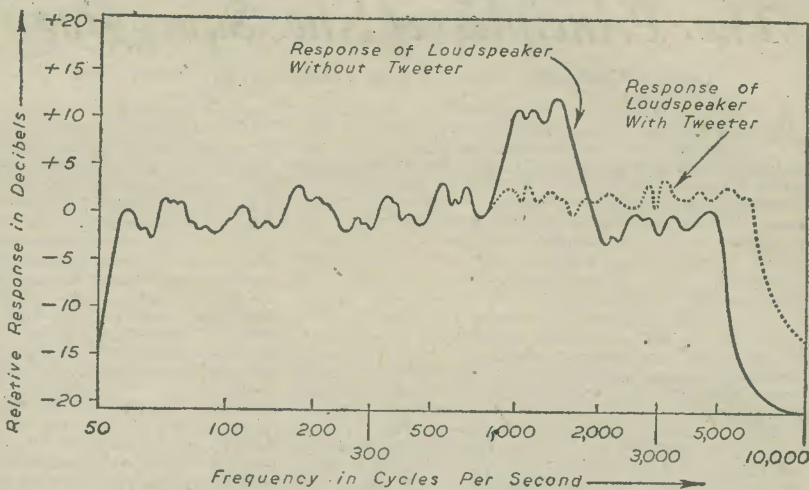


Fig. 4.—Illustrates effect of adding "tweeter" cone on loudspeaker performance.

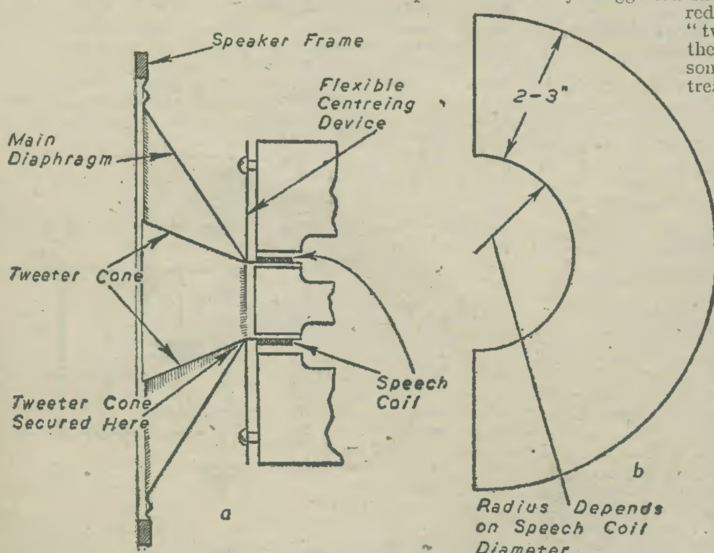


Fig. 3 (a).—Sectional view of straight-sided "tweeter" cone. (b) A suggested method of constructing a "tweeter."

The Principles of the Squegging Oscillator

An Informative Article Explaining its Theory and Operation

A CERTAIN amount of controversy has arisen recently in the correspondence columns of this journal over the classification and operational details of the squegging oscillator. There seems also to be a certain amount of dispute as to the differences between squegging and blocking oscillators, though essentially all oscillators of this particular form are squegging oscillators, blocking oscillators simply being particular instances of squegging circuits having certain relative values of the natural feed-back frequency and the charging time constant.

The reason for these differences of opinion may be due to the fact that the usual explanation of the operation of squegging oscillators, while simple, is not wholly correct. In its usual form the squegging oscillator consists of an ordinary feed-back valve circuit with a grid leak and condenser, a typical circuit being depicted in Fig. 1. This arrangement will, by a suitable choice of component values, generate anything from continuous oscillation of more or less sine wave form, to short, regularly spaced bursts of oscillation. It is this latter condition of operation, when bursts are produced at a repetition frequency determined mainly by the product CR that is known as the squegging condition.

Feedback

The customary explanation of the manner in which this circuit functions is as follows: feedback occurs from L1 to L2, and the valve commences to oscillate at a frequency determined by the grid tuned circuit L2C1. This oscillation very rapidly builds up, and, as it does so, the grid rectification effect of the valve with C and R causes the mean grid potential to swing negative. This effect is cumulative, and after a short while the grid becomes so negative that the valve is carried beyond cut-off and oscillations cease. This condition remains until the charge on condenser C has leaked away through R and L2, when the valve again commences to conduct and the cycle of events repeat themselves. The voltage between grid and cathode therefore varies in the manner of the waveform shown in Fig. 2(a), each cycle consisting of a short burst of oscillation, driving the grid beyond cut-off in the process, followed by a relatively long period of quiescence, during which the grid condenser discharges exponentially through the grid leak.

This squegging condition is achieved by using a much tighter coupling between L1 and L2, and a much higher value for C and R, than would normally be used when continuous oscillations are desired. The form which the oscillating circuit takes is of little importance, and such circuits as the Colpitts or the Hartley may be employed in place of the reaction-coil arrangement of Fig. 1.

The Blocking Oscillator

Blocking oscillators are generally constructed so that L1, L2 and C1 constitute an iron-cored transformer which may or may not have damping resistances across the primary and secondary. An ordinary, good quality audio transformer, having a ratio of about 3 : 1 is quite general, the secondary being connected into the grid circuit. In this case C1 does not exist as a separate condenser, but is made up of the self-capacity of the transformer windings.

Consider such a system at an instant when the condenser C (still referring to Fig. 1) is so charged that the valve grid is negative beyond cut-off. This charge commences to leak away through R and L1, and consequently induces a small e.m.f. in L1 such that there is a slight increase in anode potential. This effect continues as C discharges, and at last a stage is reached where the valve begins slightly to conduct. The rising anode current through L1 then induces an e.m.f. in L2 in such a direction that the grid is driven rapidly positive, and in a very short while the valve is fully conducting.

Now as the grid is driven positively, there is a fall in the anode potential due to the back e.m.f. set up in L1, and condenser C is charged by the flow of grid current. L1 thus experiences an additional load due to the grid-cathode A.C. resistance of the valve. This damping effect, together with the fall of anode potential, eventually succeeds in reducing the rate of rise of anode current and hence the grid voltage. Again the effect is cumulative and the anode current falls rapidly, driving the grid negative and carrying the valve beyond cut-off. The grid waveform varies in the manner shown in Fig. 2 (b), the valve cutting off after one-half cycle of oscillatory voltage.

While transformer back-coupled oscillators can be made to function in this manner, actual practice shows that ideal conditions are not easy to obtain due to damped oscillations set up in the transformer windings. A method of overcoming this is to use shunt resistances (the lesser of two evils) across the primary and secondary windings, even though the use of such resistances reduce the useful voltages developed and limit the charge on the condenser. They are also somewhat critical in value.

Another method of achieving the result outlined above is to employ a tuned circuit in place of the transformer, the natural frequency of this tuned circuit being so chosen that the time for one cycle is equal to twice the period over which the valve will be conductive. The action of the system is then very similar to the transformer-coupled circuit provided that the grid circuit time constant composed of C and the grid-cathode A.C. resistance of the valve is small compared with the period of conduction.

When the grid is carried positive in this case, the precise potential reached depends upon the ratio of the time constant CRg to the time of one-half cycle of the resonant frequency of the tuned circuit. Taking this ratio to be small, then the condenser C will charge as rapidly as the applied voltage rises, and the voltage across C will be practically equal to the applied voltage. Relative to the cathode the grid potential will be only slightly positive, since it consists of the algebraic sum of the voltages across the coil and the condenser, and these are very nearly equal though opposite in sign (ignoring slight resistive elements). When the voltage across the coil commences to fall the change in grid potential soon carries the valve beyond cut-off, and when the voltage across the coil is zero, the grid is negative by an amount equal to the condenser voltage. L2 being part of an oscillatory circuit, the next half cycle of oscillatory voltage carries the voltage across the coil to an amount practically equal to the previous positive swing, though negative in sign. The potential at the grid consequently goes negative by an amount almost equal to twice the condenser voltage already present.

Now, since the conductive grid time constant CRg is small enough to permit the condenser to charge

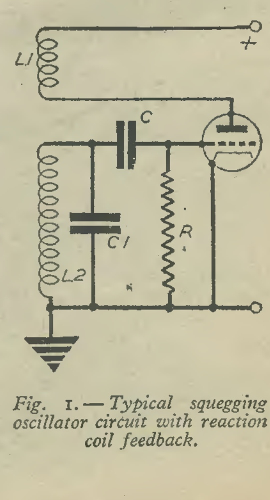


Fig. 1.—Typical squegging oscillator circuit with reaction coil feedback.

almost completely during the first positive half cycle of oscillatory voltage, the second positive half cycle will fail to lift the paralysing bias on the grid and the valve will remain cut off. The oscillations will then rapidly die away, and the process will only repeat when the charge on the condenser has leaked through R sufficiently to allow conduction to recommence. The grid waveform for this cycle of events is shown in Fig. 2 (b), already referred to above, where it is seen that the valve is cut off after the first half cycle of grid oscillatory voltage. This is the blocking condition as distinct from the squegging circuit whose grid waveform was shown in Fig. 2 (a). It must not be overlooked, of course, that the blocking oscillator is only a particular form of squegging oscillator, and that *all* oscillators of this nature are actually squegging oscillators, as was remarked previously.

Theory of Squegging

In order to understand the fundamental theory of squegging oscillators, it is necessary to grasp the implications of the fact that the effective mutual conductance of a valve varies with the grid bias applied. Mutual conductance is generally defined as the ratio of the change in anode current to the change in grid voltage producing it, infinitesimally small quantities being taken in each case. In the notation of the calculus:

$$\text{Mutual Conductance } g_m = \frac{\delta I_a}{\delta V_g}$$

i.e., the tangent to the I_a-V_g curve (Fig. 3) at any particular point.

This definition of g_m is not of much value when the amplitude of the input voltage is large, for then the characteristic is curved throughout the working range and the static value of mutual conductance arrived at by the above method no longer applies. For our present discussion a somewhat different definition must be found When a relatively large sinusoidal input is applied to the grid, the anode current will fluctuate accordingly, but the anode waveform will not in general be sinusoidal. It may be nearly so, or it may consist solely of short pulses corresponding to the positive tips of the input waveform. It is possible to show, however, that the anode waveform, whatever its variations, can be resolved into a harmonically related series of sine and cosine terms with a fundamental frequency equal to that of the grid waveform. We now define mutual conductance as *the ratio of the fundamental frequency component of the anode current to the grid voltage.*

The manner in which the *effective* mutual conductance varies with grid bias is quite a simple matter to follow from Fig. 3. When a valve is biased at a point A (about the centre of the steepest part of the curve), the slope, and therefore the mutual conductance, has a maximum value $\hat{g}_m$. As the bias point is moved back towards B, the slope of the curve becomes less, and g_m therefore

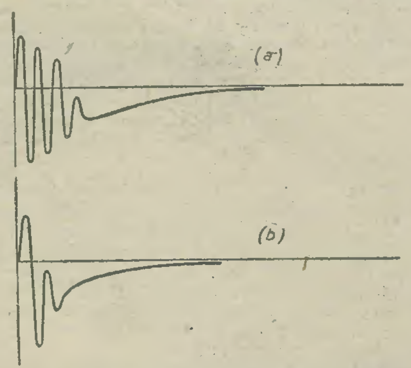
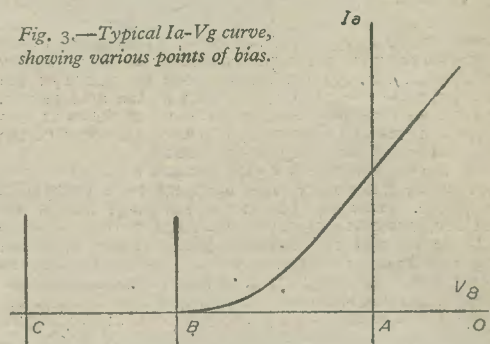


Fig. 2.—Grid-cathode waveforms for squegging circuits. (b) Depicting the special case of blocking.

Fig. 3.—Typical Ia-Vg curve, showing various points of bias.



decreases. g_m does not necessarily become zero, however, when the bias point is moved beyond the cut-off value of the valve at B, for during part of the positive half cycles of input voltage the grid potential may still be carried into the conductive region BO. Only when the grid bias is taken back to a position such as C, where BC is equal to or greater than the peak value $\hat{v}_i$ of the input voltage, will the mutual conductance fall to zero. As the grid bias is moved from A in a negative direction towards C, the mutual conductance accordingly falls from its maximum value $\hat{g}_m$ to zero.

Now also from Fig. 3, taking the characteristic as ideal, that is, ignoring the bottom bend between A and B, we may note the effect of the input voltage amplitude on the mutual conductance. For an applied sinusoidal input voltage of amplitude $\hat{v}_i$, with the valve biased at the point A, the mutual conductance will be constant for all values of $\hat{v}_i$ from zero up to $\hat{v}_i$=AB. As soon as the amplitude exceeds this value g_m must begin to decrease, for the valve is only conducting over part of the input cycle. As $\hat{v}_i$ becomes greater and greater, g_m becomes smaller and smaller, and eventually reaches a minimum value approximately equal to $\frac{1}{2}g_m$ when AB is small compared with $\hat{v}_i$.

With the valve biased at the point B, g_m becomes independent of $\hat{v}_i$, for the valve is conductive for one-half of each cycle at all times, and its value is then approximately equal to $\frac{1}{2}\hat{g}_m$.

The third operating point at C gives a mutual conductance which is zero for values of $\hat{v}_i$ less than BC, but which increases as $\hat{v}_i$ increases and eventually reaches a maximum value approximately equal to $\frac{1}{2}g_m$ when BC is small compared with $\hat{v}_i$.

In a practical characteristic curve, where the bottom bend is taken into account, it is a simple matter to see that for a valve biased at the cut-off point B, g_m will increase from zero to a maximum as the input voltage amplitude $\hat{v}_i$ is increased from zero.

The basic theory of squegging is now comparatively simple to understand. As is known from oscillator theory the conditions as to whether a tuned grid oscillator will generate oscillations or not depends upon the relative values of the conductance of the tuned input circuit, M, and the input conductance of the valve M_V, which latter is dependent upon g_m and may be positive or negative. When Mv is negative and greater than M the circuit will oscillate with increasing amplitude. When M_V is positive, or M—M_V is positive, the valve will not oscillate.

Consider the instant when the charge present upon the grid condenser has leaked away sufficiently for conduction to recommence. g_m is then finite and its value is increasing as the grid voltage falls. Thus Mv is becoming larger, and eventually a point is reached where its value becomes equal to −M. Oscillation then commences, and as the valve is operating on a curved portion of the characteristic the input voltage brings about an increase in g_m which in turn increases the value of $-M_V$ and so causes a still further build-up of

$\hat{v}_i$. As soon as the oscillation is established, therefore, $\hat{v}_i$ builds up very rapidly, but without an appreciable change in the bias point of the valve. This is due to the failure on the part of the grid condenser to charge at any great speed through the grid-cathode resistance of the valve, despite the rectifying action of the grid circuit. In fact, all that the rectification effect achieves at this stage is merely to prevent the further discharge of the grid condenser through the grid leak.

By the time the grid condenser has charged to any appreciable amount, $\hat{v}_i$ has built up to a very large amplitude. Due to this the bias voltage affects g_m and Mv, but not before the grid has moved to some distance beyond the cut-off point. There are then two conflicting actions at work; g_m is tending to decrease as the charge on the grid condenser increases, and at the same time tending to increase as $\hat{v}_i$ increases. If $\hat{v}_i$ is still rising rapidly the grid bias is tending to rise at a similar rate but with a difference of magnitude which is considerable and very roughly constant. Despite the build up of $\hat{v}_i$, therefore, as the bias rises, the fraction of the amplitude cutting into the conductive region of the curve will decrease and g_m will begin to grow smaller. The rate of increase of $\hat{v}_i$ will consequently fall off, but the condenser will go on charging all the time the amplitude is sufficient to sweep into the conductive region. As soon as the input peaks fail to carry the valve to the point of grid current, the condenser ceases to charge. At this stage $-M_V$ is less than M; that is, the value of g_m is insufficient to maintain the amplitude; the value of $\hat{v}_i$ therefore falls to zero very rapidly, leaving the valve cut off and the grid condenser charged. As soon as the condenser has discharged sufficiently through the grid leak the cycle of events repeats.

It is apparent that as long as the bias point remains on the conductive regions of the characteristic squegging cannot occur. This, however, is not the real distinction between squegging circuits and circuits generating continuous oscillation, for the latter condition is possible even when a valve is biased beyond cut-off. The true conditions under which an oscillator squeggs or generates continuous oscillation depends upon the initial rate of increase of input amplitude; and if this is high the bias voltage lags a considerable way behind the amplitude, and a very large value of $\hat{v}_i$ is reached before the bias can appreciably reduce the value of the mutual conductance.

In any circuit of this nature the input amplitude is always limited by the effect of the increasing bias on the growth of the mutual conductance, itself due to the rise of the input amplitude. If the effect manifests itself before the bias reaches the cut-off point of the valve, squegging does not occur, even though the bias may afterwards exceed this value. If it comes into play after the cut-off point has been passed, squegging necessarily occurs. Summed up, squegging does not occur if the rate of change of amplitude is decreasing at the cut-off point, but it does occur if the rate is increasing at this point.

It is hoped that these few notes may clear up some of the uncertainties and doubts of the operation of squegging oscillators.

Decibel Notation Simplified

By HEREFORD WAKE

Paper Read Before the Institute of Practical Radio Engineers

The Transmission Unit

THIS unit, a logarithmic one, was first introduced in the U.S.A. for the purpose of showing that two quantities of power, from two circuits, functioning under similar conditions, differ by *n* units when the ratio is $1 : 10^{n(0.1)}$. A unit having ten times the T.U. value is the *Bel.*

The Neper

Is a continental telephone transmission unit. One neper equals 0.8686 bel and is defined as the equivalent to the unit of attenuation length, B1, based on the naperian logarithm of the ratio of the two currents.

The Decibel

This may now be termed the transmission unit of radio and is 1/10 of a bel. A better description is to call it the *unit of level*, for if one factor has a power F_1, and another factor a power F_2, the difference in level is $10 \log_{10} (F_1/F_2)$ decibel (abbreviated to db), or $20 \log_{10} (V_1/V_2)$ db. V = volts. (Note later how these factors and their numerals are conversely computed.)

Power Level

The actual difference of power level between points in a radio network, though capable of representation in a number of different ways, may be best understood from the three following examples: (1) By showing them as a *ratio difference*, or the number of times one is greater than the other. (2) By showing how much *greater* (or less) one is than the other. (3) By showing the ratio of one to the other *logarithmically.*

Assume a quantity of P_1 to equal 5 watts; another quantity of P_2 to equal 1,000 watts. By (1), P_2/P_1= 1,000/5, or it is 200 times P_1. But for (2) the same quantities, 1,000 *minus* 5=995 watts=P_2 as being greater than P_1 by 995 watts. For (3) the logarithm or log of P_2/P_1 must be found. The logarithmic systems applicable may be either the briggs or common to the base 10, or the naperian *e* to the base 2.7183. If the former, the ratio is shown in *bels*; if the latter, in *nepers.* Log 10 of the "200" of (1)=2.301 bels, and log *e* of (1)=2,693 nepers. To convert nepers to decibels, tenths of a bel, multiply the nepers by 8.686, or multiply decibels by 0.1151 to get nepers—not that they will be wanted in radio.

Decibel Notation

The bel, however, is a bit cumbersome for radio work, so that the decibel notation is employed, and with it, in general, the common system of logs. Thus the logarithmic ratio of (3), expressed in decibels, is $10 \log_{10} (100/5)$=200=log 2.301=10×2.301=23.01 db. Multiplying the log result by 10 has, of course, converted it from bels to decibels. The change of the power level of a sound by 1 db. is the smallest the ear can detect and one has to virtually double the power output of an amplifier to attain a gain of 3 db. Thus the decibel is really a power unit, though it can be used to express voltage ratios if such voltages are related to power ratios.

Level Values

Arbitrary reference levels of power vary, but for radio work, 0.006 watt or 6 milliwatts is used, that is, 6 milliwatts is assumed as an arbitrary level for *zero db.* This, of course, makes necessary the use of plus and minus prefixes in order to indicate the quantity direction, so that the power output *in watts* of a radio device is converted into decibels, *assuming output impedances as being equal*, by the equation:

Number of db. $= 10 \log_{10} \frac{P_1}{P_2}$ (see amended formula later)

where db. No. is the desired level of power in db.; where

P_2 is the reference level or the 0.006 watts, and where P_1 is the output of the device or amplifier. Use of the subnumeral 10, following the word "log" obviously refers to log tables with 10 as the base, so that repetition of it is unnecessary.

As a further simple example, consider an amplifier to have an undistorted output of 3 watts and that we want its decibel notation. Assuming the 0.006W level, this quantity, divided into the 3, results in 500, and 10 multiplied by the log of 500 equals $10 \times 2.69 = 26.9$ db.

Voltage and Current Notation

Electrical power, *minus phase difference between voltage and current*, is shown as either I^2R, $E \times I$ or E^2/R, and although the decibel defines a ratio of two powers, voltage and current ratios may be computed for finding decibel gains and losses, in which instances the input and output impedances need consideration. To this point in the discussion, P_1 has been used as the numerator and P_2 as the denominator, but for reasons to be later disclosed and to possibly simplify text-book treatment of the subject as a whole, what follows should be observed and assumed as:

$$\text{Db.} = 10 \log \frac{P_2 \text{ or } W_2 = Wo = \text{larger power}}{P_1 \text{ or } W_1 = Wi = \text{smaller power}}$$

where i=input and o=output, these two symbols also applying to E=voltage, I= current and R=impedances of larger or smaller values respectively. By this notation $Pi = Ei^2/Ri$ and $Po = Eo^2/Ro$, or db. $= 10 \log Po/Pi$, from which it can be reasoned that db. $= 10 \log (Eo^2/Ro) \div (Ei^2/Ri)$, or db. $= 10 \log (Eo^2 \times Ri) + (Ei^2 \times Ro) = 10 \log (Eo/Ei)^2 (Ri/Ro)$.

That is, db. $= 10 \log (Eo/Ei)^2 + 10 \log Ri/Ro$, or db. $= 20 \log Eo/Ei + 10 \log Ri/Ro$. Transposing: db. $= 20 \log (Eo \sqrt{Ri}) \div (Ei \sqrt{Ro})$.

For the current ratios, substituting for Pi and Po db. $= 10 \log (Io^2 \times Ro) \div (Ii^2 \times Ri)$, or db. $= 20 \log Io/Ii + 10 \log Ro/Ri$, which may be shown as db. $= 20 \log (Io \sqrt{Ro}) \div (Ii \sqrt{Ri})$.

This resolving shows that db. $= 20 \log Io/Ii$ for current and that db. $= 20 \log Eo/Ei$ for voltage. But should these voltages and currents operate in unequal impedances we must employ the following formula, letting Z=impedance:

db. $= 20 \log Ei/Eo + 10 \log Zo/Zi + 10 \log PFi/PFo$, for voltage.

db. $= 20 \log Ii/Io + 10 \log Zi/Zo + 10 \log PFi/PFo$, for current, where PF=power factor values for the impedances. Many text-books use the symbol *k* for the power factor notation PF. So that by converting voltage ratios into decibels, the power levels are available from computation, or to ascertain the decibel gain when input and output values of E are known, the gain equals the number of decibels equalling $20 \log Ei/Eo$, where Ei=voltage input and Eo=voltage output. If the gain is wanted and the decibels are known, *divide them by 20 and extract the antilog* to get the voltage ratio, that is, E(gain)=antilog db.n/20, where E=the power ratio or voltage gain: db.n=the number of decibels: 20=the divisor, thus reversing the equation $20 \log Ei/Eo$.

Algebraic Notation

The decibel lends itself to this quite well, inasmuch as gains and losses of a device can be algebraically computed. For example, if a certain network has a loss of 8 db. in one circuit and two gains of 10 db. in other circuits, the total gain $= -8 + 10 + 10 = 12$ db.

Decibel Tables

The practical radio engineer can, however, dispense with the problems of computing decibel ratios and powers by referring to the various published tables available, an example being the Decibel-Watts Table (see Table 1):

Not only are commercial amplifiers given output levels in db. ratings, but gramophone pickups and microphones as well. Examples noted have been: Carbon microphones -45 db. (minus 45 decibels). Condenser microphones -90 db. Velocity microphones -95 db. Moving-coil microphones -90 db. Piezo-electric microphones -70 db. Gramophone pickups -25 db. The minus sign is, of course, assumed against a reference level, say, the 6 milliwatts previously referred to. Therefore, a microphone with a rating of -45 db. must deliver its output power 45 db. lower or less than 6 milliwatts. On the other hand, an amplifier or device may have a rating of $+40$ db. level, this meaning that it functions with a power output 40 db. above the reference level. From the conversion table computing such overall values is simplified.

Another very useful table is that compiled to show voltage and power ratios of decibel gain, from which can be reciprocally computed voltages and power ratios of decibel loss, extracts following in Table 2.

Table 1—Decibel-Watts Conversion Table

Decibels	Watts	Decibels	Watts	Decibels	Watts
40	60.00	19	0.4744	− 1	0.00474
39	47.43	18	0.3795	− 2	0.00397
38	37.950	17	0.3037	− 3	0.00303
37	30.360	16	0.2372	− 4	0.00237
36	23.718	15	0.1898	− 5	0.00190
35	18.975	14	0.1518	− 6	0.00152
34	15.180	13	0.1187	− 7	0.00119
33	11.859	12	0.0948	− 8	0.00095
32	9.487	11	0.0759	− 9	0.00076
31	7.590	10	0.060	−10	0.0006
30	6.000	9	0.0474	−11	0.00047
29	4.743	8	0.0380	−12	0.00039
28	3.795	7	0.305	−13	0.00030
27	3.036	6	0.0237	−14	0.00023
26	2.371	5	0.0190	−15	$1.90 \times 10-4$
25	1.900	4	0.0153	−16	$1.51 \times 10-4$
24	1.518	3	0.0119	−20	$6.00 \times 10-5$
23	1.185	2	0.0095	−30	$6.00 \times 10-6$
22	0.948	1	0.0076	−40	$6.00 \times 10-7$
21	0.759	0	0.006	−50	$6.00 \times 10-8$
20	0.600				

Ratio Examples Derived from the Table

By reference to this table one can find the gain in decibels, current or voltage losses or gains, power loss or gain ratios, or the decibel equivalents of voltage loss or gain ratios. The tabulation as printed, however, should be primarily viewed as for *plus* decibels showing voltage and power *gains* only. For losses, or *minus* decibels or ratios, the reciprocals of the gain ratios are used, a slide rule having a reciprocal scale being a convenient means for accomplishing this, or reciprocals can be found arithmetically. The following examples illustrating how the tabulations are employed:

Decibel Gain

Assume that an amplifier has had its power output increased by 35 times and the gain in decibels is required to be known. From the Power Ratio column find 35. The nearest figures are 35.48. Opposite, under the Decibels column, will be noted 15.5, this being the *gain* in db. A power ratio loss for the same figures would be the reciprocal of the 35.48 or $1/35.48 = .02818$ = a power loss ratio corresponding to a *loss* of 15.5 db.

Current or Voltage Gain Ratios

Assume that the voltage gain ratio (or current) corresponding to a gain of the 15.5 db. is wanted. Look up the 15.5 under the Decibel column and note the equivalent for a voltage gain ratio as 5.597. For a loss for the same figures find the reciprocal of the gain ratio or $1/5.597$, which is .1679.

Db. Equivalents for Given Loss or Gain Ratios

Assume a decibel gain is wanted following an increase of twice the original voltage to a device. Twice, of course, = 2, so that the nearest tabulated number to 2 must be found in the Voltage Ratio column. This is

Table 2—Decibel Ratio Conversion Table

Decibels	Voltage Ratio	Power Ratio	Decibels	Voltage Ratio	Power Ratio
.0	1.000	1.000	10.5	3.350	11.22
.1	1.012	1.023	11.0	3.548	12.59
.2	1.023	1.047	11.5	3.758	14.13
.3	1.035	1.072	12.0	3.981	15.85
.4	1.047	1.096	12.5	4.217	17.78
.5	1.059	1.122	13.0	4.467	19.95
.6	1.072	1.148	13.5	4.732	22.39
.7	1.084	1.175	14.0	5.012	25.12
.8	1.096	1.202	14.5	5.309	28.18
.9	1.109	1.230	15.0	5.623	31.62
1.0	1.122	1.259	15.5	5.597	35.48
1.5	1.189	1.413	16.0	6.310	39.81
2.0	1.259	1.585	16.5	6.683	44.67
2.5	1.334	1.778	17.0	7.079	50,12
3.0	1.413	1.995	17.5	7.499	56.23
3.5	1.496	2.239	18.0	7.943	63.10
4.0	1.585	2.512	18.5	8.414	70.79
4.5	1.679	2.818	19.0	8.913	79.43
5.0	1.778	3.162	19.2	9.120	83.18
5.5	1.884	3.548	19.5	9.441	98.13
6.0	1.995	3.981	20.0	10.000	100.00
6.5	2.113	4.467	30	3.162×10	1000.00
7.0	2.239	5.012	40	100.000	10000.00
7.5	2.371	5.623	50	3.162×10^2	10^5
8.0	2.512	6.310	60	10000.000	10^6
8.5	2.661	7.079	70	3.162×10^3	107
9.0	2.818	7.943	80	10^4	10^8
9.5	2.985	8.913	90	3.162×10^4	10^9
10.0	3.162	10.000	100	10^5	10^{10}

1.995—opposite 6 in the Decibel column—so that 1.995 is the equivalent to a gain of 6 db. The loss ratio for this or any other given value is again its reciprocal.

These reciprocal values are possibly best visualised from figures resolving about the tabulated db. 10, the voltage gain ratio of which is 3.162. The power ratio is 10—for a gain. The reciprocal of the voltage gain ratio is 3.162×10^{-1}; the reciprocal of the power gain ratio is 10^{-1}. Another easy-to-understand example resolves itself around the tabulation for 100 db., which can be set down thusly:—

Voltage Ratio Loss	Power Ratio Loss	Decibels — +	Voltage Ratio Gain	Power Ratio Gain
10^{-5}	10^{-10}	100	10^5	10^{10}

The table may be extended for values not included by taking the next lowest multiple of 20 and noting its corresponding power ratio and then taking the difference between the wanted level and the multiple of 20 and noting the corresponding power ratio, the two ratios being then multiplied to get the answer. Assume 25 db., which by this reasoning equals 25−5=5 db. The power ratio for the 20 db. = 100; the power ratio for 5 db. = 3.162, multiplying the two ratios = 100 × 3.162 = 316.2. Voltage and current ratios may be similarly arrived at, as also may be loss ratios by recourse to reciprocal computation.

Tables are in print listing both power and voltage gains and losses, but due to the difficulty of contact for obtaining permission to reprint at the present time, the one used here serves a very useful purpose for, as stated, by the application of a slide rule having a reciprocal scale on the slide, the computations are quickly arrived at. A close study of the table discloses some additional interesting factors, one being that the *power* ratio gain for one decibel is coincident with the *voltage* decibel gain for two decibels, 1.259, this being in evidence similarly at other points of tabulation, the reciprocals of power ratio losses and voltage ratio losses computing likewise.

Simplified Working of Problems having Negative Characteristics

When actual working out of problems are done arithmetically and by aid of logs, it is advisable, as set out under "Voltage and Current Notation," to use the larger value as the numerator, for by so doing the dividend or answer is always more than one; thus the characteristic of the log of a ratio will always be zero or a higher positive value, and the result thus attained virtually indicates whether it is a gain or a loss: that is, resolve a problem with positive values and change the sign in the answer.

Computing Reference Levels

This is best visualised from an example, assuming a device with an output of 1,200 milliwatts and a reference level of 6 milliwatts. Therefore 0 db. = 0.006 watt. Db. = 1,200/6 or db. = 10 log 1,200/6 = log 200 = 2.301, 10 × 2.301 = 23.01 db.

Translating

For arithmetical computation of ratios the following example can be studied, which is one given in a number of text-books and requoted here due to the simplicity of the figures used: An amplifier having a known gain of 50 db. has a maximum output of 5 watts. What is the ratio of P_2 to P_1? If N = 10 log P_2/P_1, N must equal 50 and the output of P_2 equal 5,000 milliwatts. Therefore, 50 = 10 log Ratio, and log Ratio equals 5. Ratio is also equal to the antilog of 5 = 100,000, thus P_1 = 5,000/100,000 = .05 milliwatt. Knowing the value of the output voltage enables the required input voltage to be similarly computed by application of the formula N = 20 log E_2/E_1. It will be noted, however, that using the tables and finding reciprocals simplifies problems even as easy as this one.

Concluding

Students pursuing this subject should anticipate some practice before proficiency is attained in arriving at a quick solution of problems, either from the tabulation method or from arithmetical working. Checking the notation as described in this paper against a possibly more ambitious treatment in an advanced text-book is suggested as a further aid to a complete understanding of it as a whole.

Loudness levels, intensity levels, and noise levels are permissibly expressed in decibels without recourse to a reference level, remembering, however, that for acoustic work in general, zero level of intensity is assumed to be 10^{-16} acoustic watts per square centimetre.

For Export Only

IN this third programme of extracts from B.B.C. broadcasts intended for export only, the home microphone on October 3rd covered two programmes: "London Column," normally heard in the North American Service, and "Chapter and Verse," from the Overseas Services.

"London Column" is just two years old, and when first broadcast to America was re-broadcast by one station in San Francisco. Since then the demand for it has increased tremendously, and it is to-day carried by 42 American broadcasting stations. Research carried out in the United States shows that some 65 million people listen to the programme each week.

The purpose of the first editions of "London Column" was, by making a digest of current B.B.C. broadcasting, to give American listeners an indication of how the war looked from London. The 100th edition, which home listeners heard, was not exactly typical of the programme which has the Canadian actor Robert Beatty as narrator, but recalled some of the more dramatic broadcasts heard in previous editions. It also served as an example of the more emphatic approach expected by the American radio listener.

The second half of the programme was a broadcast from another popular series, "Chapter and Verse," which has been running in the Overseas Services for more than four years. "Chapter and Verse" was a programme of poetry and music, where the announcements were confined to the beginning and end of the programme, the poems linked by music played on recorders.

ON YOUR WAVELENGTH

By THERMION

Amateur Transmitting Licences

IT is good to learn that the Council of the R.S.G.B. has learned from the G.P.O. that it has now agreed to accept applications for radiating licences from those who held an artificial aerial licence at the outbreak of war.

It must not be taken, however, that such licence will be granted. Those who held an artificial aerial licence and who wish to apply for a radiating licence are required to submit proof of their ability to send and receive the Morse Code. In this connection they may find "Mastering Morse" by the Editor of this journal and obtainable from these offices for 1/2d. by post, of great assistance.

Those requiring a radiating licence may submit as proof of their ability to transmit the Morse Code a Discharge Leave Certificate carrying testimony that the applicant has served in a recognised radio service trade. Applications should be addressed to Radio Branch, W2/6, Engineer-in-Chief's Office (Alder House), G.P.O. London, E.C.1. Applicants should give their full name, the address of the licensed station, call sign, and give grounds for training exemption from the Morse Code test.

This is a good sign indeed—a sign that we are getting back to the point where we left the hobby in 1939.

Not Broadcasting House

A CARPING critic, one William H. Borland, is so unacquainted with the configuration of Broadcasting House that he thinks that the small sketch at the top of this page is a drawing of it. It is, in fact, a drawing of the editorial offices from which this journal, and our companion journals *Practical Mechanics* and *Practical Engineering* are published. I will not quote his letter, which is full of similar inaccuracies.

Wireless Receiving Licences

AT July 31st, 1945, there were 9,858,000 wireless receiving licences issued in this country. The total is made up in the following way: London Postal Region, 1,746,000; Home Counties Region, 1,279,000; Midland Region, 1,405,000; North Eastern Region, 1,530,000; North Western Region, 1,348,000; South Western Region, 831,000; Welsh and Border Region, 586,000, making a total for England and Wales of 8,725,000. The number of wireless licences in Scotland is less than ten per cent. of the total, namely 982,000 only, whilst Northern Ireland has a total number of 851,000.

Notwithstanding the war the number of receiving licences continues to grow, and although the licence fee has remained unchanged and there has been a considerable increase in B.B.C. revenue, the amount spent by the B.B.C. on entertainment during the war has gone down. We may now look forward to improved programmes. Like all other undertakings the B.B.C. lost a high percentage of its staff, and many of the entertainers were either called up or joined E.N.S.A. or one of the other service entertainment units. Television, which is in the offing, will bring fresh problems and create opportunities for a new style of radio entertainer, one who can be seen as well as heard.

"Communications Old and New"

I HAVE been interested in a book entitled "Communications Old and New," written by Lt.-Commdr. R. T. Gould, R.N., and published for Cable and Wireless Ltd., at 3/6d. by the R.A. Publishing Co. This book gives a well-illustrated history of communications from the earliest days of civilisation to date, from the tom-tom, the runners, fires, horns, bells, heliograms, smoke, flags, messages in bottles, pigeons, rockets, shutter and semaphore, the electric telegraph, wireless telegraphy, photo-telegraphy and television. It is a book well worth reading.

Wesel Repeater Station

A KEY-POINT in the Army's communication system in Germany to-day is the Royal Signals Repeater Station at Wesel-on-the-Rhine.

As Wesel was on the main axis of the advance of Second Army and 21 Army Group it was essential, if the necessary number of satisfactory circuits were to be provided and maintained, to have a large repeater station somewhere near there to bridge the gap across the devastated area and link up with the undamaged systems further east.

A forward reconnaissance by a Royal Signals officer immediately our troops entered Wesel revealed that the telephone exchange and almost all of its equipment had been damaged beyond repair. It was necessary, therefore, to start afresh; take a suitable building—a roadhouse just east of Wesel was chosen—install Army equipment and improvise the necessary frames.

German underground cables, with a ring system providing alternative routing by-passing Wesel were found, after some searching, and after some 14 days carrier telephone systems were in operation back to Venlo, and 50 trunk circuits were established in all. Steel-work for frames and racks was obtained from damaged factories in Wesel and erected by the Royal Signals, and a certain amount of German equipment from the damaged German repeater station was adapted.

RADAR

They say that it's new, but it's really quite old,
It commenced when the mountains were raised,
And Adam and Eve often heard it at work,
And it made them distinctly amazed.
For when Adam went forth, leaving Eve in their cave,
She popped out her head for a dekko,
And raised up her voice, crying "Adam, Yoo-Hoo!"
Mountains answered "Yoo-Hoo!" in an echo.
And had they but known, this was Radar at work,
Although in most primitive guise.
Now with science at work it is brought up to date
And boosted as "modern surprise."
But we should not grow boastful, it's old as the hills,
And the truth (we should never abuse it)
Is that Radar began when Creation took place,
If man had but known how to use it!
Well, now he's found out, what use will he make
Of this marvel which so much amazes?
Let's hope not to help in some atomic war
Which might easily blow us to blazes!

"TORCH."

Our Roll of Merit

Readers on Active Service—Fifty-ninth List

J. Rombaut (Sign., R.C.S.).
W. Saunders (L.A.C., R.A.F.).
J. F. Tatem (Royal Marines).
A. Davies (L.A.C., R.A.F.).
M. Falk (Cpl., R.E.M.E.).
B. H. Pound (L.A.C., R.A.F.).
H. Roberts (Cpl., R.A.F.).

More About Class C Amplifiers

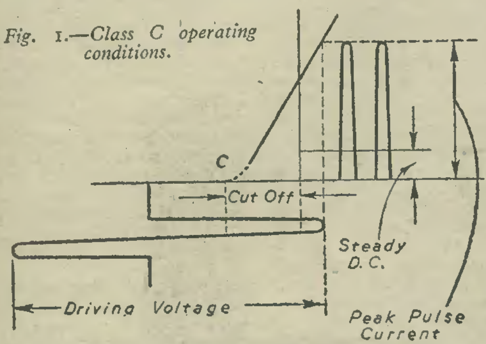
Technical Details Concerning "Angle of Flow," and "Load Conditions"

SOME time ago the writer published an article in this periodical giving an outline of the general principles of Class B and Class C amplifiers.

The Class C is of particular interest because of its use as an oscillator for H.F. heating, but it is thought that some further technical details may prove of general interest.

As stated in the earlier article, it can be used only for radio-frequency power amplification, because the output current is highly distorted, whilst a tuned R.F. circuit responds only to the "fundamental frequency," or first harmonic component.

Fig. 1.—*Class C operating conditions.*



With two valves operating in Class C push-pull, the *current* output of each valve takes the form of rectified pulses, shown again in somewhat more detail in Fig. 1.

But though the current is thus far from being anything like a sine-wave, much of the difficulty in understanding Class C will vanish if it is remembered that a sine-wave *voltage* oscillation occurs across the anode tuned-circuit.

This simplifies matters considerably when it comes to estimating the power output. In fact, it is just a simple matter of Ohm's Law, or, rather, V^2/R, where R is the A.C. load resistance in ohms. Then, with a given H.T., it is just as easy to estimate what maximum power can be got into a given resistance.

There are two ways of using a Class C stage. First, the H.F. voltage "swing" (or "drive") applied to the grid may be large enough to develop the greatest possible output in a given load resistance. This means driving hard enough to cause the current peak to rise to *the maximum available electron emission of the filament*, Fig. 2(a), which generally means driving the grid positive into considerable grid current as well.

This large current peak will develop across the load a peak alternating voltage nearly equal to the H.T., i.e., the full H.T. supply volts can almost be developed as "peak volts" across the load resistance. Nearly so, of course, for if that were exactly true no volts would be left on the valve anode—an average figure for the output voltage is some 80 per cent. of the H.T., leaving 20 per cent. on the anode.

Therefore, under these driving conditions, our peak output volts will be about 0.8 of the H.T. volts, when the power output can be quickly estimated by $\frac{1}{2}$(Peak Volts)^2/R. The "$\frac{1}{2}$" takes account of the R.M.S. value by which "power" is always reckoned.

An oscillator with sufficient self-bias to operate in Class C would work up to a point where it delivers maximum output as described: the oscillation will continue to build-up, and with it the self-drive, until something finally limits it. Of course, it may not be a case of emission limitation, e.g., if the H.T. were not sufficient to make use of the peak emission.

The Class C Modulated Stage

The second way to use Class C is to drive to about half the available emission when generating an *unmodulated carrier*, as in Fig. 2(b), and so reserve the peak emission when it will be required at maximum, 100 per cent. modulation, as shown.

Obviously, if worked as in (a) modulation of the output would not be possible: the current is already rising to its greatest possible value. What "modulation" there would be would show very considerable distortion, but we will not discuss this now.

Even though, however, the full emission is utilised only at the peak of modulation, the full H.T. *voltage* is used for unmodulated carrier, as described above, to leave only about 20 per cent. voltage on the anode. How, therefore, can the current rise to twice its unmodulated peak, when 100 per cent. modulation takes place? It does seem as if a little further increase would drop the anode volts to zero.

The point is quite correct. Extra volts must be derived from somewhere, though evidently not from the H.T. supply to the Class C. In *anode* modulation, they are derived from the L.F. *modulating* stage—another power valve, or two in push-pull, which supplies the additional power to generate the H.F. *sidebands* corresponding to the modulation.

It is not the purpose of this article to go into modulating principles, but it will be necessary to see *why* the output of a Class C does depend on the H.T. power supplied. At first, it may seem obvious that the two must be dependent, but in a stage delivering a pure sine-wave, Fig. 3, the statement is not true—varying the H.T. at audio-frequencies would change the power *dissipated* at the anode, *but not the A.C. output.*

Grid Modulation

Whilst discussing the matter, too, it may be of interest to say a bit more on grid modulation.

If the L.F. voltage were applied to the *grid* of the Class C, Fig. 4(a) and (b), *no change of H.T. input would be required*, as described above. What happens is simply that the *grid-bias* is swinging at audio-frequency, as shown roughly in Fig. 4(b), which means, in effect, *varying the H.F. driving voltage* above the cut-off point C—even though the H.F. derived from the driving source is constant.

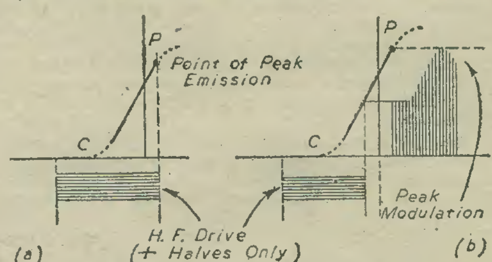


Fig. 2.—*Approximate illustrations showing different working point when modulating.*

With the bias-point taking different positions relative to C over the L.F. cycle, the effect is somewhat the same as if the H.F. voltage itself were already modulated at the driving source. The valve delivers current pulses whose amplitudes increase and decrease accordingly.

(*Continued on page* 503)

Any control of the R.F. driving-volts in this way is an *efficiency control, at a constant H.T. input.* In the grid circuit, two things are varying, namely: the grid-bias, and the resultant driving volts. The nett result, however, is that at maximum drive amplitude above C (peak positive L.F. voltage), both the H.F. output and efficiency will be at their maximum.

But this implies that *the efficiency must be comparatively low under unmodulated conditions.* This is true: the steady drive must be set to give an unmodulated peak current of half the modulated peak—for 100 per cent. modulation, Fig. 4(b). We saw that this same *carrier condition* applied for anode modulation, but with a difference.

In grid modulation, the valve cannot be driven under unmodulated conditions to utilise anything like 80 per cent. of the H.T. voltage, because no modulator stage is employed to deliver the L.F. power. The latter—or rather the sideband power—is obtained by varying the efficiency of the H.F. stage itself. In other words, a large proportion of the H.T. exists on the anode at the *carrier*-current peak, and the unmodulated efficiency is low—30 per cent. or less.

Maximum efficiency, corresponding to something like the normal figure for Class C working, is reached at peak modulation.

Input/Output Characteristic

Why is it that varying the H.T. will alter the H.F. output in nearly the same proportion, thus maintaining the ratio Output/Input = the Efficiency nearly constant?

It by no means follows always that applying more, or less, H.T. to a stage will result in a corresponding change in the A.C. output. For instance, in a distortionless Class A power valve driving a loudspeaker, applying more power from the H.T. will not necessarily put more power into the speaker—the larger "input" will be almost entirely dissipated as heat at the anode, unless more grid-swing can be employed to convert it into a larger A.C. output.

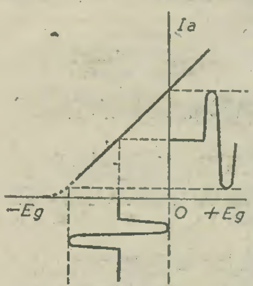


Fig. 3.—"Sinusoidal" or Class A working. (Compare with Fig. 1.)

When, however, a valve is biassed so as to give a rectifying effect, as in Class B or Class C, matters are entirely different. A 20 per cent. increase, say, in the H.T. power will now give practically a 20 per cent. increase in output—provided, of course, the valve is not already driven to give the peak available filament emission. The power dissipated at the anode will also increase about 20 per cent. but the efficiency remains reasonably constant.

The answer, therefore, is that the increased voltage will not remain *on the anode.* Because the minimum voltage at the peak of the current pulse now tends to be greater than before, *the current peak itself will rise to a point where the minimum voltage is restored,* so developing greater peak volts across the load. The same minimum volts at larger current, however, means a proportionally higher power dissipation as well.

To do the same thing in a linear Class A amplifier, we would have to *apply more drive to the grid.* This takes place automatically in asymmetric amplifiers, by virtue of the fact that *the bias point shifts with respect to current cut-off,* C, according to the H.T. volts.

"Angle of Flow"

The term *angle of flow* means the number of *degrees,* electrical, for which the valve is conducting—taking a full cycle as 360 deg.

Thus, in Fig. 5(a) is shown one full R.F. cycle of grid

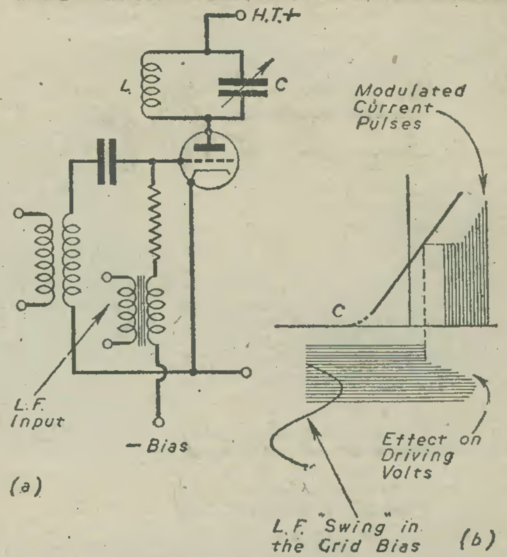


Fig. 4.—Approximate conditions for grid-modulation.

voltage (or alternating voltage across the anode tuned-circuit), whilst the shaded pulse shows current delivered by the valve for only 120 deg. of the cycle. No current at all can flow during the negative half of the cycle, since this simply applies a bias greater than the cut-off value C, Fig. 1.

The name "flick impulsing" has been given to this method of energising the oscillatory circuit. It may be compared with giving a pendulum a short "push" during each swing, to maintain the oscillation—the latter being sine-wave "swings" of voltage and current in the LC-circuit.

As said in the earlier article, the advantage is a higher efficiency. The intervals during which the valve takes power are short, and then most of this power is converted into A.C. output—no dissipation takes place all the time, as in a Class A stage, since for an angle of flow of 120 deg. there will be 240 deg. intervals when no power at all is taken.

The grid-bias necessary is some 2-3 times the cut-off bias. Thus, under "static" conditions (no H.F. drive) the stage again cannot take any H.T. power. If more bias is applied, the conduction angle becomes shorter still, Fig. 5(b), showing an angle of only 90 deg. approx.

The intervals during which no power is taken will now become 270 deg. The efficiency will be improved,

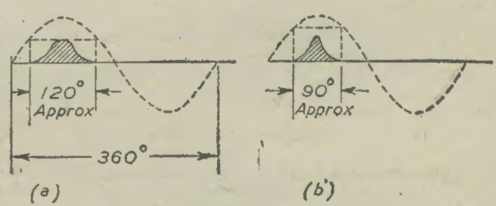


Fig. 5.—Illustrating "Angle of Flow."

but with the same drive and H.T. the input and output would be considerably reduced. It could be restored by increasing these quantities. In fact, efficiencies greater than 90 per cent. have been achieved by short current angles.

But the advantage gained is not so great as this figure suggests. The large driving voltage necessary runs the valve heavily into grid-current. As the angle of flow is reduced, this current increases rapidly. This, in turn, means large *driving power*, so the size of the penultimate stage goes up; in fact, an angle less than 115 deg. to 120 deg. is seldom used in practice, since what is gained in efficiency is offset by the larger driving stage, H.T. equipment, etc.

Load Impedance

In an R.F. power stage, of course, there is no question of getting maximum *undistorted* output. The distortion is so considerable in Class C as to preclude its use entirely for L.F. work—even in push-pull.

Distortion is not so serious a factor in the H.F. sense, because, as said earlier, the tuned-circuit largely eliminates the resulting harmonics. But this statement should be read carefully; there must be no distortion of a *modulation envelope*.

Actually, there always is, to some slight extent. But, like a detector which is rectifying H.F., it is possible by careful adjustment of the bias, etc., to get reasonably *linear modulation*—just as linear detection can be obtained.

The aim is to set-up the stage correctly to give the required carrier power and percentage modulation to the desired maximum at minimum distortion. There is no such rule as the one which states that the "optimum load" should be $2r_a$, as in Class A amplifiers.

In Class B and Class C amplifiers the load impedance is a somewhat peculiar figure. For instance, the actual impedance "seen" by the current pulse is much less than the actual A.C. impedance of the tuned-circuit measured under sine-wave conditions. In Class A the A.C. output is of sine-waveform, and the two impedance values coincide.

A full discussion of the point would take us too far afield into A.C. quantities. It is, however, easy to understand that when we say the "A.C. impedance" of a load is a pure resistance of value R, that is only true of a *sine-wave supply at the resonant frequency.* When a valve delivers what is really a *D.C. pulse* the load conditions are a little more complicated.

First Harmonic Output

However, without entering upon mathematics, the following explanation will help towards an understanding.

Suppose the measured A.C. impedance of the tuned-circuit is 1,000 ohms. This is the value a Class A amplifier delivering a sine-wave of current would see. It is also the impedance for which the circuit is designed.

But a Class C stage is not exactly equivalent to an A.C. generator. The pulsating current it delivers might be represented simply by a "switch," which closes the H.T. circuit for a minute fraction of a second, giving a pulse of current, then remains open for a longer time, closing again, etc.

Of course, no mechanical switch or "vibrator" could possibly perform in this way at *radio-frequencies.* A valve which cuts-off over an appreciable portion of an A.C. cycle can easily do so. The number of "pulses per second" will be the same as the frequency, so the tuned circuit will be energised by the impulse method previously described.

In other words, the pulse is *equivalent in its effect to some value of current flowing over the whole cycle.* Mathematically speaking, it is said to embody a current component at *fundamental frequency*; in more familiar terms, it gives rise to a pronounced *first harmonic*—along with other *even* harmonics to which the tuned-circuit will not respond.

We might simply say the tuned-circuit "picks out" the first harmonic current and by-passes all the higher harmonics. Nevertheless, the pulse itself is not the true alternating-current value as far as the tuning is concerned, and there is no reason for thinking the impedance should be 1,000 ohms when all the other harmonics are included. In fact, this "pulse impedance" can be as low as 300 ohms in Class C.

Effect of Varying the Load

Once a Class C stage has been set-up correctly, especially for modulation, very little adjustment of the tuning or load impedance will be permissible.

Readjustments can be made within limits, of course, if it is fully realised that alteration of one quantity will necessitate resetting all the others. In fact, it is quite a complicated business to explain theoretically all the factors involved if we altered, say, a coil tap, i.e., the load impedance.

Suppose with a 1,000 ohms load, as above, we are utilising at 100 per cent. modulation the peak filament emission current at a minimum voltage on the anode of 20 per cent. of the H.T.

If now we made some adjustment that would increase this impedance, there may be enough margin of voltage left to draw the same peak current, but at a minimum anode voltage of less than 20 per cent. of the H.T. The power output would be larger, but if the impedance were increased too much the anode voltage would become too low to draw a current corresponding to the peak emission.

If it became very high, such as by removing the external load on the tuned-circuit, the amplitude of the pulses and the average D.C. taken from the supply would fall to small proportions. The power output becomes negligible, though quite a large H.F. current may circulate in the tuned-circuit.

If the load impedance were *decreased* the peak current would rise to a higher point to develop nearly the same peak volts, and nearly the same output—if the larger emission were available. But, since this could not occur if we are already utilising the full emission to give 100 per cent. modulation, the peak volts would not be obtained—insufficient output would be given to modulate 100 per cent., with resulting distortion.

This is by no means the whole story. Conditions in the grid-circuit are altered immediately one thing is changed in the anode circuit, and that may reduce the driving power and grid-swing.

Altogether, therefore, the Class C is at once an interesting and complicated type of amplifier. It is hoped this supplement to the previous article will help those interested in the practical aspects of the subject. Most of the principles outlined also apply to the Class B radio-frequency stage.

Restoring Communications in the Far East

18,000 Miles of Cable to be Recovered

UNDER the sea from Penang, in the Straits Settlements, through Singapore to Batavia, to Borneo, Hongkong and Shanghai runs an 18,000-mile chain of British cables. With their associated wireless stations, and linked with the world-wide "via Imperial" network westwards through Colombo and Madras, southwards to Australia and New Zealand, they kept Britain in peacetime in constant communication with the Far East and the Antipodes.

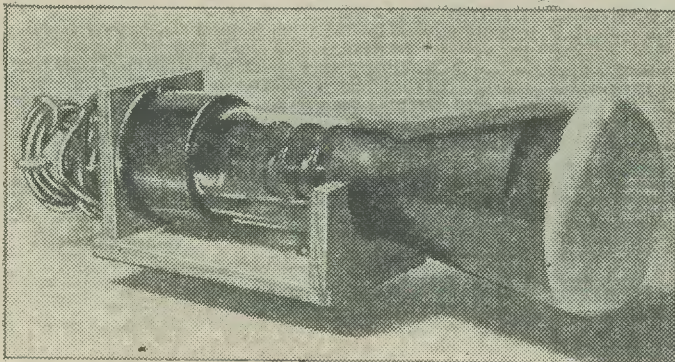
Since 1942 the whole of this 18,000-mile chain has been in Japanese hands.

Already Cable and Wireless, Ltd., have trained operators and engineers in Colombo and Rangoon ready to advance as the armies clear the enemy out of the islands. Fifty young men, specially trained in Australia and New Zealand and wearing Telcom uniform, have already arrived in Colombo to join the communications corps, which includes local youngsters and others from Karachi.

Cable ships are preparing to follow the navies and repair the submarine cables where they have been damaged by the Japanese.

Specialists will go in advance of the operators to inspect the cable and wireless stations and to ascertain damage. It remains to be seen what equipment the Japanese have left untouched in Singapore, which was the main supply depot for the whole area.

A Cathode-ray Oscilloscope



The completed oscilloscope.

Constructional Details of an Inexpensive and Useful Test Apparatus

By E. P. HARRIS

ONE of the most useful pieces of equipment available for the radio engineer and experimenter is the Cathode-ray Oscilloscope. It is an indicating device which can show in the form of a graph all that is happening during the operation of a circuit. It can compare frequencies with precision, show immediately the complete curve of a valve, and many other things. It is invaluable in the aligning of superhets, in testing for A.C. leakage, and may be employed for all applications in which a visual means of studying transient or recurrent operations is required.

The heart of this apparatus is the well-known cathode-ray tube. Very briefly, the cathode-ray tube (C.R.T.) functions as follows: A beam of electrons is focused on to a chemical which, when they strike it, cause it to become fluorescent. It has been found that electrons are deflected by either a magnetic field or a static charge, and so provision is made to deflect the beam by one of these methods; the whole being, except for electro-magnetic deflection, when the deflection coils are fixed on the outside of the tube, sealed into a glass envelope.

The advantage of this as an indicating device is that there is no lag, the response being instantaneous. In any type of meter there is a lag due to friction of the bearings, and also while the charge builds up.

To the keen experimenter the oscillograph is a very necessary piece of equipment. It eliminates a considerable amount of guesswork, and it could almost be called the universal instrument. It is, however, surprising how many of the amateur fraternity think that to construct such a piece of apparatus means expending about £20 to £30. This is probably due to the fact that the sale price of an oscillograph made in the factory is approximately £60. Sometimes even more.

This is entirely wrong. The maximum cost of the instrument described in this article is not more than £10, and that is if all new parts have to be purchased. In point of fact, it will probably cost very much less, as no doubt most constructors will have a considerable number of components on hand.

It is not necessary to use a large cathode-ray tube, such as a 7in. Much work can be and is done by the use of smaller tubes such as the Osram 4081 3in. tube. The great advantage of the smaller tube is that the operating voltage is greatly reduced. A 7in. tube may require up to 3,000 volts. A smaller tube such as the one mentioned above only about 800.

This means a considerable saving in cost, and also it is very much safer. The thousands of volts required by the larger tube can give one a nasty surprise on occasions, as I have experienced.

The problem of insulation is a very real one with the big tubes, but with the smaller tubes it is not so important. This is not an invitation to be slap-dash; it is just an observation. Also, as the cost of condensers rises rapidly with the increase in working volts, a further saving was effected by the choice of a small tube.

Power Supply Circuit

As will be seen from the diagram, Fig. 2, the circuit can be divided into two parts—the tube and H.T. supplies, and the time base.

The H.T. supply circuit may seem a little unusual at first glance, but upon consideration it will be realised that it is a half-wave rectifying arrangement with a common positive line and two negative lines. This works extremely well when only small currents are encountered. It has also the advantage that only one transformer is required to supply the H.T. for both time base and tube. With this arrangement it will be seen that the H.T. positive is earthed. This gives much smoother operation. This must be remembered, as the cathodes and other points, usually at earth potential or negative with regard to the chassis, will now be live with regard to the chassis.

Resistance-capacity smoothing is used, as the current taken by both the time base and the tube are so small that to use chokes would be a waste of those components when resistances will do the job just as well.

It will be seen that the transformer used is an ordinary 350-0-350. This gives just over 700 volts for the tube and about 350 volts for the time base using this circuit. The rectifying valve is a MU12/14, and although the maximum rated working voltage of this valve is 500 volts, it is quite in order to use it in this circuit because the current is so small.

The potential divider, supplying the tube electrodes with their correct working voltages, has two variables. These are "Focus" and "Brilliance." The former control varies the voltage applied to the second anode, while the latter varies the amount of negative bias applied to the modulator, or control electrode. As all voltages are

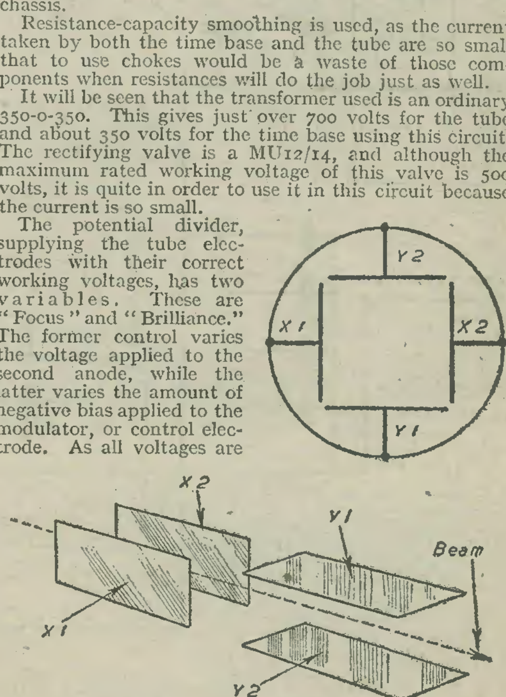


Fig. 1. (above).—Plate positions viewed from screen. (Below) Details of plate construction.

measured with respect to the cathode, it will be seen that the voltage developed across Rb is of a negative value with respect to the cathode of the tube. Also as all voltages are measured with respect to the cathode it will be realised that the actual voltage applied in the main anodes (1 and 3) is the voltage developed across Rb subtracted from 700, which in this case is 650 volts.

The greater the negative voltage applied to the modulator, the less electrons reach the screen, until finally the electron flow ceases entirely. This is the state in which the spot is called "blacked out."

The whole system of electrodes in a C.R.T. are in reality a system of electron lenses, following the same principles, in most respects, of their brothers, the light lenses.

The time-base H.T. supply is taken from the common positive and the centre tap of the H.T. winding of the transformer. Between these points there are about 350 volts.

Time Base

The object of the time base is to sweep the beam of electrons backwards and forwards across the screen of the C.R.T. giving a horizontal base or datum line. The speed of this sweep is made variable for reasons which will be explained later.

It has already been said that a beam of electrons can be deflected either by a static charge or a magnetic field. In the C.R.T. which uses the static method of deflection, there are two pairs of plates at right-angles to each other, each plate of one pair being exactly in the same plane as the other of that pair (Fig. 1.).

If a voltage is applied to these plates a static charge builds up on them, and the beam is deflected towards the positively charged plate. It is unusual, to say the least, for this plate to collect all the electrons and so black out the spot. This is due to the velocity with which the beam travels. Each small particle of the beam is only under the influence of this action for a fraction of a second. The sensitivity of the beam to deflection is usually quoted by the manufacturer thus: 150/v. mm. per volt, where v is the final anode voltage. Translating this and assuming a final anode voltage of 600, then the sensitivity is 150/600 mm. per volt, which is ¼. In other words, it will take one volt to deflect the beam a quarter of a millimeter. From these figures may be calculated the voltage required to give full screen deflection. Tubes using this method of deflection are known as electrostatic, the others as electromagnetic.

The time base illustrated (Fig. 3) is known as a soft valve time base, as it employs a gasfilled valve. There is a limiting frequency above which this type of time base will not operate, due to the ionisation of the gas particles in the valve. There is also a minimum frequency when the wave form suffers from distortion. This distortion is due to the fact that the condenser does not charge evenly, and as a consequence the trace varies in speed as it crosses the screen.

The time base is essentially a linear condenser-charging device where the rise in potential across a condenser is transferred to the plates or deflecting coils of the tube. The greater the potential the greater the deflection. The discharge is made extremely rapid so that the return trace is hardly visible. This means that the spot appears to be travelling in one direction only. This is known as the direction of writing, and it should be, as in normal writing, from left to right.

The maximum and minimum frequencies for the time

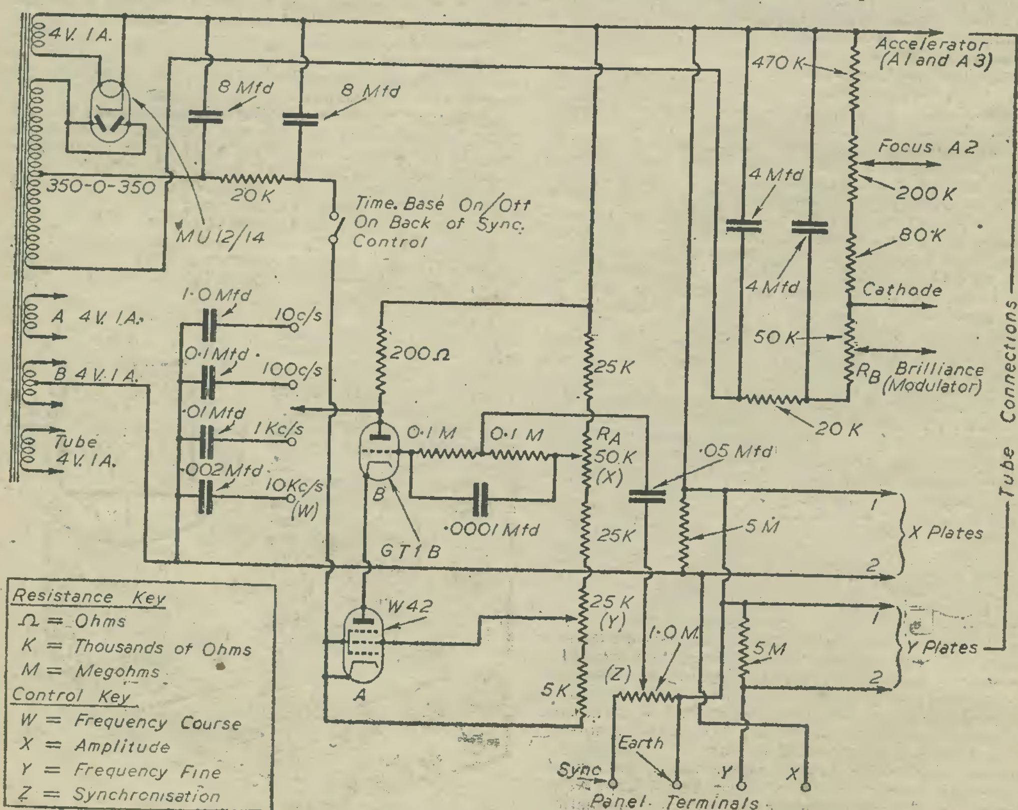
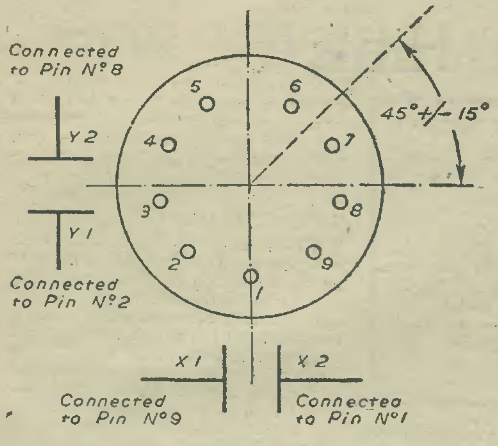


Fig. 2.—Theoretical circuit diagram of the cathode-ray oscilloscope.



Pin No 3 A_2 (Focus)
" 4 Heater and Cathode
" 5 Heater
" 6 Modulator
" 7 Accelerator (A1 and 3)

Fig. 3.—View from underside of time base.

base illustrated are 10,000 c.p.s. (10 kc/s) and 10 c.p.s. respectively. Time bases employing hard valves are available for operation up to 250 kc/s, and in special cases up to and over 1 mc/s.

As has been stated, cost was taken to be the main consideration, coupled with an effective and useful instrument. This is the reason for the use of a gas valve time base. The maximum frequency of 10 kc/s is extremely useful, and with it a considerable amount of work can be done.

The selection of the sweep frequency is made by S1, which is a single-pole rotary four-position switch. This switch gives a coarse setting of the sweep frequency in the following approximate steps: 10 c.p.s., 100 c.p.s. 1 kc/s and 10 kc/s. The gaps between these frequencies are bridged by the potentiometer Pf, which varies the screen voltage of the discharge valve and therefore the instant at which it commences its operation. By use of these two controls continuous operation is secured between 10 c.p.s. and 10 kc/s.

The length of the time-base sweep is controlled by Ra, this being known as the amplitude control. This control determines at what level of H.T. the discharge shall commence.

A control is also provided so that the time base may be kept in step with the signal under observation. This is called the synchronisation control (Sync). If the time base and the signal are not in step, the trace will wander. That is to say, it will not be stationary but will rove back and forth across the screen.

It is extremely important that the spot is not kept stationary and at full brilliance. If this is so, then the screen will be burnt at that spot.

Construction

It is preferable that the 'scope should be constructed on a metal chassis. If this is not possible, then plywood is suitable. In any case, the whole unit must be screened by a metal case (Fig. 4), so that external fields do not distort the trace. A suitable case can be constructed from thick metal gauze. Apart from the following notes, the construction follows standard lines.

The only special precaution which has to be taken during construction is to see that the tube is kept well away from the mains transformer, so that its magnetic field does not distort the trace. Also the leads to the Y plates must be of a heavy gauge wire. The latter should also be away from wires carrying A.C. The photograph shows the best way to mount the tube.

In the mounting of the tube, allowance has to be made for errors in the placing of the base with regard to the tube. This is so that the X plates sweep (time base) is truly horizontal.

Finally, all controls and terminals are brought to the front panel. (Fig. 4.)

General Notes

The reason for having the time-base sweep variable is as follows: Assume that a 10 kc/s signal is under observation; then the slower the time-base repetition frequency, the more waves would be illustrated on the screen. If, however, it is desired to examine only one wave, say, for distortion, it will be realised that the time-base speed must be the same as the signal. Therefore, by making the time-base speed variable it is possible to increase or decrease the matter on the screen at will. There are other reasons, but the one mentioned will serve to illustrate the utility of a vari-speed time base.

To examine a signal on the oscilloscope described, it should be fed to the terminals marked Y and E. For stability the terminal S (Sync) is bonded to Y, so that, as has already been stated, the trace will not wander across the screen. The Sync control on the panel should then be advanced until the trace is stationary. As the stability of the time base is quite high, a simple method of detecting small frequency variations is as follows: Connect the signal to Y and E only. Select by means of the time-base frequency controls the most suitable repetition speed. If the trace has the appearance of moving to the right, it means that the signal frequency is greater than that of the time base. If, however, it moves to the left then it is slower. If the movement is back and forth, then the frequency is unstable.

COMPONENTS

350-0-350 v. transformer with four 4 v. 1 a. windings	One 0.05 mfd.
Osram MU12/14.	Two 50K potentiometers.
Osram W42.	One 25K potentiometer.
Osram GT1B.	One 200K potentiometer.
Osram 4081 cathode-ray tube.	One 1.0M potentiometer with switch.
One 8×8 mfd. 400 v. wk.	Two 25K ½ w.
One 4×4 mfd. 800 v. wk.	One 5K ½ w.
One 1.0 mfd.	One 80K ½ w.
One 0.1 mfd.	Two 20K ½ w.
One 0.01 mfd.	One 200 ohm ½ w.
One 0.002 mfd.	Two 100K ½ w.
One 0.0001 mfd.	One 470K ½ w.
	Two 5.0M ½ w.

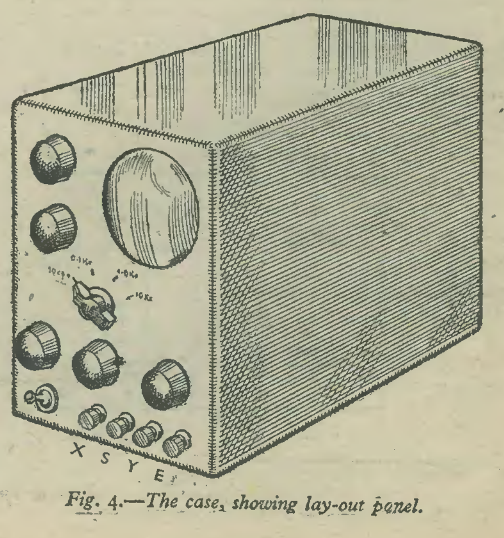


Fig. 4.—The case, showing lay-out panel.

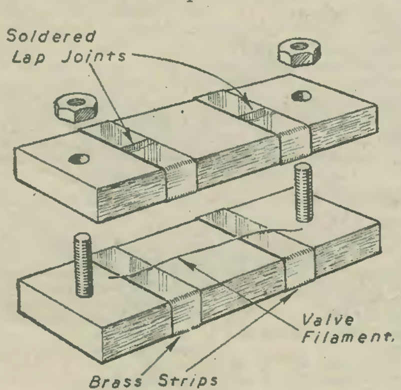
Practical Hints

Making Low-current Fuses

AN electrolytic condenser in my set recently broke down. As a result the rectifier was ruined and the H.T. winding on the transformer nearly burnt out. In order to prevent this next time, I have put low-current fuses in the leads from the H.T. winding. These were made in the following manner.

I had an old worn-out valve with a 2-volt 0.1 amp. filament, and I carefully broke the glass envelope and removed the filament.

I cut two pieces 1in. by $\frac{3}{8}$in. from some 3/16in. asbestos sheet and wrapped two pieces of thin brass sheet about $\frac{1}{8}$in. by $1\frac{3}{8}$in. around each end of each piece, soldering the ends together as shown in the diagram. A hole was made at each end of each piece and two nuts and bolts completed the fuse carrier. A piece of 0.1 amp. valve filament was sandwiched between the two halves of the carrier and the nuts and bolts were screwed up tight. One valve filament is sufficient to make four fuses.



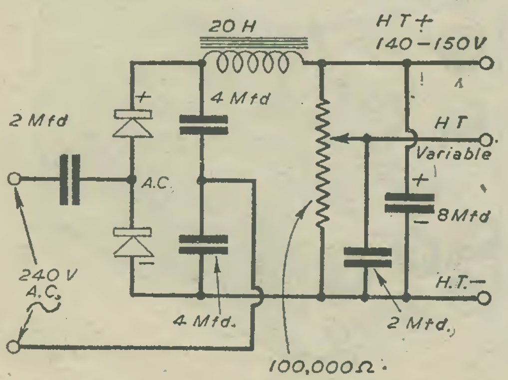
Exploded view of a low-current fuse holder.

I soldered wires on to the brass strips and suspended the fuse in the wiring, but a holder could be made by fixing two brass clips to a piece of ebonite.

A fuse of this type is suitable for protecting the valves in any battery set with two or more valves, and for this purpose it should be put in the H.T.— and G.B.+ lead.—J. D. BARR (Uppingham).

Battery Eliminator

HERE are some details of a small size battery eliminator that may be of interest to other readers. The rectifier is a Westinghouse H.T.14, in a standard voltage-doubler circuit, but fed from the mains via a 2 mfd. condenser in place of the usual transformer. At full output, the rectifier has about 100 v. input, 140-150 v. output. The 8 mfd. smoother is a 250 v. electrolytic, all other condensers being of the paper type.—R. J. AMBLIN (Bath).

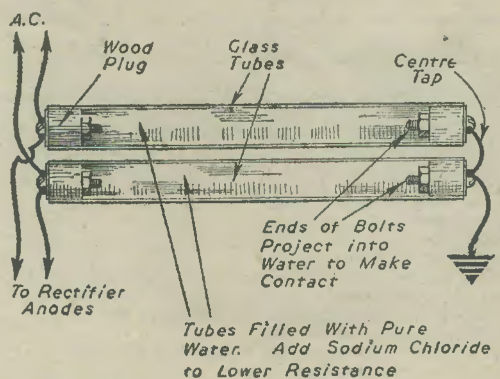


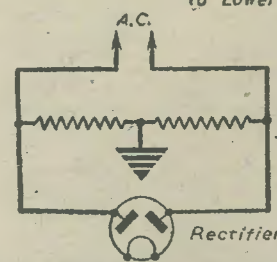
Circuit diagram of a small battery eliminator.

Centre-tap for Rectifier

THE accompanying diagram shows a simple method of securing a centre-tap for a full-wave rectifier when dispensing with the use of a transformer, and having no suitable wattage resistances on hand. Two glass tubes, about $\frac{1}{2}$in. diameter, and 4in. or 5in. long, are plugged at the ends with wooden stoppers, through the centres of which screws or bolts are fitted, as indicated. The tubes are filled with water, the ends of the bolts making the necessary contact.

Bleeder resistances, grid-leaks, etc., may be made in the same way.—W. E. RIGG (Luanshya, N. Rhodesia).





General arrangement and circuit diagram of a centre-tapping device for a full-wave rectifier.

A Dual-purpose Mike

Constructional Details of a Home Transmitting and Receiving Auxiliary Mike

By "EXPERIMENTALIST"

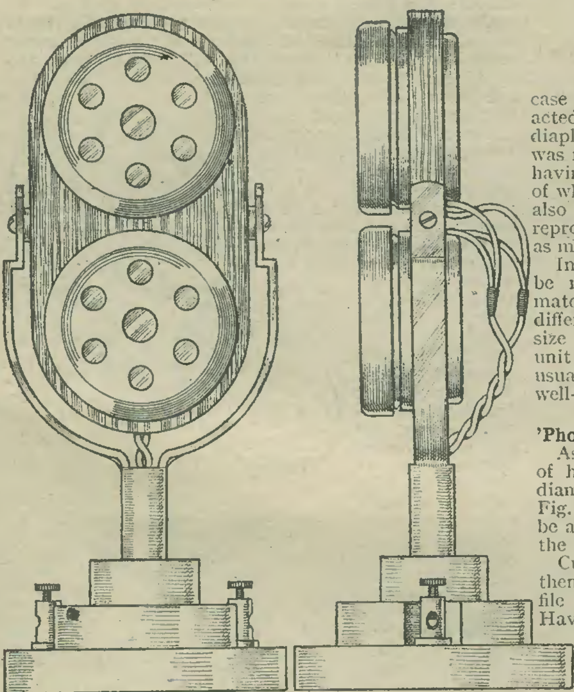


Fig. 1.—Front and side elevations of the mike.

PHONE units can be used for transmitting or receiving purposes at home, and in order to combine the two features, a somewhat unorthodox but simple, easily-made auxiliary mike has been designed, as shown by the elevations at Fig. 1.

This mike, unlike most other types, does not need a step-up transformer or battery. In order to prove this, connect your headphones to the pick-up terminals on a radio receiver and get someone (in another room) to speak or sing into the 'phones in a normal way. The voice will be reproduced fairly loud and clear, but a good volume—as provided by a 3-valve set or a superhet—will be necessary.

For the second test, connect the 'phones to the loudspeaker terminals or wires (after disconnection) and switch on the set. Broadcast features will be heard loud and clearly—even from a 1-valve set. When sets are not provided with pick-up terminals, of course, one may use a valve-holder adaptor in the detector stage, the mike being attached to the adaptor terminals. If used for miniature extension speaker purposes, the mike is connected to share the same output as the loudspeaker, i.e., it is connected to the speaker terminals or wires. In many commercial-built sets, such as superhets, the extension terminals are mainly for headphone listening only, so that direct connection to the speaker terminals is necessary, if the mike is to reproduce programmes at speaker strength.

Tests on the writer's 2-valve set gave excellent results, but it was seen that the 'phone units could be made more sensitive. When tried as a microphone, the 'phone case covers—because of the small central "ear" hole—acted as a sort of baffle, and besides, the thin soft-iron diaphragms "vibrated" stiffly. Much of the trouble was reduced by boring extra holes in the covers and by having the edges of the diaphragms partly serrated, all of which is explained later on. These "improvements" also affected the receiver results suitably, the mike reproducing all sounds distinctly, if not on the same par as moving-coil speakers.

Incidentally, a more "super." mike-cum-speaker can be made from moving-coil headphone units, but a matching transformer needs to be employed and a different type of holder designed and made, since the size is 1½ins. overall, with a 3in. front flange. A single unit would doubtless serve—not twin units. The units usually have a 45 ohm ½in. coil, being energised by the well-known Alni magnets.

'Phone Unit Frame

Assuming you wish to experiment with an old pair of headphones having a 2in. diam. casing and 2¼in. diam. cover, mark and cut out the frame shown (see Fig. 2) from ⅜in. wood, using a fretsaw. The casing must be a neat, tight fit. The tiny recesses provide space for the wire leads.

Cut out the case apertures first and try the cases in them. A slight force fit is wanted, so use a half-round file if the apertures are a bit too small in diameter. Having fitted the cases suitably, they are removed and the rest of the shape cut. It is better to fit the cases first in this way, otherwise you might split the wood where short-grained.

The base pieces could also be cut out and prepared

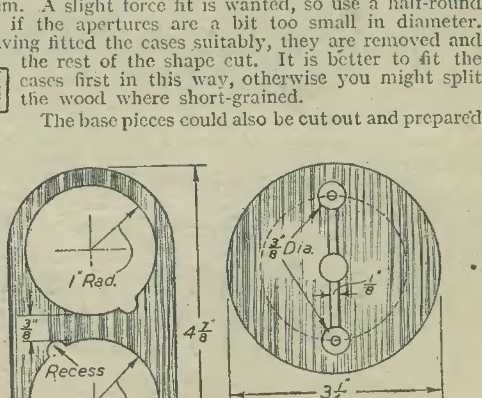


Fig. 2.—Size and shape of 'phone frame, with details of base pieces.

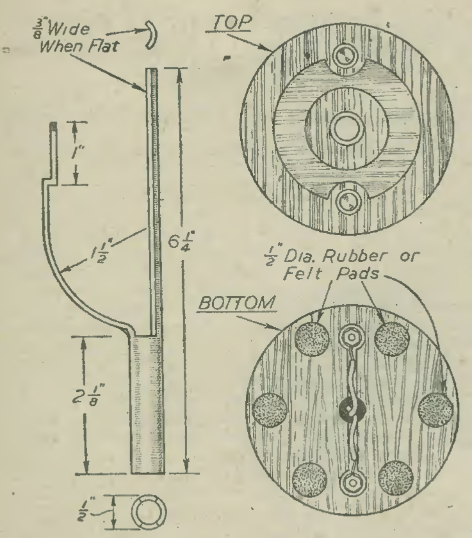


Fig. 3.—How fork piece is made from metal tubing, with views of the main base piece.

at this juncture. Three pieces are wanted, cut from ½in. wood. The main base piece is 3¼ins. in diam., the next size being 2¼ins. in diam., the smallest piece being 1¼ins, in diam. The latter have a ½in. hole bored through their centres.

A ⅜in. hole is bored through the centre of the main base. Before doing so, scribe a 2¼in. circle on the bottom side and bore a ⅜in. hole about ⅜in. deep on the line opposite to each other, as shown. Continue the boring with ⅛in. drill or gimlet, going right through.

These holes are for brass terminals, the ⅜in. deep recesses being provided so the nuts of the terminals are flush with the underside of the base. Channels, for the wire flex, are made ⅛in. deep by ⅛in. wide. Note the grain direction, by the way.

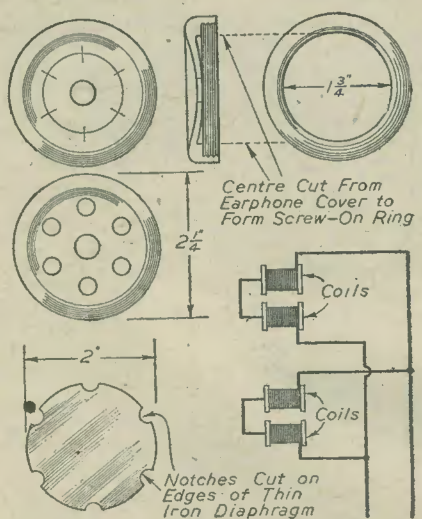


Fig. 4.—How 'phone cover is treated, with diaphragm notched, with detail of the simple flex connections.

The semi-circles cut in the edges of the next largest base piece provide space for the terminals (see top view at Fig. 3). Glue it upon the main base piece, then add the topmost piece. The grain of the wood runs in opposite directions, as can be clearly seen, and this prevents the wood from warping and thus causing the mike to "rock" unsteadily.

A fork, or trunnion, is made from a 6¼in. length of ½in. diam. metal tube. A piece of towel rail is ideal. To make the fork, the tube is double-cut down its length to a depth of about 4⅛in. Remove the waste from the sides by "nicking" the metal with the hacksaw and bending it up and down a few times.

Flatten out the fork lengths on an anvil (any flat metal surface) with a hammer, then proceed to bend them to a 1½in. radius, as shown. A 3in. diam. bottle makes a good former. Do not attempt to flatten the fork pieces near the stem; the slight curvature does not permit this to be done.

Having bent and bored the trunnion "lugs" as indicated for ⅛in. by 6 round-head screws, the fork can be forced into its base. It goes in 1in. deep only. If a slack fit, remedy matters by fixing a strip of gummed paper around the stem to make it a force fit.

The headphone covers, as stated previously, need to be perforated with a number of extra holes to enable audible sounds to impinge more favourably upon the diaphragm. Six ¼in. diam. holes will suffice, marking them out and drilling them as depicted at Fig. 4.

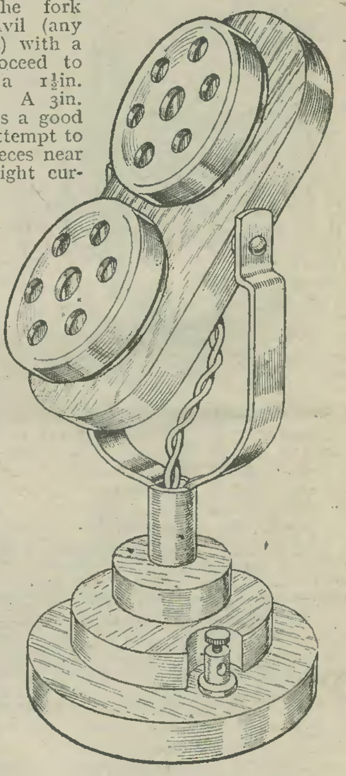


Fig. 5.—Sketch of the completed mike-cum-reproducer.

An alternative is to remove the centre from the covers to the inner "lip" or flange (see side sectional view). This, of course, means cutting out an aperture 1¾in. in diameter.

In respect to the diaphragms, six ⅛in. deep semi-circular notches are cut in the edges, as shown. This can be done with a pair of scissors or a rat-tail file. The diaphragms must afterwards be made quite flat, minus "burrs" of metal on the surfaces.

Short lengths of flexible twin wire are connected to the inside terminals in the units. Force the units in their framing so the casing outlet holes are in alignment with the small recesses cut in the frame. The wires project at the back and an extra piece of twin flex is connected to these (see simple circuit detail) and brought through the fork stem, the ends being bared and attached to the terminals (see bottom view at Fig. 3). All this is best done when the frame has been pivoted between the fork arms.

In use, the 'phone units can be tilted to cut out some of the tendency towards top-heaviness, as suggested in the sketch at Fig. 5.

An Introduction to Communications Receivers—3

The Intermediate-frequency Amplifier and the Second Detector.

By FRANK PRESTON. A.M.Brit.I.R.E.

ONE of the most important functions of the intermediate-frequency amplifier of a communications receiver is to provide the necessary high degree of adjacent-channel selectivity. It is for this reason that the person who has been accustomed only to the simpler type of superhet broadcast receiver is inclined to be overwhelmed by the large number of tuned circuits to be found in the I.F. section of the average communications receiver.

Intermediate Frequency

It is most usual to have two stages of I.F., but some of the more sensitive types of receiver have three and occasionally four. The intermediate frequency employed is generally in the region of 450 kc/s, but it is not altogether unusual to find an I.F. as high as 1,600 kc/s in receivers designed entirely for short-wave or ultra-short-wave use. In some special types of U.S.W. receivers an I.F. of up to 5 mc/s may be used, but such a frequency is seldom employed in the types of communications receiver with which the amateur is likely to be concerned; in fact, it may be argued that receivers of special types in which these high I.F.s are used are not correctly described as "communications" receivers.

A Representative Circuit

A skeleton circuit of a two-stage I.F. amplifier is shown in Fig. 1. It will be seen that a crystal gate is included in the first I.F. transformer circuit, whilst a triple-tuned I.F. transformer is used to couple together the first and second I.F. valves. The third transformer is of the conventional double-wound pattern. Modifications sometimes included are principally concerned with the provision of variable selectivity; sometimes the primary and secondary windings of the I.F. transformers are coupled together through a link circuit arranged so that the degree of coupling may be varied. Alternatively, one or more of the transformers may have a tertiary winding and variable resistor for varying the bandwidth.

In general, however, the arrangement shown in Fig. 1 is typical. An adequate degree of selectivity for either 'phone or C.W. reception is provided by the crystal filter, whilst tuning can be flattened to a certain extent by adjusting the crystal load circuit represented by the tuned circuit marked L3—C2 and the series variable resistor marked R.

The Crystal Gate

The crystal-filter circuit is perhaps the most interesting part of the intermediate-frequency amplifier under consideration. It will be seen that the secondary winding, L2, of the first I.F. transformer is centre-tapped, and that a bridge circuit is provided by the two halves of the secondary winding, the crystal and a small variable condenser marked C1. The latter condenser is described as a phasing or balancing condenser, and its purpose is to phase out, or neutralise, the effective capacity of the crystal holder. In practice, the phasing is generally carried out after detuning the receiver (so that it is not tuned to any signal) and then adjusting C1 until the level of the background noise is reduced to a minimum.

The output from the crystal gate is applied to the grid of the first I.F. valve and to the loading circuit already mentioned. Variation of the resistor R alters the loading on the crystal and therefore controls the degree of selectivity. Provision would generally be made for short-circuiting the crystal when a high degree of selectivity is not required—when receiving telephony, for example.

An alternative type of crystal gate is illustrated in Fig. 2. In this example an "artificial" centre tap is provided for the secondary of the I.F. transformer. This tapping is provided by means of two series condensers. Such an arrangement has the advantage that the precise electrical centre of the tuned circuit can better be obtained by using two balancing condensers than by making a physical centre tapping to the coil winding. The reason for this is that the electrical centre is generally

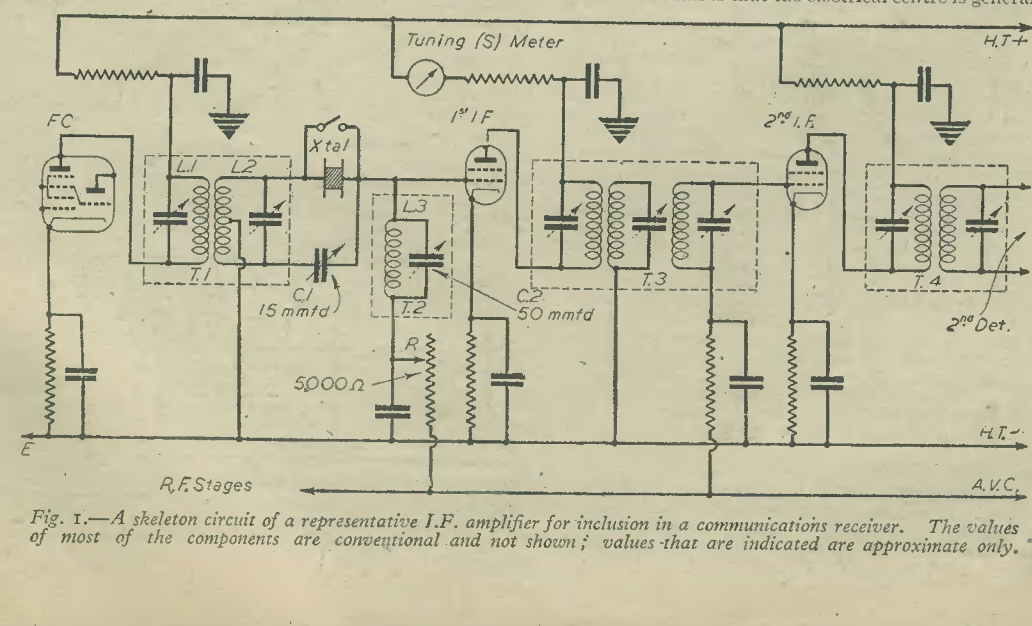


Fig. 1.—A skeleton circuit of a representative I.F. amplifier for inclusion in a communications receiver. The values of most of the components are conventional and not shown; values that are indicated are approximate only.

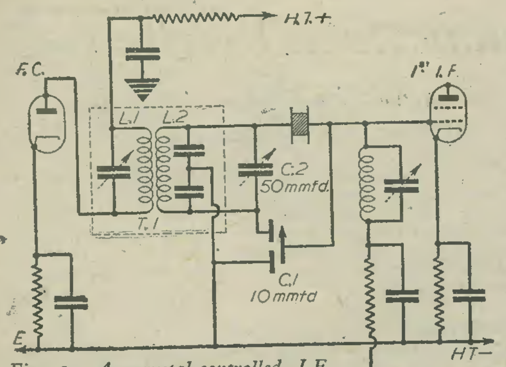


Fig. 2.—A crystal-controlled I.F. circuit, which differs in some details from that shown in Fig. 1.

in a different position from the mechanical centre of the winding.

Crystal Selectivity Centre

A differential type of condenser is employed for phasing, so that adjustment of the condenser does not affect the tuning of the circuit. There is a similar loading circuit to that shown in Fig. 1, but the load is fixed. Variable selectivity is obtained in this case by adjustment of C2. Contrary to what might at first be expected, tuning is at its flattest when the condenser tunes L2 to the resonant frequency of the crystal; varying degrees of slight mis-tuning bring about a more "peaky" response. This behaviour is explained by the fact that L2—C2 are virtually in series with the crystal and when tuned to resonance have a maximum (theoretically infinite) impedance. Additionally, the impedance is resistive; that is, the circuit acts as a pure resistance. This resistance in series with the crystal greatly reduces the effective Q ("goodness factor") of the crystal circuit and so brings about a reduction in selectivity. The point will be understood more readily if it is remembered that the Q of a tuned circuit (or of a crystal) is found from the formula: $Q=2\pi fL/R$, and that the Q of a crystal alone is extremely high.

Band-pass Crystal Filter

Yet another type of crystal filter gate is shown in Fig. 3. This time two crystals, of frequency differing by about 300 c/s, are used in a band-pass circuit. The two crystals are connected in opposite arms of a bridge, with the result that they are phased in opposition. In consequence, a symmetrical flat-topped response curve (although the flat top will extend for only a few hundred cycles per second) is produced. A differential condenser is used for phasing, so that any variation in capacity of the two crystal holders can be balanced out.

It is possible in a circuit such as this to have two or more different degrees of "crystal" selectivity by making provision to switch different crystals (and of frequency varying in difference from that of the other crystal) into one arm of the bridge. When still flatter tuning is required one of the crystals can be short-circuited, so that only one half of the bridge is operative. This may result in a slight loss of gain due to the fact that only one-half of the transformer secondary winding is then employed. The loss need not be great, however, if a good transformer with high-inductance secondary is employed. Another method of eliminating the crystal gate is by switching in a different secondary which does not include a crystal.

S-meter Connections

The remainder of the I.F. amplifier calls for very little comment. It is customary to use variable-mu tetrodes or pentodes and to make provision for supplying A.V.C. to all of the I.F., as well as the R.F., valves. In addition, the screens are generally fed from a stabilised H.T. supply line, as explained in last month's article when making reference to the frequency-changer. An S-meter or tuning indicator is almost universal in better-class communications receivers and is, in some cases, included in the anode or cathode circuit of the first I.F. valve, as shown in Fig. 1.

With this method of connection, the meter needle reading falls as the strength of the applied signal increases; this is because of the normal A.V.C. action of reducing anode current as increased signal to the A.V.C. valve causes additional bias to be applied to the controlled stages. A more sensitive type of S-meter circuit, and one in which signal strength and meter reading rise together, is shown in Fig. 4. In this arrangement the meter is included in a bridge circuit, and a variable resistor is provided for setting the meter reading to zero. The method of setting the variable resistor is to detune the receiver, turn the manual R.F. gain control to maximum and then adjust the resistor so that the meter shows a zero reading.

The Second Detector

A double-diode is almost universally employed as a second detector, and this may either be a separate valve or it may be a part of a double-diode triode, as shown in Fig. 5. In the circuit illustrated, the double diode also provides A.V.C., but in some cases a separate double-diode is provided for A.V.C. This point will be referred to again next month when dealing with the subject of noise limiters.

Fig. 5 shows a fairly standard second-detector-first A.F. stage and little need be said about this part of the circuit beyond stating the fact that provision is made for cutting out the A.V.C.; this is done when receiving C.W., for reasons which were given in the first article of this series. This brings us to the beat frequency oscillator, the purpose of which is to make possible the reception of C.W. It will be remembered that if C.W. is to be audible is must be caused to beat with another C.W. oscillation varying in frequency by, say, 300 to 2,000 c/s. In general, a note of 1,000 c/s is found most comfortable and most easily read.

The B.F.O.

Since a diode cannot be used as an oscillator it is necessary to employ a separate oscillator, the output from which can be applied to the diode circuit where it will beat with the incoming signal at intermediate frequency. If, then, the I.F. is 465 kc/s, the B.F.O. (as the beat frequency oscillator is called) should tune to 465 kc/s plus or minus about 1 kc/s or 1,000 c/s.

The B.F.O. shown in Fig. 5 employs a tetrode in an electron-coupled circuit. Output from it is taken from the cathode and applied to the detector diode through a fixed condenser, as shown. The tuning circuit of the

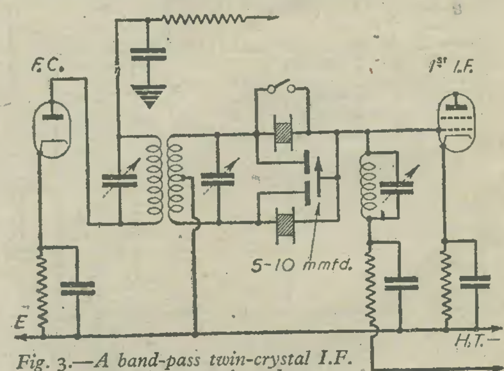


Fig. 3.—A band-pass twin-crystal I.F. circuit. This has certain advantages over the type of circuit in which only a single crystal is used.

B.F.O. consists of a coil and fixed condenser, while in parallel with the fixed condenser is a small variable condenser; this is mounted on the front panel. It is generally arranged that the B.F.O. is tuned to intermediate frequency when the variable condenser is at its midway setting, and that the frequency can be increased or decreased by something rather more than 1,000 c/s by turning the condenser full in either a clockwise or anti-clockwise direction.

One may ask why provision is made for bringing the B.F.O. frequency either above or below the I.F. The reason is that the effective selectivity of the receiver can be increased by making use of this choice; if there is an interfering signal at a frequency below that of the wanted signal the B.F.O. would be tuned to the higher frequency, and vice versa.

Audio Note

It is important that the audio note should be produced by tuning the B.F.O. and not by de-tuning the receiver. To ensure this, the receiver should first be tuned to the "dead space" with the B.F.O. tuning condenser at its zero setting. The desired note is then obtained by adjustment of the B.F.O. condenser. If this were not done the I.F. would be slightly off tune, with a consequent loss of gain and of selectivity.

Other B.F.O. circuits are employed. For example, a triode (or tetrode or pentode) may be wired in a Hartley or Colpitts circuit. It is probably true to state, however, that the electron-coupled and Hartley circuits are most widely employed.

Next month's article will be the last of this series and will deal with noise limiter and noise filter circuits.

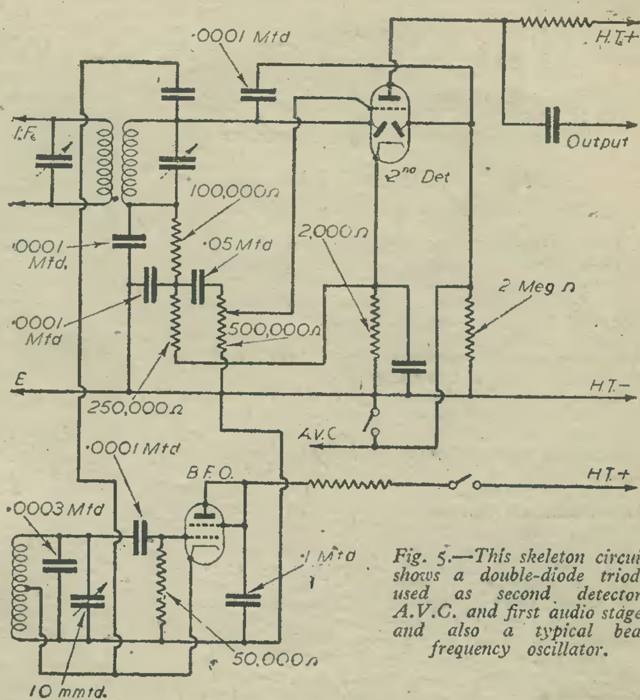


Fig. 5.—This skeleton circuit shows a double-diode triode used as second detector, A.V.C. and first audio stage, and also a typical beat frequency oscillator.

Radio on the Road

(*Continued from page 489.*)

In either case the line cord or internal resistance is not needed, but the heater leads should be brought straight out to the battery, the earthed one going to the negative of course.

For the H.T. supply I suggest that from its size the H.T. unit can be nicely built into a deep back for the set, though in some chassis it will be found that the transformer can be fixed to the chassis, since there is often space for it. In that case the interrupter may be fitted away from the set and only supplying the transformer with six volt interrupted current. The wiring can be screened or run in light earthed tubing if this idea is used. Maybe the reader will convert an existing set, and then it may be found better to build the interrupter and transformer into a deep back, which can be hinged or screwed to the rear of the set.

An I.E.E. regulation forbade the running of cables in a car carrying current at high tension, so that it is not possible to mount the interrupter unit apart from the set, such as was popular in the early days of car radio, when motor generators were used mounted underneath the bonnet or underneath the car.

By adopting the idea of supplying a set with six or twelve volt interrupted current from an interrupter not incorporated within the set also opens up possibilities in running any small mains set from the car battery if one does not mind the drain of several amps. for the heaters. A suitable wiring would have to be put on to the transformer and it is often possible to wind it on top of the existing windings.

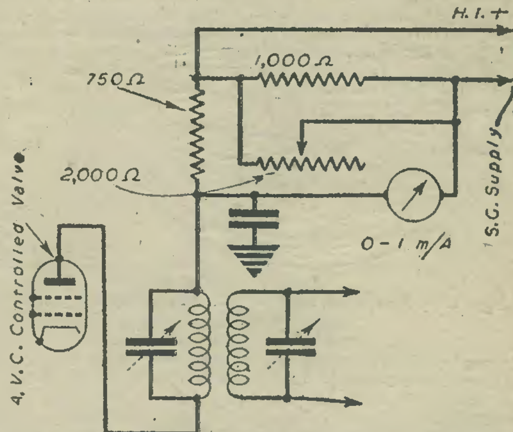


Fig. 4.—This diagram shows a method of connecting an S-meter in a bridge circuit consisting of different resistors. Resistor values are representative only.

Gramophone Record Repeaters—II

Further Instructions on the Construction of a "Pre-set" Record Repeater

By "EXPERIMENTALIST"

(Continued from page 476 of the October issue)

IN a previous article dealing with the construction of simplified "pre-set" record repeaters designed for use on 7in. and 8in. discs, the writer promised details of adjustable arm types, one of which could be used on 8in. and 10in. discs. Front views of these repeaters are shown at Figs. 3 and 6, and it will be seen that they are just as easy to make as the hole-adjustment types mentioned, but are slightly larger, owing to the "racked" adjustable arm which had to be devised, since the sliding-bar adjustment is covered by a patent, and cannot be copied.

However, despite this drawback, the new arm adjustment is, in principle, like the sliding-bar idea, and enables the repeater to operate successfully on the 7in. or 8in. or 10in. gramophone records for which it is made. Most recordings, as you may have noticed, either finish near the circumference edge of the labels or ¾in. away from the label edge, the latter being the extreme.

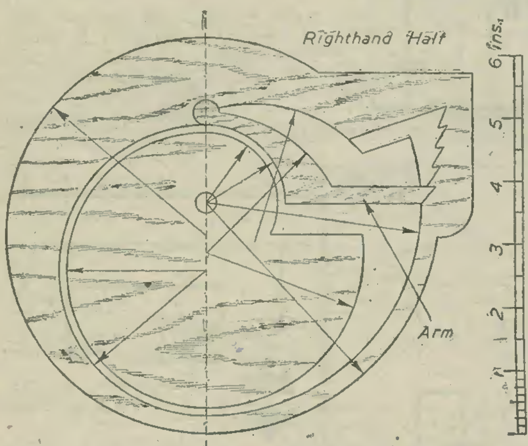
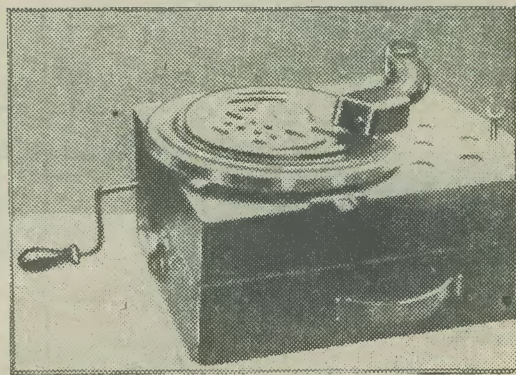


Fig. 1.—Main shapes for a 7in. record repeater, with scale.

Consequently, the arm has been planned so it has an adjustable movement which suits all the varying sound track endings common within the ¾in. from the label edge of gramophone records. You may not, perhaps, be able to set the repeater "fine" so it releases itself at the point wanted, but should, for example, the finale of a recording be cut off a bit too soon because the arm is "out" by a fraction of an inch, one can always try the next most suitable notch, i.e., the one which brings the soundless ending spirals into line with the guide track of the repeater.

A 7in. Record Repeater

Details for a 7in. repeater are provided at Figs. 1, 2 and 3. The two main shapes, plus the adjustable arm, are fretsawed from ⅛in. plywood (a suitable piece of plywood, by the way, can be made by gluing three pieces of mahogany veneer together, with the central ply running crosswise with the outside pieces; veneer about 1/32in. thick would serve, and may be oak, walnut, etc.).



The repeater fitted to a gramophone.

The main shapes and arm are best marked out with pencil compasses on a sheet of plain paper, working from the central dotted line. Scribe the right-hand radii lines first, then join up the left-hand side.

The two main shapes are transferred to the wood by means of carbon paper, or the pin-prick method. In the latter case, all corner and compass centre points are marked through upon the wood with a sharp-pointed instrument such as the pointed leg of the compasses, then all straight lines ruled from their points and radii lines connected to their points.

It is imperative that the adjustable arm is made a fairly tight fit between its "knuckle" and the toothed rack. Therefore, mark it out independently on a scrap piece of plywood or the waste wood remaining when the main shapes have been marked out, then cut out all three pieces carefully with a fretsaw. The "gap" piece of waste wood, which separates the main shapes, must be cut away in one piece, as it is used later on for "filling" purposes.

A Simple Design

As explained in the previous article, a simple fretwork design cut in the main pieces helps to reduce weight

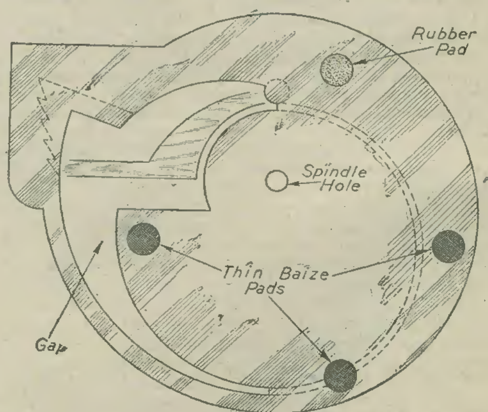


Fig. 2.—Back view, showing "gap" cut in celluloid backing and pad positions.

and, as a result, the concussion of the arm against the pick-up (or sound-box) needle. A suitable design is provided at Fig. 3, which is easily copied.

When you have the main shapes cut out, smooth the inner edges with glasspaper, i.e., the guide track edges, then obtain a piece of thin celluloid sheeting (cleaned, X-ray film or anything similar) measuring 8in. × 6½in. The main shapes are adhered to one side of the film, with the waste cutting of wood within the gap to keep the parts separated truly; the cutting is only fitted in temporary, unglued, of course.

When both main shapes have been adhered it is removed and the work placed under weights until the glue sets. In respect to a good adhesive, prepared, semi-liquid glues can be used. If the surface of the celluloid is lightly rubbed with fine glasspaper, the glue will obtain a much stronger hold; a cement, one having a celluloid base, such as model aeroplane glue, may be used.

Some of these adhesive cements, however, are quick-setting, and as the gluing of the main shapes to the film backing is tedious and slow, the writer recommends sem-liquid glue such as "Certofix" or "Acrabond," and similar reliable makes.

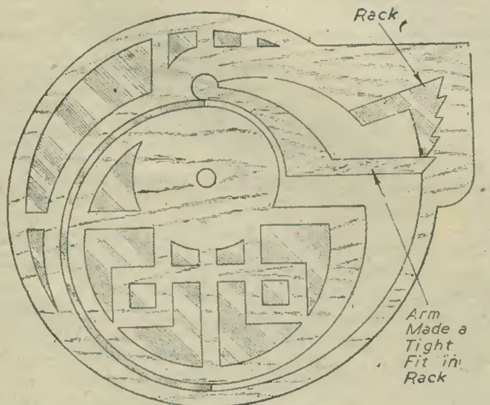


Fig. 3.—Front view of completed repeater, showing simple fretwork design.

Cutting the Gap

The glue should be allowed 24 hours to set, 12 hours being the minimum. The edges of the adhered film are trimmed first, following which the gap (see Fig. 2) is cut out, using a sharp-pointed penknife.

The gap stretches halfway at the rack side of the repeater parts. Having cut the opening, cut three ½in. diameter discs from thin baize (or cloth) and glue them in the position indicated. The fourth pad is cut from thin rubber, and affixed with glue or rubber solution; a repair patch from a bicycle repair outfit could doubtless be used.

The arm is filed and glasspapered to fit snugly and tightly in its rack. It should engage tightly with all the teeth, of course. It may be necessary to "pack" any teeth which give a loose fit with gummed pieces of paper.

An 8in. Repeater

Those of you desiring an 8in. repeater only need to add ½in. to the radius measurements shown at Fig. 1. The central radius is the same for 8in. repeaters as it is for 7in. repeaters, which is 1⅛in. Do not increase this radius, and in respect to the adjustable arm, its length should only be increased by ½in. The knuckle is also kept ⅜in. in diameter, and the guide track ¼in. wide.

If you only possess a few 8in. discs, it is not worth the trouble making a special repeater for them. The 10in. size of repeater can be made to "service" 8in. records. Owing to the greater eccentricity of the elongated spindle hole, however, repetition is not on the same par as that produced by a proper 8in. repeater, such as the model described. A lot depends on the records; actual experiment will reveal more than mere words.

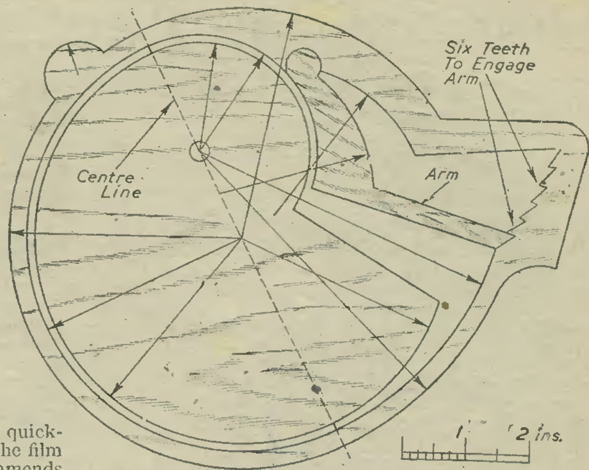


Fig. 4.—Main shapes for a 10in. repeater.

A 10in. Repeater

The 10in. model is detailed at Figs. 4, 5 and 6. It is constructed much in the same way as the 8in. model and only differs in size and design. It has, as shown, an extra arm tooth in its rack and the extra 8in. spindle hole position is depicted at Fig. 5.

The various radius centres are indicated by the arrows at Fig. 4. The 8in. spindle hole is not shown in this diagram for the sake of clarity. The radii lines are scribed at the rack side of the central dotted line first.

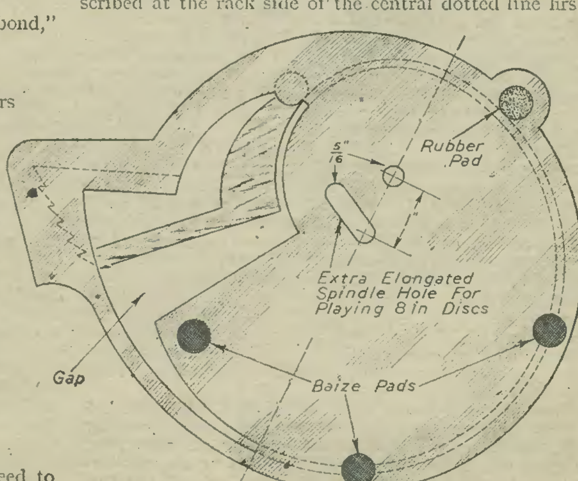


Fig. 5.—The back view of the 10in. repeater.

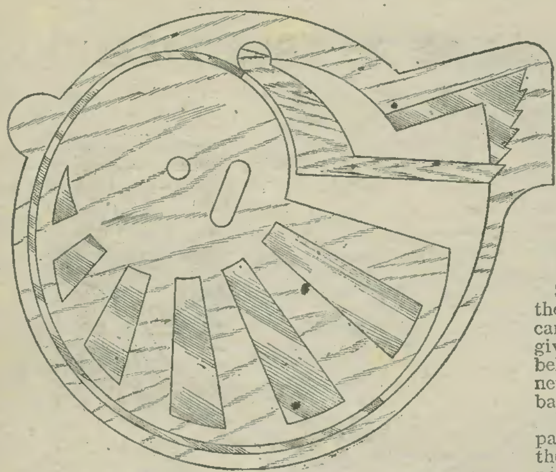


Fig. 6.—Front view of 10in. repeater.

It might help if all the radius sizes were stated rather than let you work from the scale. Starting from the spindle hole, the lengths are $1\frac{3}{4}$in., $1\frac{7}{8}$in., the next smallest size being $2\frac{3}{8}$in. The sizes then increase from $3\frac{1}{4}$in. to $3\frac{3}{8}$in., $3\frac{5}{8}$in., $4\frac{7}{8}$in. and $5\frac{1}{8}$in., the latter being the longest arrow pointing from the spindle hole. The radius of the smallest arrows is $\frac{1}{2}$in. and $\frac{3}{4}$in. respectively.

Using the Repeater

The models made and tested by the writer seem to operate more easily than the patented article. You may experience some slight bother, as he did, when making a trial performance. You may find, for example, that as soon as the pick-up needle releases the repeater, the repeater merely jerks around a bit with the revolving record and remains inactive, being held in place by the needle.

There are two reasons for this set-back. Firstly, the needle may not be able to "jump" upon the film surface owing to the squareness of the edge. An acute angle, or slope, needs to be cut, filed or glasspapered at the "lifting" edge so the needle glides up the bevel easily.

Secondly, the rubber pad may be too far distant from the lifting edge. In this case, the revolving record cannot, with the help of the weight of the pick-up, give the slight "push" necessary to drive the repeater below the needle, so the rubber pad must be altered to a new position nearer the lifting edge of the celluloid backing.

Very thin, fine green baize pads are necessary. These pads merely protect the record surface and help to raise the back of the repeater to the same level as the rubber pad; if a woolly material is used, there may be too much drag so that, revolving on the turntable of a cheap, single-spring motor, the record rotates slowly, in moaning jerks, until the pick-up needle nears the centre of the recording when, owing to the lessening of the centrifugal drag, the speed increases to normal.

Records with dusty surfaces will also cause the above effect. And if the pads are more than 1/16in. thick, the needle has a higher distance to jump. A thickness of 1/32in. is best. If baize pads cause too much drag, try discs of thin leatherette.

How Wireless Experts Hoaxed the Japs

A TINY group of islands in the Indian Ocean known as Cocos or Keeling Islands has been put on the map again after 41 months on the secret list.

On one island in the group there has been for many years an important station in the Cable and Wireless "via Imperial" communications network, but its continued existence as a cable station during the war has been so secret that it has been known officially as "Brown."

In the rainy dusk of the evening of Wednesday, March 3rd, 1942, the day before Batavia fell, 700 miles away, a Japanese ship slipped in close to the barrier and opened fire on Cocos. Shells tore over the Cable Station roofs knocking down showers of coconuts; huge fires set the island ablaze. The Cable and Wireless men cabled the news to London as they emerged from slit trenches while the raider sailed away.

That night Cable and Wireless officials in London, after getting Admiralty permission, send by radio a plain language message to their Batavia station. Batavia heard it at 4 a.m. It told them that it was no good hanging on because Cocos had been destroyed and was out of action.

At noon the Japanese broadcast that their forces had split Cocos in two and destroyed all cable and wireless communications.

Receivers Still Working

But the receivers were still "alive" on the island and the Cable and Wireless men picked up the news of their own destruction.

The Japanese never again attacked Cocos from the sea, though frequent reconnaissance flights were made by Japanese aircraft and on three occasions bombs were dropped which fortunately did not do any very serious damage to the telegraph station. Throughout the war Cocos has continued to play a vital part in maintaining Allied communications. The staff have had to take great care to avoid making any alterations or repairs to buildings, or to undertake any re-painting, which would lead the enemy's reconnaissance 'planes to think that the station was anything but abandoned.

Shortly before the attack in March, 1942, a meeting was held in London to consider a proposal to abandon Cocos before the Japs arrived. At that meeting was Mr. W. G. R. Jacob, Cable and Wireless, Ltd. Engineer-in-Chief, who advised against.

The question had a personal as well as an official interest for Mr. Jacob. His 26-year-old son, J. C. W. Jacob, was one of the 11 Cable and Wireless engineers and operators on the island, and though due for transfer he volunteered to remain.

While the Japs were firing, these 11 men and their Chinese assistants remained in slit trenches, 4ft. deep in water. But four of them were blown 30ft. along a verandah as a shell hit an iron girder. Shelling continued for an hour. Chinese workers who lost all they possessed received compensation—and then asked to be sent home, to hit back at the Japs on their own soil.

The Cocos-Keeling Islands lie midway between Australia and Ceylon. Their 1,140 people live by exporting copra and coconuts. Cocos is a junction for cables linking South Africa, the Dutch East Indies and Australia. The Cable and Wireless station also operates a private wireless service for ships calling at the islands.

Cocos played a big part towards the destruction of the German cruiser *Emden* during the 1914-18 war. The *Emden* landed a party on November 9th, 1914, and destroyed the telegraph station, just as the Japs hoped to do in 1942. The Cable and Wireless station sent out a warning which was picked up by H.M.A.S. *Sydney* escorting a convoy not far away; and the Australian cruiser engaged the Emden, crippled her and forced her to run ashore on North Keeling Island.

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These monthly advertisements are not intended to sell special lines, but rather to indicate the comprehensive nature of our stocks—our "Interim" Catalogue will be of additional interest (2½d. post free).

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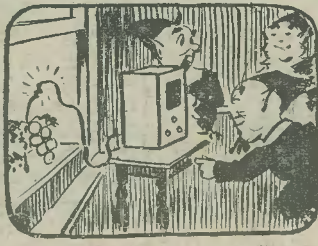

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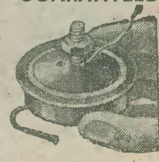

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An Intermittent Fault-finder

A Useful Servicing Aid Described by 2ATV

THAT type of fault which occurs at irregular and possibly widely spaced intervals, and which often has a duration of only a few seconds, is one of the greatest bugbears with which the service engineer is confronted. Such faults are usually due to an intermittent open-circuit or high-resistance connection in an inductive component, such as a decoupling or coupling capacitor, or an R.F. or tuning inductor. Sometimes it may be a dirty switch contact, and again it will be a bad weld in the structure of a valve. Whatever the reason, generally the problem is to track down the fault to a particular stage in the receiver under test, as it is often found that the mere connection of test prods, or slight vibration, will temporarily disperse the trouble.

There also arises another snag, from the engineer's point of view, in that the radio set has to be left running at a volume sufficient to indicate when the fault occurs. This leaves two alternatives. The first is to leave the set on "soak," and wait for the fault to happen, an impractical method as the waiting period may be a matter of hours. The second choice is to employ the waiting time in servicing other receivers, but this is also unsatisfactory, as the fault may be missed when it does occur, through being masked by the output from the receiver in hand at the time.

Obviously, what is needed is some form of indicator which will give warning of the breakdown, and yet allow the set to be operated silently. Coupled with the indicator there should be some means of determining the change in circuit conditions during the period of failure. Now, it has been determined by E.M.I. that, in some 97 per cent. of cases, an intermittent fault results in an appreciable drop in the volume output of the set. This fact provided the clue on which is based the instrument about to be described.

Test Signal

First, a signal must be provided, and the strength of it must be constant. It is therefore useless to rely on tuning the set to a broadcast station. Since the fault may lie in the R.F. stages of the set, the injected signal must be at radio frequency, while, as the indicator will work on a drop in volume, the signal must also be modulated at audio frequency. Thus the first piece of equipment needed is a standard test oscillator or signal generator.

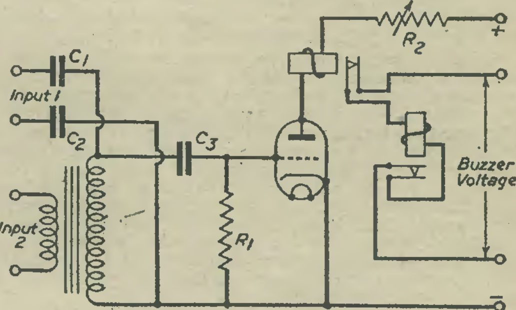
Obviously, as the receiver is suspect in its entirety, it is politic to disturb it as little as possible. This condition can be fulfilled, and the advantage of silent working gained, by connecting some form of indicator in place of the loudspeaker. The output of the set should preferably be taken from the secondary of the speaker transformer, since the only part of the set which will then not be investigated is the speech coil, and experience shows that this rarely gives trouble.

The circuit diagram shows a suitable indicator. Two alternative input channels are given, as in some cases it may be more convenient to take the signal from the primary winding of the transformer due to the speech coil connections being inaccessible. If so, silent working cannot be obtained unless the transformer is free from suspicion, when it can be disconnected and replaced by a load resistor of a suitable value for the output valve in use. C1 and C2 are .1 μF blocking capacitors, while the transformer is a standard speaker type.

Valve

The valve should be a medium or high-impedance triode, and works as a leaky-grid detector. As only audio frequencies are concerned, the time constant of the grid resistance and capacitance is comparatively large, suitable values for normal modulating frequencies being 50,000 ohms and .05 μF. respectively. In the anode circuit of the valve is a sensitive relay, which will operate at a current of two or three milliamps, and a variable resistor the value of which will depend on the H.T. supply available, but which will probably work out at around 50,000 ohms. No attempt is made to specify any particular power supply, as the unit is intended to be built from components at hand. The unit can be battery or mains operated, and it is sufficient in this respect to state that a smoothed H.T. voltage of 100 is ample. The relay is shown as operating a bell or buzzer, but it could in addition control a visual warning system. So much for the actual indicator.

There now remains the determining of change in circuit conditions which in most cases will be reflected in the voltages and currents obtaining at various points in the receiver. It should here be noted that the instrument will not pick out the actual component at fault, but it will provide data which, studied intelligently, can be the means of tracking down the culprit. To obtain this data, at least two measuring instruments are needed, a voltmeter and a current meter. The accuracy of the dial readings is unimportant, providing that consistent readings are obtained for any given voltage or current, as these instruments are used only for comparison purposes. If a sufficient number of meters is at hand, the whole receiver can be investigated at one time, but if two only are available the set must be checked in stages. It will then be necessary to use multi-range meters, which are easily built up, especially as there is no need for extreme accuracy, and which can be housed in the same cabinet as the indicator.



Theoretical circuit of the faultfinder.

Operation

It may here be useful to set out the operating procedure and to analyse one or two typical faults and their consequences. Assuming that the output stage is being checked, the voltmeter would be connected across smoothed H.T.+ and H.T.−, and the current meter in series with H.T.+ and the primary of the speaker transformer. Input 2 of the indicator is connected to the secondary of the transformer, or input 1 to anode and chassis, and a steady modulated signal fed into the receiver. The anode current of the indicator valve is then adjusted by varying R2, until the relay is on the point of operating. A note is then made of the readings given by the two meters.

Presently, the bell rings. The meters show that the anode current of the output valve has risen sharply, whilst the H.T. voltage has dropped. Obviously the fault is in this stage. The voltmeter is then connected across the cathode resistor and a further test discloses that the rise in anode current is accompanied by an increase in bias potential. So far it has been established that a drop in H.T. voltage is caused by an increase in anode current, and that the latter is not due to any fault in the cathode resistor or capacitor. But it *could* be caused by a breakdown in the coupling capacitor, resulting in the potential actually on the control grid being partly cancelled out. This is confirmed by substitution and a further "soak" test.

Example

Take another example. This time, no appreciable differences in readings are noted until the I.F. stage is checked. Then, it is found that the anode current of the I.F. valve rises by about half, whilst the H.T. voltage, measured at the junction of the I.F. coil and the decoupling resistor, shows a decrease. Further tests show that the screen potential remains sensibly constant, and that the cathode voltage increases. The indications are that the valve is oscillating, and a possible cause of this is inefficient screening or decoupling. The valve is metallised, and inspection proves that the contact between metallising and the appropriate pin is sound electrically and mechanically. Suspicion next falls on the screen decoupling capacitor, and substitution here effects a complete cure.

The Development of Radar

An Extract from the Speech of Sir Stafford Cripps, made at the Luncheon of the Radio Industry Council, at the end of August

"AS is now known to the world, the story of the development of wartime Radar is largely the story of the insistent demand from the Services for shorter wavelengths, calling for valves of higher power and greater sensitivity than had ever been conceived of before. It was only by shorter wavelengths that we were able to secure the greater precision required by the Navy and Army for the control of gunnery and searchlights, the location of submarines and other vessels, and, in the cases of the R.A.F., the specially light and small sets necessary for airborne purposes. Here again, the partnership which was built up between the Government establishments, the universities and the industrial laboratories made possible the rapid development of the new technique of short wavelength working.

"For the original radar chain system which located aircraft approaching our shores, a wavelength of 1,200 centimetres was sufficient, though even this was considered short when Radar began in 1935. By the time war broke out in September, 1939, entirely fresh ground had been broken by the development of a new type of valve capable of generating powerful radar signals of from 50 to 150 cm. wavelength. To this we owe C.H.L., the system of detecting ships and low-flying aircraft from the shore; G.C.I., the system of ground controlled interception of enemy aircraft; the first A.1 sets in night fighters for locating enemy bombers; and the first A.S.V. sets used by the Navy and Coastal Command for detecting surfaced submarines, even at night.

"But even this was not good enough. Still the Services asked for better definition and more compactness for their Radar. The demand for valves and circuits to work on wavelengths as low as 10 centimetres now became insistent, and, as before, the effort to meet this requirement was divided between the Government research establishments, the university laboratories and the industrial research laboratories. It was fortunately at this moment that the brilliant research work undertaken at Birmingham University led to the application of the "resonant cavity" principle applied to magnetron valve design and showed, by a laboratory model, that it would work. From their past study of magnetron valves our industrial scientists were quick to see its possibilities and to use this idea to produce a light and compact air-cooled valve of 20 times the power and suitable for airborne use. Both the Birmingham and the industrial scientific contribution were of the utmost value and importance.

10 cm. Radar

"The 10 cm. radar equipment was now much nearer. Further research produced the other essential components and, these being married together and engineered into a prototype equipment, a successful demonstration of radar transmission and reception on 10 cm. was given on August 3rd, 1940, less than eight months after the first verbal request had been made to the industry that a research contract should be accepted. The equipment was first flown in an aeroplane on March 9th, 1941, and this became the first functional prototype of 10 cm. radar.

"Then in quick succession and almost simultaneously came other new and startling devices. For Coastal Command, as I have already said, there was the improved type of A.S.V., and for the Navy the radar sets known as Type 271 for detecting surface submarines from destroyers or corvettes, which perhaps more than any other factors enabled us to win the final victory over the U-boat. For the Army there was the G.L. set Mk. III by which the Army's anti-aircraft and other guns could be trained exactly on to targets long before they could be picked up by normal methods.

"Finally, there was developed H.2.S., the device which shows visually in the heavy bomber a continuous picture of the unseen ground below and which, by freeing the bomber from any dependence on ground radar stations, so greatly intensified the effectiveness of our bomber offensive. It was a remarkable achievement, but I cannot think of it without recalling the sad tragedy which accompanied its birth, and as a result of which five of the small team working on it in 1942 were killed in an air accident while trying it out. Amongst those killed were two of the most prominent engineers in the British television industry, Mr. E. D. Blumlein and Mr. C. O. Browne, with their assistant, Mr. F. Blythen.

"So far I have referred only to the part played by the industrial research scientists, but whilst their work was the necessary first step after the initial designs and models, often of the very roughest, had been given to the factories by the Government scientists, the great job of producing these varied and intricate equipments was going on ceaselessly day and night. Every radio firm in Britain, and many firms which before the war had never made a radio valve in their lives, devoted their resources entirely to meeting the endless demands of the Services. And, though I am talking to-day only of Radar, we must never forget that, insistent though the demand for was Radar, the Services' requirements for ordinary radio communications for signalling were on a prodigious scale.

Huge Output

"By the peak of the European war, a quarter of a million workers, men and women, were engaged on the production of radar and radio equipment. Some idea of the wonderful job which these men and women did can be realised when I tell you that, whereas before the war we produced in this country only a few million valves a year, in 1944—invasion year—we produced no less than 38 million valves, of 600 different types, for the three Services. This vast production was achieved under the constant threat of aerial bombardment and since a great proportion of the production capacity had pre-war been established in the London area, a great deal of it was in fact carried out under almost continuous bombardment by V1's and V2's."

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

THE high light in the H.M.V. releases for this month is the great work of Verdi, namely, his "Requiem Mass." This recording is great in many respects. From a musical sense it is, undoubtedly, one of Verdi's finest products, written at the very zenith of his career. From the point of view of production, the performance is superb, and I think it is only right that a word of praise should also be given to the technicians who made possible such a perfectly flawless recording.

The work was first performed in the Church of St. Mark, Milan, on May 22nd, 1874, Verdi himself conducting. The date was the first anniversary of the death of Manzoni, in whose honour the Requiem Mass was composed. It is interesting to note at this stage that few musical works have such an interesting history. Verdi actually commenced the Requiem for the great Rossini, but owing to the failure of his original plans, which he formed for a Requiem Mass to be written by the leading Italian composers, no individual being singled out for the sole honour of writing it, in honour of Rossini, and incidentally, of Italy and her music, the project appears to have been dropped until 1873, when Alessandro Manzoni died. When Verdi had his original idea for a Requiem Mass to be written for Rossini, he contributed the "Libera Me," and with the passing of Manzoni, he decided to write the complete Requiem, thus arose the very unusual state of affairs, a Requiem Mass being commenced in honour of one great composer and finished for another. At Milan, the Mass was a great success, Verdi taking great care to select the orchestra of a hundred players; the chorus of one hundred and twenty voices, and the finest voices for the soloists which he felt were most suitable for a true interpretation of his great work. The Mass, however, did not call forth praise from every quarter, in fact, it is said that it received more criticism than any of Verdi's other works, but it is now recognised as a work of deepest sincerity, great inspiration, beauty and truth. The Mass takes the form of seven items. 1. Requiem and Kyrie. 2. Dies Irae. 3. Offertorio. 4. Sanctus. 5. Agnus Die. 6. Lux Aeterna, and 7. Libera Me.

The recording was made in the Royal Opera House, Rome, and conducted by Tullio Serafini, the following artists taking the vocal parts, in Latin: Maria Caniglia (Soprano); Ebe Stignani (Mezzo-soprano); Beniamino Gigli (Tenor); Ezio Pinza (Bass), and the Chorus and Orchestra of the Royal Opera House, Rome. The 10 records are supplied in Album No. 388, price 60s. plus 39s. 2d. tax.

In the 10in. series, I have only room for two H.M.V.s, the first of these being a topping recording by our old friends Anne Ziegler and Webster Booth. They have selected two songs from the film "Waltz Time," in which they appear, the titles being "Land Of Mine" and "You Will Return To Vienna." As one would expect, they sing these with all their usual charm and skill, and I, therefore, recommend *H.M.V. B*9432.

The other record is by Joe Loss and his Orchestra, its number being *H.M.V. BD*5896. For this, Joe and his Orchestra have recorded "I Don't Care If I Never Dream Again" and "I Wish I Knew," both good fox-trots, the vocals being taken by Harry Kaye.

Columbia

THE three 12in. records I have selected this month from the Columbia list, are all musical, and I think my choice will be welcomed by all. I start off with the Liverpool Philharmonic Orchestra, conducted by Maurice Miles, giving a fine performance of "The Merry Wives of Windsor," by Nicolai, on *Columbia DX*1201. To follow this, I recommend "London Fantasia," by Clive Richardson, *Columbia DX*1204, which is performed by the Columbia Light Symphony Orchestra, conducted by Charles Williams, with the composer at the piano. Both of these records are first-class, and will form welcome additions to the good music, without being too involved, sections of one's record library.

The third 12in. also calls for favourable comment. It is *Columbia DX*1203, on which The Palace Theatre (London) Orchestra, conducted by Richard Tauber, have recorded "Gay Rosalinda" (Fledermaus), by J. Strauss, arr. Korngold. This is a very enjoyable composition, and Richard Tauber and the Orchestra show great understanding in their presentation.

Albert Sandler and his Palm Court Orchestra, provide some ever-popular light music with their recording on *Columbia DB*2183. They have chosen a Selection from "Desert Song," which introduces "Romance"; "Song of the Brass Key"; "Desert Song"; "French Military Marching Song," and, of course, "One Alone." A nice recording for enjoyable light listening.

Frank Sinatra sings, in that inimitable style of his, "When Your Lover Has Gone" and "She's Funny That Way," on *Columbia DB*2186.

Victor Silvester and his Ballroom Orchestra offer a fine gay quickstep, "The More I See You," and an equally good fox-trot (slow), "Say It Isn't So," on *Columbia FB*3139. A good record for the dancers.

Lou Preager and his Orchestra, from the Palais de Danse, Hammersmith, have recorded "Sophisticated Lady" and "Saturday Night," both slow fox-trots, on *Columbia FB*3137. Two pleasing numbers, well orchestrated.

Parlophone

WE have had Richard Tauber with the baton, now we can hear him in his more usual rôle, as a singer with a tenor voice, the quality of which is too well known for me to add any words of praise. For his latest recording on *Parlophone RO*20540, he has selected "Au Revoir" and "The Night Has Known My Tears," two songs which he renders in English in a delightful manner.

For those requiring a little "hot" music, I recommend Harry James and his Orchestra playing "Crazy Rhythm" and "Blues In The Night," on *Parlophone R*2977. These two numbers form Nos. 31 and 32 of the 1945 Super Rhythm-Style Series.

Geraldo and his Orchestra have two good numbers on *Parlophone F*2087. They are "I Begged Her," vocal by Len Camber, and "Let Him Go—Let Him Tarry," with Carole Carr with Three Boys and a Girl taking the vocal. Both numbers are fox-trots, and presented in true Geraldo style.

The Organ, the Dance Band and Me, have recorded "The Little Things That Mean So Much" and "You're So Sweet To Remember," both fox-trots, on *Parlophone F*2089. Billy Thorburn at the piano, and H. Robinson Cleaver at the organ, make a good show with these numbers, and they are assisted by Primrose who takes the vocals.

Regal

THE one Regal is a 10in. and it has been recorded by Harry Leader and his Band from the Astoria Ballroom, London. They play two fox-trots, ideal for dancing, entitled "Chewing a Piece of Straw" and "Remember Me." The number of the record is *Regal MR*3763.

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).

Stations Identified

SIR,—In reply to Mr. Ealey's (Swindon) letter, July issue, I believe this station to be Buenos Aires as I have heard this name repeated several times at the end of the transmission, but unfortunately I cannot speak Spanish.

It may be of interest to readers to note that station CHOL carries transmission 2 of the Canadian International Short Wave Service now, on 11.72 mc/s. 25.6 m. in the evenings until 22.45 G.M.T.

Here also are a few of the stations I have not lately seen mentioned: A.F.N., 6.080 mc/s. (London); Valladolid (Spain) FETI, 7.070 mc/s.; TAP Ankara, 9.465 mc/s and 9.510 mc/s.; XGOY, 9.636 and XGOA, 9.720 mc/s.; 10.055 mc/s. SUV, Cairo. Rio de Janeiro PSH, 10.22 mc/s.; SBB2, Stockholm, 10.78 mc/s.; Braz FZI, 9.44 mc/s. India gives a complete schedule of their S.W. news broadcasts at 22.30 G.M.T., 05.00 I.S.T. on 25.51 m. and 31.15 m., also this is repeated at 03.00 G.M.T. in English on Sundays. Here is an extract giving times and wavelengths of their English broadcasts:

19.30 G.M.T., 31.15, 31.30, 41.15, 48.47 m.
03.30 G.M.T., 16.83, 19.55, 19.62, 19.74, 19.79, 25.27, 25.36, 31.30, 48.47 m.
05.30 G.M.T., 19.74 m.
09.30 G.M.T., 19.54, 19.62, 19.74, 25.27, 25.36, 41.15 m.
11.30 G.M.T., 16.83, 19.74, 25.45 m.
13.30 G.M.T., 19.79, 25.45, 25.51, 25.62, 31.30 m.
02.40 G.M.T. weekdays } 16.83, 19.54, 19.74, 19.79,
02.50 G.M.T. Sundays } 25.27 m.
Colonial News Letter, 12.20 G.M.T., Saturday, 19.79, 25.51 m.
Repeated Sundays, 02.40 G.M.T., 16.83, 19.54, 19.74, 19.79, 25.27 m.—M. EVANS (Chippenham).

Stations Heard

SIR,—Here are two corrections to my letter which you published in a recent issue:

(1) The station at San Francisco which I heard on 15.34 mc/s. 19.56 m. had the call sign KNBI, not KGEI as I stated there. KNBX is now operating on 21.61 mc/s. 13.88 m.

(2) All India Radio uses 31.15 m. and 31.28 m., not 31.28 m. and 31.36 m., for its broadcasts in the 9 mc/s. band.

I thank all those who have helped me with VONF, —A. H. B. BOWER (Hull).

The Northern Radio Club

SIR,—From August 1st, 1945, the Northern Radio Club holds meetings every Wednesday night, 6.30 to 9.30 p.m., at its new club premises: The Northern Radio Club, 16, Stratford Road, Heaton, Newcastle-on-Tyne.

Persons interested should attend meeting at above address or write Hon. Sec., 522, Denton Road, Newcastle-on-Tyne, 5.—ALAN ROBSON (Newcastle-on-Tyne).

J Calls

SIR,—I have just read in the August issue Mr. Goldberger's letter about J calls although these are used by British Forces Stations in M.E. The Americans always use them for their transmitters in the European theatre of operations, such as JEVA, etc. Although I have not logged many new stations this month I quote a few extracts. ODE Beirut 8,036 kc/s. 37.34 m. from 15.00-15.45 hrs. with English programme R6, Madrid 9,485 kc/s. 31.63 m. from 16.15-16.45 hrs., with news programme WQV 14,500 kc/s. 20.50 m., 20.30 hrs. calling JEET. This was the query by O. Greaves last month. WQV is an R.C.A. transmitter operated by C.B.S. New York and JEET is U.S. Forces transmitter in Germany. WWV still gives good reception on 15 megs. 20 m. with its standard frequency transmission. It may interest readers to know that JCJC on 7,220 kc/s. has moved up the band to 7,192.5 kc/s., and has been replaced by JCKW 7,220 kc/s. 41.55 m. power 7.5 kw. situated just near Jerusalem—B. HAYES (New Bradwell).

A.C. Mains S.W. Four

SIR,—Re my article entitled as above, and published in your August issue, and concluded in your September issue, several resistance values were printed, which should read as below:

R1—.5 *meg*ohm; R4—4 *meg*ohms; R11—1 *meg*ohm; R8—.5 *meg*ohm pot. (Values down to 150 k. should be tried here if L.F. instability is present.)—R. SHATWELL (Lancs).

Short-wave Four-valver

SIR,—A short while ago I constructed the "Four valve short-waver" as described in your May issue. The results I have had have been excellent.

Here is a list of some of the stations logged on a 15ft. indoor aerial:

WNRA, WRCA, WCBN, WLWO and WNBI in the 16 m.b.

CHTA, WCBX, WRUA, WOOC, WGEO, WLWO, WBOS, WNBI, Mortala on 19.79 m. and Leopoldville in the 19 m.b.

PRL8 Rio de Janeiro, WGEA, WCAC, WCBN, WOOW, WNBI and CHOL, Sackville, Canada, on 25.60 m. in the 25 m.b.

In the 31 m.b. Vatican City on 31.41 m., Brazzaville on 31.76 m., WNRA and the Voice of America in North Africa on 31.2 m. in the 31 m.b.

I have also heard the following Press stations: MCI and MCD, both in the 18 m.b.

I constructed the receiver on a chassis and I use no earth.—N. G. J. THOMPSON (Lee, S.E.12).

Switching Off

SIR,—It surprises me that there should be so much discussion on the subject of how leaving H.T. on valves can or cannot harm them, when it is so easily summed up.

It cannot do them any harm during the period that they are off.

It does, however, cause harm while the cathodes (filaments) are warming up or cooling down, tending to ruin the emission.

The time taken, however, in this cooling or warming process is, with filaments, so quick that the effect is small, and with cathodes they are strong enough to "stand up to it."—K. GROSVENOR (Walsall).

Esperanto

SIR,—May I comment on your article "Universal Language" in the current P.W.

You agree that a common tongue is desirable, and give good reasons for this. Nevertheless, Esperanto, which is the only practical solution, and moreover an altogether admirable solution of the problem, you dismiss by statement or criticism. Why?

You speak of Esperanto as "an ill-fated attempt," and say that "those nations who approved of Esperanto failed to persuade their people to adopt it." No Esperantist has ever advocated Esperanto as a

(*Continued on page* 524)

"universal" language, to replace the mother-tongue: but only as a second or auxiliary language. For 60 years it has grown in spite of all attacks of prejudice and ignorance, till now it is in world-wide use. It has never failed in any test to which it has been put. It is today stronger than ever, though in countries where Hitler ruled he endeavoured to suppress it.

[*How many use it out of the world's population?*—Ed.]

I cannot accept your statement that a standard international language is not only unacceptable but impossible. I have spoken it for 40 years with people from a hundred nations. The existence and growth of Esperanto is a fact that demolishes any such theoretical objection. In point of fact it is spoken and used the same way all over the globe. And any argument that a thing is impossible becomes futile when confronted with the fact that the impossible thing is very much alive.

I agree with you that other countries would object to adopting a national language, providing world-wide propaganda for a particular country. That is one of the reasons why no national-language solution is satisfactory. Nor will the Englishman nor the foreigner have anything to do with any of the highly artificial and still-born schemes for mutilating English spelling and grammar according to the whim of some would-be improver of English. As one who loves English, I cry "Hands off!" But in Esperanto we have a language that is neutral, Eastern in grammar and Western in vocabulary—the living language of a living people, with a vast and growing literature of its own—one in which hundreds of thousands of people think and pray and make love, and joke and sing and do anything and everything for which language is needed. It was the first and home language of my children. To suggest that it must be "colourless as a mathematical formula" is to show complete ignorance of the facts. And why should a language be colourless because it is in universal use? English is fairly universal—yet colourless?—M. C. Butler (Kingston).

"Quest for Quality"

SIR,—The article "The Quest for Quality" in the September issue of Practical Wireless is, to me, one of genuine interest and common sense. Since reading it the second time, I am tempted to add to it.

In a sense, I think this is something I am qualified to do because about half my life of 50 years has been devoted solely to music and the other half principally to amplification although in this latter half, music has had a prominant place as a hobby.

A lot of my work now is as a tutor for musical appreciation and, of course, for this work I use records (radio also, sometimes) to a very large extent.

Personally I think it is high time that considerably more attention was given to the question of quality and I am convinced there is an ever increasing number of people who would genuinely appreciate something considerably better than the usual reproduction.

Whilst reading the article, I made three notes:

(1) I certainly say "why worry about distortion from a technical point of view." There is always a lot of distortion present in the best of actual performances.

(2) Tone quality is only one aspect of music and not, by any means, all important.

(3) What I have always wanted in reproduction is complete control, not only of volume but of balance also. I freely admit that what suits me may be distorted from a technical point of view, but as I am the one concerned, this just does not matter.

This would appear to be a flat contradiction to what I have previously said. I mean it in the sense that reproduced music has given us a completely different set of tone colours and tone shades, in the sense that a great artist would still be a great artist if he played on a cheap instrument, i.e., it is the interpretation, the mind of the performer that really counts. But of course, this argument cannot be used as an excuse for poor reproduction any more than it can be used as an excuse for an artist to use an inferior instrument. In every aspect of music only the best is good enough.

I think the writer of the article has struck the fundamental note in his paragraphs on the loud speaker. I have proved, to my satisfaction, that the speaker is by far the weakest link in the chain.

It seems incredible to me that one paper cone can be expected to reproduce faithfully the terrifically complicated vibrations necessary to cover all the tones and frequencies of an orchestra. It is one of the wonders of the world that any one speaker can give results that even resemble an orchestra. In actual instruments, no attempt is made to cover even the whole of the audio frequency band, let alone any combination of instruments.

It was this thought that prompted me to make the equipment I am using at present, an equipment which, although leaving a lot to be desired and only carrying my ideas out to a certain degree, is giving me considerably more satisfaction than anything I have had before.

I use a three channel amplifier and three speakers, one for the top, one for the middle and one for the bass response, and I have complete volume control over each speaker. Whereas there is no sharp cut-off for any speaker response, I have done what I can, both to speakers and amplifiers, to keep them to their respective frequency bands.

The improvement on complicated music, i.e., orchestral etc., is very noticeable and proves beyond doubt that a speaker, coping with only a third of the audio range, can make a much better job of it than when expected to cope with all audio frequencies.

On the other hand, if any reader should care to hear the equipment, I shall be very pleased to arrange for him to do so.

I would like to suggest that Practical Wireless asks for the opinions of competent music lovers who have some knowledge of the difficulties of reproduction, regarding the question of quality. I believe much practical good would result.—G. M. (Dorchester).

Lourenço Marques

SIR,—The latest copy of your magazine to hand is that for April, 1945, and I notice that one of your readers (John A. S. Watson) has reported in his letter reception of Lourenço Marques Radio, CR7BE. As I have never received this station myself whilst in England, I took the trouble to find out some details of the station while we are visiting here.

The wavelengths, frequencies and call signs in use at present are:—

19.63 m., 15,285 kc/s, CR7BG; 51.20 m., 5,859 kc/s, CR7AA; 19.68 m., 15,240 kc/s, CR7BD; 60.91 m., 4,925 kc/s, CR7Bu; 30.50 m., 9.837 kc/s, CR7BE; 85.96 m., 3,490 kc/s, CR7AB; 31.10 m., 9.645 kc/s, CR7BJ; 395.00 m., 759 kc/s, CR7BK.

The scheduled times of operation, at least until the end of September, 1945, are:—

Weekdays: 05.00-07.00 and 09.30-11.45 on 19.68, 31.10, 51.20, 395 m. 16.45-20.30 on 51.20, 85.96 and 395 m.

Sundays: 09.00-12.00 on 30.50, 31.10, 51.20, 85.96, 395 m. 15.00-19.00, two separate programmes, one on 30.50, 85.96 and 395 m., and the other on 19.68 and 51.20 m.

These transmissions are intended mainly for the Colony of Moçambique. For foreign reception the transmitter on 30.50 m. is in use weekdays only from 18.25-20.30.

All these times are G.M.T., and the local time here is two hours ahead of G.M.T.

News transmissions in English are given on weekdays at 05.50, 17.10 and 19.50, and on Sundays at 10.25, and are preceded by news in Portuguese. Most of the programmes are announced in English as well as in Portuguese, and station identification is usually made every quarter-hour. Incidentally, the correct name of the station appears to be "Radio Clube de Moçambique."

I hope perhaps this information may be of interest to other readers. Assuring you of my continued interest in your magazine.—CHARLES CALL (Radio Officer, M.N., Lourenço Marques).

British Forces Stations

SIR,—In the issue of PRACTICAL WIRELESS for June, 1945, which has only just reached me, I am interested in the letter from Mr. B. P. Ceallaigh, of Dublin. He asks for identification of a station heard last summer on 47.8 m. with a test transmission of a South African nature giving the call sign "JJFH" in English and Afrikaans.

I am informed by my colleagues of the UDF that this was their UDF Army Broadcasting Station testing from Rome, on a power then of 1½ kW. The station has been n operation ever since on an increased power of about 2 kW., and has latterly been radiating on a medium frequency as well as the short wave.

This station is now ceasing transmission in Italy, and programmes for South African troops are to be radiated from the British Forces Broadcasting station, Rome.

I attach a list of the locations and frequencies of the British Forces stations operated in Italy and Southern Austria by the Army Broadcasting Service. I should be very interested to hear from any of your readers who may at any time pick up any of our transmissions.

Bari, 1,249 kc/s; Naples, 1,204 kc/s; Rome, 1,483 kc/s; Udine, 868 kc/s; Klagenfurt, 863 kc/s; Riccione, 1,285; Milan, 1,420 kc/s. All these stations are under 500 watts, with the exception of Klagenfurt, which is just over 1 kW.—P. B. P. Slessor, Lt.-Col., Chief Broadcasting Officer, The Army Broadcasting Service (Allied Force Headquarters).

Output Transformers

SIR,—As a quality-enthusiast, I have greatly appreciated your recent articles on same. Although I know advertising space costs money, I should like to point out to your trade advertisers who include output transformers in their columns, the desirability of giving the *actual* matching impedance of both input and output windings (see, for example, Messrs. Webb's radio advertisement August issue), and *not* merely classing them as "Universals," which conveys nothing to anybody!—F. C. CRITCHLEY (R.E.M.E.).

Greek S.W. Stations

SIR,—An extract from a letter recently received from K. Karayannis and Co. in Athens, Greece, may interest other readers. The letter reads as follows:—

"There are *no* short-wave stations working in Greece at present besides the military and public service ones. On medium wave the Athens broadcasting station is working on 602 kc/s, but instead of its initial power of 15 kW. it is now working only on 3 kW., due to damage done to same by the retreating Germans, especially to the masts supporting the antenna."

Although SVM on 30.20 m. 9.935 kc/s, has been heard here, I suppose this comes under the "public service" heading. If any member wishes to exchange S.W.L. cards, I guarantee 100 per cent. replies.—JACK COOPER (Peacehaven).

Log Corrections

SIR,—I would like to make a correction to my log published in the September issue, with regard to the Paraguayan transmitters. The call-signs of these are ZPA5 and ZPA3 and not ZP15 and ZP13 as given. The confusion arises from difficulties with the Spanish language. Further additions to the log of Latin American transmissions are as follows:

Argentina: LRA5 Buenos Aires, 17.72 Mc/s. transmits every Friday, commencing at 21.00 G.M.T. with a programme in English. Is usually a fair signal.

LRA1 Buenos Aires, 9.69 Mc/s., usually heard at R5, QSA4-5 by 23.00 G.M.T.

LRA Buenos Aires, 6.09 Mc/s. (approx.) has been received at R6, QSA5 at 23.30 G.M.T. These last two transmitters work in conjunction with the call LRA/LRA1.

Brazil: Another powerful Brazilian TX is operating in the 31 m. band with the call ZXY8 on 9.61 Mc/s. Is believed to be located at Rio de Janeiro. Received at R8, QSA5 after 23.00 G.M.T. PRE9 Fortaleza has changed frequency and is now working on 6.105 Mc/s. Usually heard at R5-R7, QSA4-5.

Both ZXY8 and PRE9 space their announcements and items with 4 ascending chimes.

PRA8 Pernambuco, 6.015 Mc/s. has been heard at R6, QSA4-5 at 00.00 (Midnight) G.M.T.

PRI, location unknown, on 6.00 Mc/s. (approx.) appears to be a new TX. Heard at R4-5, QSA4 at 00.45 G.M.T.

Another unknown Brazilian is working on about 6.095 Mc/s. and is generally a good signal at R6, QSA5 by 23.00 G.M.T.

On the 62 m. band a station logged as PR?4 (probably PRJ4) is usually well received, even as early as 21.30 G.M.T., when it has been heard at R7-8, QSA5. Frequency is about 4.82 Mc/s.

Chile: CB1180 Santiago, 11.99 Mc/s. relays the medium-wave CB75.

CB1185 Santiago, 11.85 Mc/s. relays the medium-wave CB138. Announces as "Radio El Mercurio." Both these are heard usually at R6-7, QSA5 by 23.00 G.M.T. Calls are given each half hour, preceded by a gong.

CB970 Valparaiso, 9.73 Mc/s. can sometimes be identified, but suffers from several varieties of QRM and is never clearer than QSA3.

Uruguay: CXA19 Montevideo, 11.71 Mc/s. is the outstanding signal from Uruguay at the moment, being R7, QSA5 by 22.00 G.M.T. Items and announcements are spaced by a trumpet fanfare.

Columbia: HJCX Bogotá, 6.018 Mc/s. is well received at R5-6, QSA5 by 00.00 G.M.T.

Panama: HP5A Panama City, 11.70 Mc/s. has been heard at fair strength, R4, QSA4 at 00.00 G.M.T.

Cuba: COCY Havana, 11.735 Mc/s. gives the English announcement "This is Radio-Havana Cuba," but gives no call-sign. Usually heard at R4-5, QSA4 by 23.00 G.M.T.

Referring back to the Paraguayan TXs, ZPA5, 11.95 Mc/s. is located at Encarnación and ZPA3, 11.855 Mc/s. is located at Asunçion.

Haiti: HH3W Port-au-Prince is working on a new frequency of 10.105 Mc/s. and is very well received at R7-8, QSA5 by 23.30. Most announcements are in French.

Canada is now operating a new transmitter CHOL on 11.72 Mc/s. CKXA, 11.705 Mc/s. is not being used now, presumably to avoid QRM from CXA19, which is now heard in the clear.

KGEX San Francisco, 11.79 Mc/s. has been heard at odd occasions at 08.30 G.M.T., with a programme directed to the Philippine Islands, at R4-5, QSA4. This is noticeable interference from ionospheric effects.

XGOY Chungking, 9.81 Mc/s. is usually well received in the late afternoon—R5, QSA5 at 15.30 G.M.T.

RX here is a 1-V-1, with reception on phones. Antenna is a 50ft. double wire inverted L, 25ft. high at far end, running E.-W.

In conclusion, I would like to express my appreciation of your correspondence columns as a source of information on S.W. transmissions—one of the few remaining sources for keeping check on the ever-changing conditions.—G. ELLIOTT (Gosport).

4-valve Amplifier

SIR,—Some time ago I built a 4-valve amplifier consisting of the following valves: 6K7G first stage, 6K7G second stage and two 6V6G in push-pull as output; the circuit itself is a copy of a 30 watt amplifier published in PRACTICAL WIRELESS of February, 1944. I have, you will notice, used different valves to those in the original circuit as I could not obtain those particular types. The results I got were very good for both mike (carbon) and pickup, also for relaying wireless programmes, but this is the astonishing thing. It happened by chance. While the amplifier was in working order and not reproducing any given signal music could be heard faintly in the loudspeaker. I knew that it was coming over the air, as it were, but how it was being picked up in the amplifier I could not make out. When I placed a 20ft. length of wire to the grid of the first valve the signal was loud enough for any average sized room, and the reproduction was as if the instruments were actually in the same room as the loudspeaker. The station was Klagenfurt broadcasting in German. The power supply is off the mains through a transformer and rectifier. I was wondering whether the station is supplied off the town's mains and the amplifier picking it up that way, but I don't think that is likely. Could you inform me how this "freak" of radio has come about? I have also built a 4-valve receiver for short waves, but the first stage has got me rather puzzled. The valves used are: First stage 6K8G, second 6K7G, third stage 6B8G and output 6V6G. All I can get in the speaker is a very loud background noise and no signals. I have traced it to the first and second stages but I can't quite fathom out the symptoms. Would it be possible to supply a suitable circuit for these two stages or a whole circuit for the four, as radio out here is hard to get and one gets rather bored? I have looked through all the PRACTICAL WIRELESS books I have out here but can't find anything suitable for my particular requirements.—J. ALLEN (C.M.F.).

Condenser as Resistor

SIR,—As a former electrical engineer with some experience of transient conditions in A.C. circuits, I cannot let the statement in Mr. R. C. L. Baker's letter in the October issue pass unchallenged. Let me reassure your readers that nothing in the region of 6.5 amps. will flow through their valves when using a condenser "dropper" in the circuit condition mentioned.

There is a serious fallacy in Mr. Baker's arguments. He states correctly that the voltage across a condenser is $\frac{I}{\omega C}$ and then proceeds to substitute a value of zero for I, while three lines further on he is claiming that in the same instant (the instant of closing the circuit) a current of 6.5 amps. is flowing! He can't have his cake and eat it.

Oscillograph records taken on circuits using current limiting reactors (which is the function of the condenser in this instance) show that the peak current obtained under conditions of maximum assymetry is obtained when the circuit is closed at the instant of a voltage zero, not a voltage peak, and has a value of approximately 1.8 times the peak value of current when the circuit has settled down, in this case about 0.6 amps. This current is not sufficient nor of sufficient duration to injure the valves. Incidentally, it is nothing like as severe as the making current in the ordinary light bulb, which usually passes 9 or 10 times its normal current at the moment of switching on.

By accident and subsequent experiment I have found the one condition known to me when serious overcurrent is likely to occur. This is a prolonged arc such as may be obtained with a faulty plug, etc. The effect is due to the higher harmonics generated in the arc, to which the condenser offers low impedance.

If any of your readers are interested I shall be glad to go further into the conditions pertaining to the use of current limiting reactors and A.C. theory. I shall be pleased to receive any correspondence on this subject.

I have been using a series condenser in one of my sets for some time without any detrimental effects on the valves. Fuse bulbs are, of course, fitted to guard against a possible breakdown of the condenser. These bulbs also serve as pilot and dial lights and H.T. fuses, so they are not an extravagance.—A. G. HUDSON (Birmingham).

SIR,—In your August issue you published a criticism by Mr. Baker of an article on the subject of a voltage-dropping condenser.

While I agree with much of what Mr. Baker says, I do not agree with his last paragraph, in which he advises us to "stick to a dropping resistor" because "the very definite surge of current and voltage at the moment of switching on" is injurious to the valves.

If we use a normal dropping resistor, its resistance, like that of the valve heaters, will increase with time, but even if it remains constant at its maximum value, it will still cause a larger initial current than will a condenser, as shown below.

From Mr. Baker's figures, heater resistance is 229.6 ohms and total resistance is to be 766.6 ohms. Therefore the dropping resistor should be 537 ohms. Assuming that on switching on the heaters have no resistance, as does Mr. Baker, this would cause an initial current of .428 amps., as compared with the .3146 amps. he obtained for the condenser.

But in any case, what makes Mr. Baker think that these current and voltage surges will damage the valves?

Firstly, the voltage surge is across the condenser and, provided this is correctly chosen, will cause no damage to condenser or heaters.

Secondly, the current surge is of no more harm for the following reason. The cause of a breakdown in any filament is due to an excess of power, which causes the wire to melt and hence break.

By Mr. Baker's own argument, we see that the excess current is due to the "negligible resistance" of the valve heaters. Now the power dissipated is C^2R, so that this also is negligible due to the factor R, which is the resistance of the heaters. As R increases from zero, the wattage dissipated by the heaters increases, but the current falls. By a simple differentiation it can be shown that the maximum power is developed when R is a maximum.

In conclusion, I would point out that the advantages of a condenser are its cheapness and reliability, while its disadvantages are its bulk and the fact that it makes an A.C./D.C. set into an A.C. set, which is not always desirable.—F. B. TAYLOR (Altrincham).

D.C. Test Instrument and Meter Switching

SIR,—I picked up the May issue of PRACTICAL WIRELESS in the mess to-day—and before going further may I say how grateful we are for this regular contribution, which is supplied free to His Majesty's Forces.

In this issue there are two slips. On page 252 in the article on a "D.C. Multi-Range Test Instrument," I think you will agree that you would have the greatest difficulty in obtaining a reading on the 0-1 m/A switch position, as the meter is short-circuited.

In the article on "Meter Switching," on page 255, Mr. R. A. Bottomley informs us that his 0-5 m/A meter has an ohms per volt rating of 20, when it really is 200 ohms/volt. The series resistance to measure 500 volts would be 100,000 ohms and not 10,000 ohms.

The meter plus resistance would only consume 3 m/A when measuring 300 volts and not 30 m/A, so the wattage rating of the resistance need only be 1.—R. S. WOOD (R.A.F.).

Jazz

SIR,—I am not a musician nor a writer, but an ordinary listener, and I am in complete agreement with "Thermion," "Torch," Mr. Hardman, and those correspondents who have been keen enough to express their views on the objectionable jazz noises.

Presumably the B.B.C. supplies what is considered a demand, and which seems a fairly large one. If this is so, it is with disgust and disappointment that one may then ask oneself are the programmes really the result of the demands of the majority of British listeners?

The Editor has asked this question, and "Torch" has expressed our views very definitely.

With reference to Mr. Gowling's remarks, for a while I thought PRACTICAL WIRELESS was getting too technical for me at least, but it is fair, and I think, caters for all types of reader.—M. K. HUGGARD (Blackrock).

RADIOSALES

BCM/SALES, LONDON, W.C.1.

Full list 1d. S.A.E.

SPEAKERS.—2½in. Celestion, **30/-**. Rola, 5in., **25/-**. 3½in. Goodman, 3 ohm, **30/-**. All less trans. Celestion, 6½in., **28/6**; 8in. Rola, **28/6** with trans.

TRANSFORMERS.—350 v., 6 v., 5 v., 80 m.a, or 350 v., 4 v., 4 v., 80 m.a. 230 v. input, **35/-**. Midget pen output, **6/6**. Standard pen output, **7/6**.

CHOKES.—L.F. midget, 15 hy., 60 m.a., **7/6**.

DROPPERS.—.3 amp., 750 ohm, **5/6**; .2 amp., 1,000 ohm., **4/6**. Both with sliders and feet.

COILS.—MW, HF & Det., pairs **4/6**; Osc. MW 465 kc., **2/3**.

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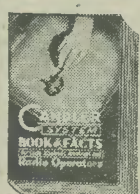

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Battery All-Wave Three (D, 2 LF (RC)) — PW55*
The Monitor (HF Pen, D, Pen) — PW61*
The Tutor Three (HF Pen, D, Pen) — PW62
The Centaur Three (SG, D, P) — PW64*
The "Colt" All-Wave Three (D, 2 LF (RC & Trans)) — PW72*
The "Rapide" Straight 3 (D, 2 LF (RC & Trans)) — PW82*
F. J. Camm's Oracle All-Wave Three (HF, Det, Pen) — PW78*
1938 "Triband" All-Wave Three (HF, Pen, D, Pen) — PW84*
F. J. Camm's "Sprite" Three (HF Pen, D, Tet) — PW87*
The "Hurricane" All-Wave Three (SGD, (Pen), Pen) — PW89*
F. J. Camm's "Push-Button" Three (HF Pen, D (Pen), Tet) — PW92*

Four-valve : Blueprints, 1s. each.

Beta Universal Four (SG, D, LF, Cl. B) — PW17*
Nucleon Class B Four (SG, D (SG), LF, Cl. B) — PW34B*
Fury Four Super (SG, SG, D, Pen) — PW34C*
Battery Hall-Mark 4 (HF, Pen, D, Push-Pull) — PW46*
"Acme" All-Wave 4 (HF Pen, D (Pen), LF, Cl. B) — PW83*
The "Admiral" Four (HF Pen, HF Pen, D, Pen (RC)) — PW90*
F. J. Camm's "Limit" All-Wave Four (HF Pen, D, LF, P) — PW67*

Mains Operated

Two-valve : Blueprints, 1s. each.

A.C. Twin (D (Pen), Pen) — PW18*
Selectone A.C. Radiogram Two (D, Pow) — PW19*

Three-valve : Blueprints, 1s. each.

Double-Diode-Triode Three (HF Pen, DDT, Pen) — PW23*
D.C. Ace (SG, D, Pen) — PW25*
A.C. Three (SG, D, Pen) — PW29*
A.C. Leader (HF Pen, D, Pow) — PW35C*
D.C. Premier (HF Pen, D, Pen) — PW35B*
Unique (HF Pen, D, Pen), Pen) — PW36A*
F. J. Camm's A.C. All-Wave Silver Souvenir Three (HF Pen, D, Pen) — PW50*
"All-Wave" A.C. Three (D, 2 LF (RC)) — PW54*
A.C. 1936 Sonotone (HF Pen, HF Pen, Westector, Pen) — PW56*
Mains Record All-Wave 3 (HF Pen, D, Pen) — PW70*

Four-valve : Blueprints, 1s. each.

A.C. Fury Four (SG, SG, D, Pen) — PW20*
A.C. Fury Four Super (SG, SG, D, Pen) — PW34D
A.C. Hall-Mark (HF Pen, D, Push-Pull) — PW45*
Universal Hall-Mark (HF Pen, D, Push-Pull) — PW47*

SUPERHETS

Battery Sets : Blueprints, 1s. each.

£5 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
"Qualtone" Universal Four — PW73*

SHORT-WAVE SETS. Battery Operated

One-valve : Blueprint, 1s.

Simple S.W. One-valver — PW86*

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

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Parvo Flyweight Midget Portable (SG, D, Pen) — PW77*

Four-valve : Blueprint, 1s.

"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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Lucerne Tuning Coil for A.W.427*, 6d.
1934 Crystal Set — AW444
150-mile Crystal Set — AW450*

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B.B.C. Special One-valver — AW387*

Two-valve : Blueprints, 1s. each.

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Full-volume Two (SG det, Pen) — AW392*
A modern Two-valver — WM409*

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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*
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"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*
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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

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Consoelectric Two (D, Pen) A.C. — AW403*
Economy A.C. Two (D, Trans) A.C. — WM286

Three-valve : Blueprints, 1s. each.

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Mantovani A.C. Three (HF, Pen, D, Pen) — WM374*
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SPECIAL NOTICE

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

The index letters which precede the Blueprint Number indicate 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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Heptode Super Three A.C. — WM359*

PORTABLES

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Rousa Short-Waver — AW452*

Two-valve : Blueprints, 1s. each.

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Home-made Coil Two (D, Pen) — AW440

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MISCELLANEOUS

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Harris Electrogram battery amplifier (1/-) — WM399*
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New Style Short-wave Adapter (1/-) — WM388
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