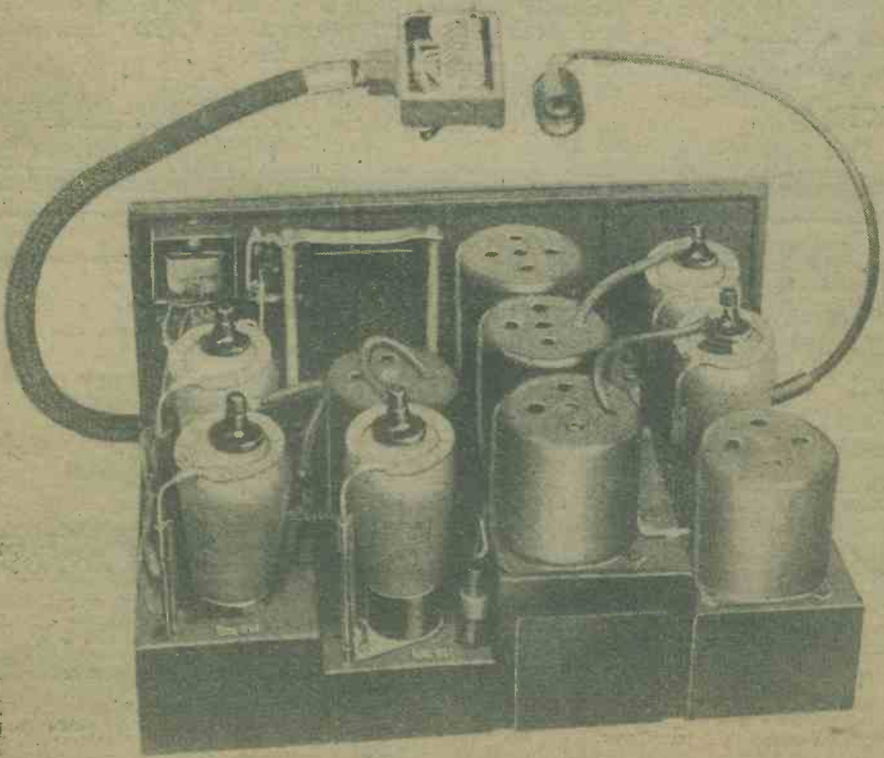
A VIBRATORY H.T. UNIT

Practical Wireless 9D EVERY MONTH

Editor F. J. CAMM

Vol. 18. No. 434. NEW SERIES. AUGUST, 1942

LUFTWAFFE RADIO



The superhet receiver which forms part of the radio installation of the Messerschmitt M.E.109

Practical Wireless
and PRACTICAL TELEVISION
EVERY MONTH
Vol. XVIII. No. 434. AUGUST, 1942.
Editor F. J. CAMM
Staff: L. O. SPARKS. FRANK PRESTON.

COMMENTS OF THE MONTH BY THE EDITOR

"Serious Error of Judgment"

THE B.B.C. issued a statement in reference to Lord Wedgwood's much criticised broadcast to the United States in which he appealed to them to take over the Palestine Mandate from Britain. They stated that this broadcast was not arranged by the B.B.C., but all material, whether under B.B.C. auspices or not, which leaves Broadcasting House is subject to certain censorship regulations for which the B.B.C. is responsible. In this instance, owing to a serious error of judgment on the part of the official whose duty it was to scrutinise the script the regulations were not properly interpreted.

This speech was put on the air by the B.B.C. on behalf of the Mutual Broadcasting System. It was vetted for security purposes, but neither the Foreign Office nor the Colonial Office knew of its contents in advance, which they were supposed to do in compliance with B.B.C. rules.

Now it seems to us that altogether too much fuss was made of this particular broadcast. The B.B.C. is in the same position as the editor of a newspaper or periodical, every one of which publishes matter in every issue which does not meet with the approval of all of its readers. Sometimes the majority of the readers disapprove. The B.B.C. is not asked to make itself responsible for people's views. Many broadcasts have been unpopular, and the B.B.C. would be the last to give rise to the impression that it only broadcasts harmless matter and suppresses anything which is contrary to its own views. Danger lies that way.

Someone must have considered that this speech was worthy of a wider audience than at the lunch where it was originally made. Apparently now it is thought either that the speech should have been considerably emended or not broadcast at all. The B.B.C., like an editor, publishes or broadcasts matter but does not necessarily subscribe to the views of the author. We do not think that the B.B.C. should place itself in the position of the hallmarker of a man's views, and it should give equal programme time to the popular and the unpopular. A subject may not be found unpopular until it is broadcast, and conversely what is considered popular may prove unpopular.

The B.B.C. should be impartial, and leave the public to judge.

Valve Prices

THE British Radio Valve Manufacturers' Association point out that the Association prices include carriage and packing, and that any charge thereafter for packing and postage in excess of that actually incurred is a breach of the Association's regulations. Readers are asked to get in touch with the British Radio Valve Manufacturers' Association, 59, Russell Square, London, W.C.1, if they have evidence that dealers are offering for sale valves at excessive prices.

Advertisements containing offers of valves at these extortionate prices have been appearing in some of the daily papers.

Unfortunately, there is a black market in radio as in most other commodities; and there are those who will charge extortionate prices, knowing there is a shortage of components and that the public will pay heavily, if necessary, to get what it wants. The public has the remedy in its own hands. It should refuse to pay above the controlled prices, and report cases of overcharging. Whilst people are willing to pay, and unwilling to report, there will remain unscrupulous dealers to ply their nefarious trade. The valve shortage particularly is being exploited in this way.

British Standards Institution

THE Institution has received a communication from the Minister of Production to the effect that His Majesty's Government recognise the British Standards Institution as the sole organisation for the issue, in consultation with any Government, professional or industrial bodies concerned, of standards having a national application.

In regard to the preparation and issue of codes of practice for building and civil engineering work the Minister of Works and Buildings is making arrangements by the appointment of a representative committee with which the B.S.I. is fully co-operating.

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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.

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

"Wire and Wire Gauges"

A COMPANION to our "Radio Engineer's Vest Pocket Book" (3s. 6d., by post 3s. 9d.) is "Wire and Wire Gauges," obtainable at the same price. This new vest pocket book contains every known wire gauge, as well as the physical properties of wires. There is also a useful section on wire ropes, including details of splicing.

Pen Pals

THERE are many prisoners of war who appeal for pen pals in this country. The Post Office authorities, however, discourage the practice, which not only delays regular letters between the relatives of prisoners, but gives the enemy so much trouble that there is a danger of the letters being delayed, even if they are delivered at all. Correspondence to prisoners of war should be confined to relatives. We, of course, sympathise with prisoners of war, who naturally wish to continue to correspond with their friends having similar interests at home, and we feel certain they will understand our rule that in no circumstances can we print requests for pen pals.

ROUND THE WORLD OF WIRELESS

Rattlesnake on the Air

THE B.B.C. has a little-known but important Facilities Unit which acts as a channel between all the various departments of the Corporation and such important outside bodies as the Admiralty, the War Office, the Air Ministry and many more. Such a department naturally takes pride in going beyond its strict terms of reference, and the other day it achieved the feat of providing, at 24 hours' notice, a live rattlesnake to take its part in a programme arranged by one of the Regional producers.

Broadcast Messages from Allied Nationals

PERSONAL messages from Allied nationals in Britain are broadcast regularly to relatives in Europe in French, Dutch, Belgian, Flemish, Danish, Greek, and Serbo-Croat.

Radio Orchestra Disbands

THE B.B.C. announce that changing war conditions have necessitated the disbanding, "not without regret," of the Salon Orchestra, which was formed by Mr. Leslie Bridgewater.

They Listen to London

ACCORDING to the German-controlled Stavanger radio, hundreds of thousands of Norwegians still listen to London broadcasts three times a day.

German Radio Official Killed

GERMAN radio recently announced the death in action of Horst Duering, head of the German radio news service, who volunteered for the Eastern Front last autumn.

U.S. Broadcasts to South Africa

ACCORDING to a recent announcement, the United States have commenced bilingual broadcasting to South Africa.

Swedes Listen to B.B.C. Broadcasts

A REPORT from Stockholm announces that a recent Gallup Survey taken in Sweden discloses the fact that 10 per cent. of Swedes listening to foreign broadcasts listen only to London, 3 per cent. only to Germany. 2 per cent. only to Russia, and 68.4 per cent. do not listen to any of these. Twelve per cent. listen to both England and Germany, 1 per cent. to England and Russia and 4 per cent. to Germany and Russia.

Apart from these listed figures many more Swedes listen to the Norwegian programme from London.

S.R.R.A. and Standardisation

AT a meeting at Edinburgh recently, the council of the Scottish Radio Retailers' Association discussed a letter from the British Institute of Radio Engineers dealing with standardisation. It was pointed out that questions asked in the House of Commons were the direct result of S.R.R.A. representations. The invitation to form an education committee was further considered. The secretary reported a slow response to the scheme for pooling surplus valves.

A.T.S. Girls Repair Radio Sets

A.T.S. girls are being trained as wireless mechanics at a school in S.E. Command. When they qualify they will be the first women wireless mechanics in the history of the Army. None of the girls has any previous experience of this type of work, but they have proved themselves very adept at taking down, mending and reassembling wireless sets. (See illustration on this page.)

Million Sets Idle

IT is reported that a million wireless sets are out of use in this country at the present time. This is one set in eight, and the number is growing. Because of the number of wireless engineers who are being taken into the Services, repairs never catch up with breakdowns.

An A.T.S. girl, who was formerly a Civil Servant, repairing a wireless set.

The Board of Trade has given permission for the completion by next spring of 125,000 sets in course of production, provided labour is available. The introduction of a utility set is out of the question at present.

B.B.C. News in 23 Languages

THE B.B.C. broadcast the news of the Anglo-Russian Treaty in 23 languages (124 transmissions) in its European service.

French Listener to B.B.C. Fined

A REPORT from Vichy states that a Frenchman at Le Blanc, in the department of Indre, has been fined 500 francs, and has had his wireless set confiscated, for listening to the British radio. He is the first Frenchman to be punished for this offence.

A.T.C. Boys Learning Telegraphy

FORMER Post Office morse operators are teaching telegraphy to A.T.C. boys.

Executed for Listening to B.B.C.

THE Mulhouse *Tageblatt*, one of the Nazi papers published in Alsace-Lorraine, reveals that the 14 "Communists" recently executed at Mannheim were executed "for listening to the B.B.C., printing the B.B.C. news, and distributing it."

Radio Aids Airmen's Rescue

LESS than 24 hours after making a forced landing 150 miles away out in the Atlantic, the crew of a Whitley aircraft of Coastal Command were brought safely to a West Coast port. Considering the distance of the crew from land, this was one of the speediest sea rescues of the war; it was only made possible by the careful wireless check which is kept on all aircraft when they are on patrol. The Whitley was more than 300 miles from land when the port engine "packed up." An S O S was sent. It was picked up at base, and constant wireless touch was kept with the aircraft.

"Losing Height Slowly"

"Can you maintain height?" the pilot was asked. He replied that he was not sure. But by nursing his remaining engine carefully he made his way steadily towards land. About half-way home the starboard engine gave trouble. The pilot again wirelessed his position and added, "Losing height slowly. Abandoning aircraft in five minutes."

Other aircraft of the same squadron were already on their way to look for the Whitley. They were to keep a special watch for the airmen in their dinghy. In less than two hours the dinghy was sighted—a tiny speck on the expanse of ocean. A merchant ship was guided to the spot and the airmen picked up. Only one of them was so much as wet. When he jumped from the sinking aircraft he had missed the dinghy and fallen into the sea!

Portable Radio for U.S. Troops

THE U.S. War Department announce that a portable radio and gramophone kit with 50 records, 25 half-hour radio broadcast transcriptions, a collection of song books, harmonicas, and novels have been selected for the use of U.S. troops overseas.

Amateur Training in America

DESPITE the fact that 15,000 of the most active amateur radio operators are on naval and military communications duty, the American Radio Relay League is providing training for American youths who will shortly be eligible for national service. The courses aim at qualification for the amateur Class B licence, and it is interesting to record that no one may enlist in the Signal Corps unless he holds an amateur or commercial licence. In the U.S. Navy the rating of radioman, second class, is offered to holders of amateur Class B licences.

Radio Industries Club

AT the recent annual general meeting of the Radio Industries Club it was revealed that the membership had increased during the year by 43 per cent. Major V. Z. de Ferranti was elected president for the ensuing year.

Challenge to the B.B.C.

THE B.B.C. "can take it"—and give it, as the following airgraph letter, subsequently broadcast to the Forces in the Middle East with its sequel, shows.

"Dear B.B.C.—Just a line from three of the M.E.F. After almost drinking ourselves to death to get profits for the purpose of buying a wireless, we find to our dismay that your programmes as broadcast in the African Service hardly warranted our efforts. We appreciate all that you are doing for us lads out here, but we honestly think that your programmes could be a little more cheerful. What's happened to such 'stars' as 'Bing,' Jeanette McDonald, Nelson Eddy, Deanna Durbin, Judy Garland, Paul Robeson, Vera Lynn and a host of others? Surely all their records weren't destroyed in the Fire Blitz of London. Saturday evening (11.10.41) we heard quite a good show relayed from London for the A.I.F. So come on, B.B.C., let's hear from you. We remain your devoted listeners who suffer in silence. Can you take it? We lay odds that you can't."

"Forces Favourites"

THE joint authors of the letter (a sergeant and two corporals) were told that the B.B.C. would put on two gramophone features a week, to be called "Forces Favourites." The Forces had only to make their wishes known. This series of broadcasts has now been running for months, and "requests" continue to pour in. First favourite with the Middle East Forces is Bing Crosby, followed by Judy Garland and Deanna Durbin.

Submarine's Radio Threatens Island

ACCORDING to a cable from New York, a mystery broadcast threatening the people of Cuba has been traced to a German submarine lying about a mile and a half off Havana. The captain of the U-boat was heard by listeners to say: "This is the second time we have visited Cuba, and soon we shall give you a surprise."

New B.B.C. Announcers

HOME Service listeners may have heard unfamiliar voices announcing in recent weeks. Most of them are the voices of women, who are gradually being recruited to replace men wherever possible. Mary Malcolm, in private life Lady Bartlett, wife of Major Sir Basil Bartlett, now takes her turn on the rota. She is 24 and the mother of two daughters—Jemima, aged four and a half, now in California, and Lucy, the younger, who is in this country. Miss Malcolm has had much screen, broadcasting and television experience.

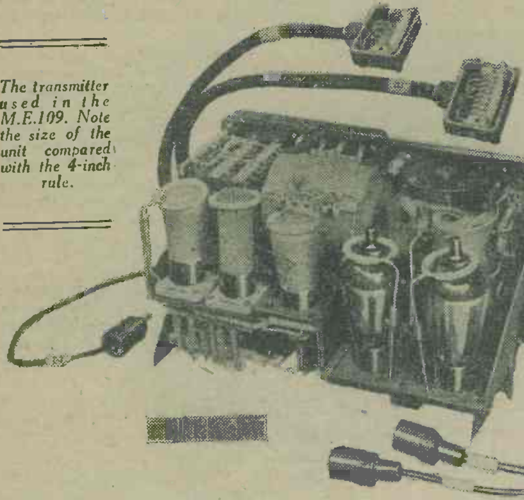
Joy Worth is another war-time recruit to announcing. A talented singer, Miss Worth was a member of the Cavendish Three until war broke out. Born in Java, Dutch East Indies, her mother was Dutch and her father English. She is 31 and sister of two famous cricketers who were recently killed in action, R. E. C. Butterworth, of Middlesex County, and J. C. Butterworth.

Maurice Peatfield, who was invalided out of the Army in July last year, has also joined the Home Announcers' staff. Peatfield is an amateur civil pilot who is on the committee of the Thanet Aero Club. He has served in the T.A. Heavy Anti-Aircraft Regiment and as Assistant Adjutant to the A.A. Command School.

Testing a set beside a tank are an A.T.S. corporal and private who are training to become radio Mechanics.

LUFTWAFFE RADIO EQUIPMENT

Details of the Radio Installation of the Messerschmitt M.E.109



The transmitter used in the M.E.109. Note the size of the unit compared with the 4-inch rule.

THE Ministry of Aircraft Production recently released data covering the design, construction and operation of the radio equipment used by the Luftwaffe, thus enabling us to give below some interesting facts about the apparatus used in the well-known Messerschmitt M.E.109.

An examination of all the information provided reveals the thoroughness of, and the vast amount of work undertaken by those responsible for investigating all matters connected with Nazi equipment which falls into their hands. It is not possible—owing to limitation of space—to give all the data of the M.E. 109's radio installation, but from the following notes it will be obvious that those responsible for the compilation of the records, investigate every detail, however small or abstruse, and great credit is due to them; they form yet another section of the "back-room Boys," about whom we hear so little although they are doing so much.

The Receiver

The receiver is a fairly conventional superheterodyne design of about five years ago, i.e., prior to the introduction of pentagrid valves. There are three H.F. circuits—H.F. grid and anode, and frequency-changer oscillator—which are tuned by a well-made ganged condenser with insulated rotors and stators. Tracking appears to be by series and shunt padders, the series padder being fixed.

The frequency changer has a reaction winding in the cathode and the oscillator-tuned circuit connected in the anode. The intermediate frequency is 509 kc/s. The I.F. amplifier has wave-wound air-cored tuned circuits in the anode of the frequency changer and grid and anode of the first I.F. stage, the latter beiug capacity coupled to the grid leak of the second I.F. stage. There is an iron-cored tuned circuit in the anode of the second I.F. stage, which feeds the metal rectifiers which act as demodulators and give A.V.C. voltage, this being fed to the H.F. and first I.F. grids through decoupling resistors.

The grid of the output stage is fed through a resistance-capacity network, the anode of the valve feeding the phones through a transformer and a pre-set volume control having three spot settings. The valve heaters, which are 4-volt, are connected in two lots of three and two in series, the set of two having a 4-ohm resistor to reduce the current to the correct value.

The transmit-receive switch on "transmit" applies extra bias to the frequency-changer valve rendering it inoperative. Side tone on transmit is obtained through a winding coupled to the first tuned circuit, which is connected to a full-wave metal rectifier coupled to the grid of the output valve.

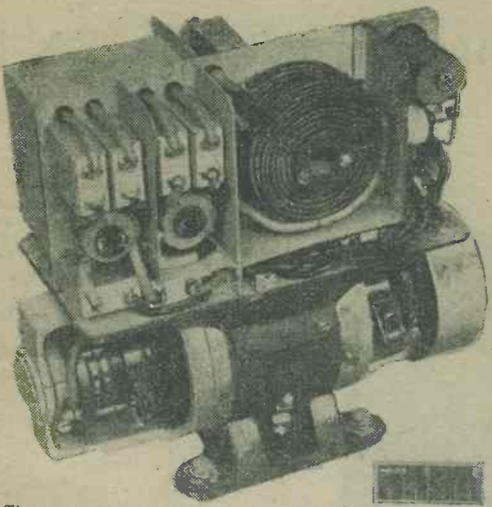
Transmitter

This consists of a master oscillator valve, a modulator, two parallel output valves, and a fifth valve which, in the transmitter examined, was replaced by a 4-ohm resistance in order to give the correct heater current to the first two valves.

The master oscillator type R.E.N. 904 has an anode coil tuned by a variable condenser with reaction on the grid. The output stage is driven through a condenser and in the grid is a choke, the earth end of which is connected to the secondary winding of the modulation transformer. The modulator is also type R.E.N. 904, and has a microphone transformer in its grid circuit. The output valves are tetrodes of the Telefunken type R.E.S.1664.

The anode is fed through a R.F. choke which has a neutralising winding to the grid. The anode is also coupled through a condenser to the aerial tuning variometer which has also a small variable condenser con-

The superhet receiver, the lay-out of which does not appear to possess any outstanding features.



The rotary transformer—with cover removed—which forms the source of power supply.

nected across it. The aerial current passes through an instrument transformer in the earth lead.

The heaters of the receiver and transmitter master oscillator and modulator are fed from the 24 volts supply through resistance. The transmitter output stage heaters are fed from the secondary of the transformer mentioned above.

The transmitter and receiver are set up on the ground, the pilot's only controls being an "off-heaters-working" switch and a "send-receive" switch. Although the transmitter and receiver can be set up on different frequencies, it would appear that if they were so used there would be considerable loss of received signal as they are connected to the same aerial which is tuned by the transmitter variometer. The transmitter output is about 2½ watts and the sensitivity of the receiver from 35 to 70 microvolts.

Power Supply

The motor generator has two windings, but the H.T. secondary has slip rings as well as brushes. The primary of transformer in the power pack is connected across the slip rings, receiver H.T. being obtained between its centre point and the transmitter H.T.—brush. There are H.F. chokes and condensers in the motor generator unit and L.F. chokes and large condensers in the power pack. Connection is by the usual Telefunken plugs with curved spring contacts.

A Vibratory H.T. Unit

The Essentials of a Simple Apparatus for Use with Battery Receivers

By "NINEJAY"

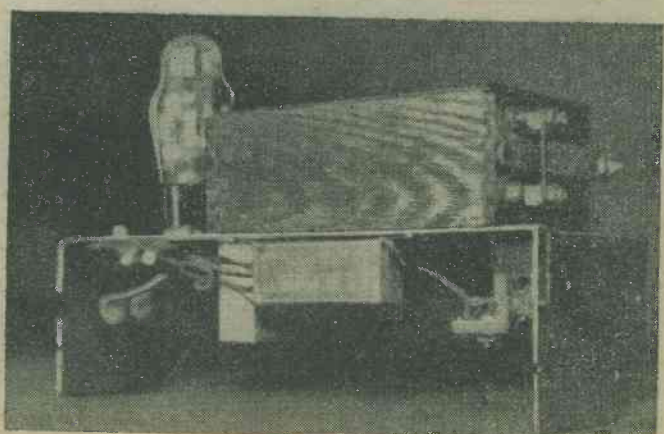
MANY readers may have at hand, or can procure for the asking, the trembler-coil out of an old model "T" Ford car. This coil forms the nucleus of an easily constructed H.T. unit giving an output of about 115/135 volts, 6/8 m/a. As some readers may also have an idle car battery, they can provide themselves cheaply with a convenient and efficient H.T. supply.

The unit described was made to work with receivers using auto G.B. and having only a H.T. negative and a H.T. positive lead. If your receiver has not already got auto G.B. incorporated in it, it is recommended that you convert the set to it. As the output of the unit is practically steady it should be easy, by means of voltage-dropping resistors, to reduce the number of H.T. leads to only a H.T. negative and a H.T. positive lead. If the receiver has a big H.T. consumption it is advisable to endeavour to reduce it within the limits of the unit.

After obtaining a coil that is satisfactory, try to get a suitable valve. This might at the present time be a little difficult, but fortunately there are quite a number of alternative types to choose from. The 6Z5 is very adaptable, as it may be operated from either a 6- or a 12-volt supply; this might prove very convenient if it was desired to use the unit on a different L.T voltage at some other time.

Tapping the Coil

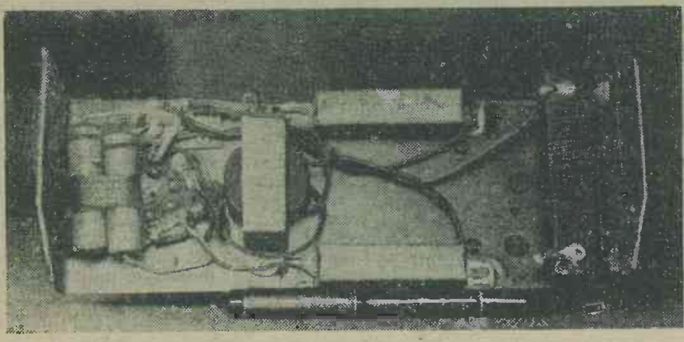
To commence with, it will be necessary to remove the coil from its box. To do this first remove the lid, then heat the box slowly in an oven until the compound covering the coil becomes soft. To facilitate the removal of the compound from the coil it will be as well to dismantle the box. When doing so, unsolder the leads from the coil which are soldered to the large brass contacts on the side of the box. After all the compound has been removed from coil it will be seen that the H.T. winding is in two sections. It will be necessary to solder a flexible lead to the fine wire joining these two sections, and this lead will act as the H.T. secondary centre tap. To get at this fine wire remove all the compound remaining between the two sections. Carefully remove the layer of paper, under which will be found the fine wire that joins the two sections. A soldering iron with a very fine point may be needed when soldering the flexible lead, as the two sections are very close. In order that the lead might not be broken off anchor it with some hot compound. Solder flexible wires to the other two H.T. leads. This leaves the coil ready for replacing in its box, but before doing so it might be



The completed unit, showing how the coil is located with respect to the other components.

better to test the H.T. windings for continuity, as they may have been damaged during the coil's removal. Now bore a suitable hole in the side of the box in order to bring out the H.T. leads. As the condenser in the box will probably be very leaky it would be advisable to use a new .5 mfd. and R1 to replace the old condenser. R1 is essential in order to reduce to a minimum any tendency to sparking at the contacts. This new condenser and resistor can be accommodated in the part of the box where the old condenser was.

Place the coil back in the box, and solder L.T. leads as they were before. Finally, check over the coil and condenser connections before covering the coil with melted compound. As the contacts on the trembler are likely to be in need of attention it would now be opportune to take them down and clean them. The nuts and bolts may require cleaning, too, as they will probably be rusty. When you have the trembler reassembled endeavour to get the contacts meeting as flush as possible, as this will minimise any tendency to sparking.



The under chassis lay-out and wiring. An idea of the size of the unit can be obtained by comparison with the fountain pen.

Reassembling the Parts

All the parts can be assembled as is found most convenient, but a small chassis, with the condensers, choke and resistor underneath and the valve and coil on top, will be found to be the neatest arrangement. The best value for C1 was found to be .01 mfd. This condenser needs to have a high working voltage, and joining two .02 mfd. in series will be found to be the easiest way of getting a .01 mfd. of high working voltage. A disused L.S. transformer could be used as the L.F. choke, the primary being the section to use. As different coils have different types of reed it is not possible to state any definite value of R for a specific L.T. voltage. The value of R is best found under actual working conditions, so it is wise to assemble the unit first. Resistor R can be made from a discarded electric fire element. Find by experiment the longest length of resistance wire that can be used consistent with the required output. It will be found that there is a certain optimum value.

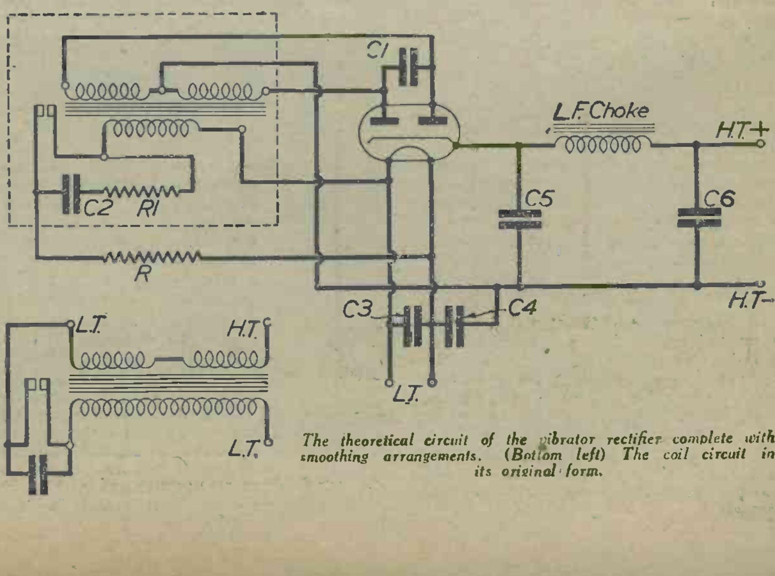
Readers would be advised to restrict the consumption within the limits of the unit, rather than try to get an increased output at the expense of increased L.T. consumption and sparking. It was found with all the units constructed that after getting the optimum value of R, and very carefully adjusting the contacts, there was no sparking and L.T. consumption was at an absolute minimum. Practically no electrical interference was experienced with unscreened models, but as there is a noise of the trembler it is desirable to place the unit in a box that will deaden the sound. If a non-metal box is used it will be found that orienting the unit in a certain direction relative to the receiver will reduce the interference to an almost imperceptible level. Observation of L.T. polarity is not absolutely essential, but it will be found that the output will be a little higher, and the reed will have a steadier beat with the L.T. leads connected a certain way.

The satisfactory working of the unit is wholly dependent on the constructor, so he can rest assured that if the unit is not satisfactory on the first test a little adjusting should give him the desired results.

Current Consumption

Using a 6Z5 on a receiver taking 9½ m/a the L.T. consumption was only .7 amp. With a 6X5 and a 6-volt L.T. supply the consumption was .9 amp., and this valve gave just the same output with only 4 volts on its filament, so that a unit could be worked from a 4-volt supply. This would be very convenient, as a 6-volt car battery could be used for both the receiver and the unit. Only one battery would have to be brought in to be charged, and in these days of restricted transport this would be a boon. Owing to the low cathode insulation of the 6ZY5G it is not recommended for use in these units.

The author does not claim anything original about this idea, and as far as he is concerned it is the result of war-time necessity. In normal times the average serviceman would not like to tackle the construction of apparatus like this, as quite a lot of valuable time is usually lost before the best possible results are obtained, and often the results are very unsatisfactory. So what he did was to supply his customer with a manufactured part. Unfortunately H.T. batteries and vibrator packs are not easy to obtain at the present time. The idea of this article was not to give a detailed constructional account, but merely to give the idea of the essentials of a simple, satisfactory vibratory H.T. supply.



The theoretical circuit of the vibrator rectifier complete with smoothing arrangements. (Bottom left) The coil circuit in its original form.

Anti-interference Aerials

Methods of Arranging Efficient Doublet All-wave Aerials. Elimination of Local Interference

IT is now generally realised that some form of anti-interference aerial arrangement is desirable for use with any type of receiver. Because of this there were various complete aerial systems on the market in pre-war days. Unfortunately for many readers, several of these were by no means inexpensive; in any case,

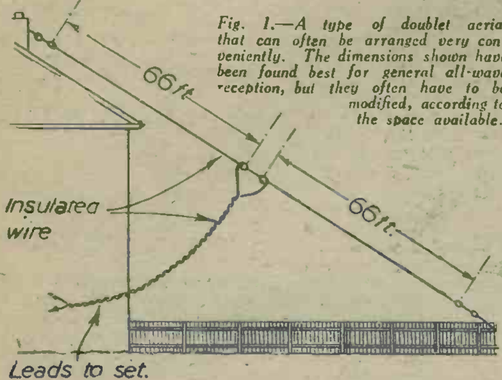


Fig. 1.—A type of doublet aerial that can often be arranged very conveniently. The dimensions shown have been found best for general all-wave reception, but they often have to be modified, according to the space available.

the average constructor would prefer to make his own. The question thus arises as to just what types of aerial can be made at home.

Undoubtedly the simplest is that known as the doublet. Sometimes it is described as a dipole, but often incorrectly, since a dipole should, theoretically, be designed for use on one wavelength—or at least on one waveband—only. And an aerial that is "tuned" to a fixed wavelength is of little use to the average amateur who is interested in the reception of a large number of stations on all wavebands, although perfectly suitable for the amateur transmitter whose work is confined to a very narrow band of frequencies.

Dimensions

A dipole is arranged in the form of two inverted-L aerials, or of two end-to-end vertical aerials, whose two down leads are twisted together or transposed in some other manner. For most efficient reception, each horizontal arm of the dipole should be one quarter wavelength long. Thus, if the aerial were for reception on 20 metres, each arm should be 5 metres—approximately

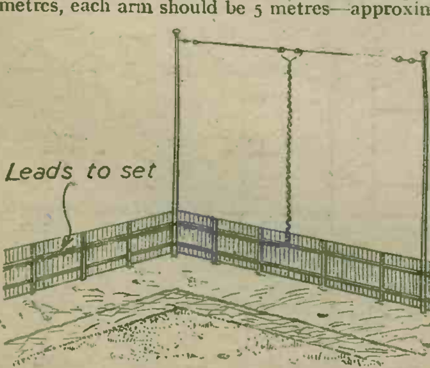


Fig. 2.—How a doublet can sometimes be erected between two masts at the end of the garden so that it is well away from the source of interference. In this case the aerials' span can rarely be more than 33ft. each, the total length of the lead-in being 66ft.

16ft.—in length. For the short-wave bands such dimensions are perfecly satisfactory and convenient, but consider the position when reception on, say, 1,500 metres is required! Theoretically, a dipole for that wavelength should consist of two arms, each about 1,220ft. long. That means that the total length of the aerial proper should be nearly 2,500ft., which is obviously impracticable.

That is not all, for the twisted down lead should, again theoretically, be one half wavelength long, or twice as long as each of the horizontal spans. That also is often impracticable, even when the aerial is designed for short-wave use. It is obvious, therefore, that a compromise must be effected if the dipole or doublet is to be satisfactory and practicable for all-wave use.

Non-radiating Down Lead

Before going into practical details of construction, it will be as well to gain an idea of the main principles underlying the doublet arrangement. Apart from its being "tuned" to the wavelength to be received, and thus being most effective at one wavelength, or on harmonics of that wavelength, one of the most important features is that the down lead is "dead." In other words, the two leads which are twisted together or crossed over each other do not act as "pick-up" devices, as does the down lead of a normal type of L or T aerial. It is due to this that the kind of aerial under consideration is anti-interference in character. Since the two down leads are balanced, the pick-up of one is countereacted, cancelled out, or neutralised by the pick-up of the other. And as the down lead is generally in the region of electrical interference generated inside the house (by electrical conductors, switches, contacts and the like) it is this which generally "collects" the interference with the usual aerial arrangement.

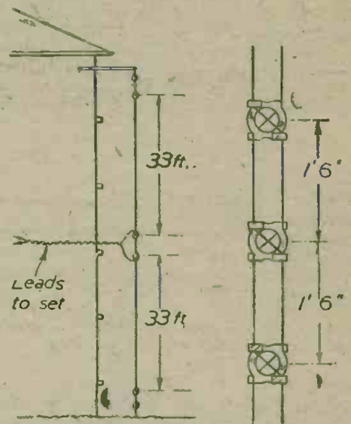


Fig. 3 (left).—Flat-dwellers or those living in a room above ground level in a high building will find that this arrangement of dipole can often be used successfully. It is not ideal as an anti-interference aerial, but is satisfactory for all-wave reception, and sensibly non-directional.

Fig. 4 (right).—When using an outside doublet it is often convenient to use bare wire along with transposer blocks as shown here for the down lead. Twisted wire can be used between the window and the set.

By placing the aerial proper a fair distance from the source of interference (the house) it picks up little or no interference in normal circumstances, and also gives maximum response to the wanted signals. For this reason, a long down lead from a doublet is generally to be preferred, the aerial being placed across the end of the garden, or as high as possible above the house.

It is worth bearing in mind that a horizontal doublet has fairly marked directional properties, being most sensitive to signals coming from a direction at right-angles to the line of the aerial. Thus, the aerial can generally be arranged so that it is most responsive to certain particularly-desired transmissions, and less responsive to others which are often responsible for interference. When it is preferred that the aerial shall be equally receptive from all directions, the vertical arrangement is to be preferred, since this is sensibly non-directional.

Practical Considerations

How, then, are we to obtain the advantages of the doublet or dipole, without the disadvantages of excessive lengths of aerial and down lead? The simplest method, for all-wave, or even medium- and long-wave reception, is to use an aerial length which approximates to those of the harmonics or sub-harmonics of the wavelengths most required. In practice, I have found that a doublet aerial of length corresponding with a wavelength of about 80 metres suits the purpose very well, and is convenient for general all-wave use. This means that the horizontal spans should each be approximately 66ft. long; if the down lead can be made of the same length, so much the better; if not, it can be of a length not bearing any definite relation to the size of the aerial proper. However, as the down lead need not be straight, the full 66ft. can often be used without difficulty, and run around the picture moulding or skirting board from the window to the set in another corner of the room.

Probably the simplest method of construction consists of using two lengths of insulated wire, attached to insulators, as shown in Fig. 1, the down lead portions being twisted together. By following this idea, there are two continuous lengths of wire right from the furthermost insulators to the set. In consequence, there need be no soldered connections (which often corrode) and nothing to give trouble. It is, of course, wise to choose wire which is covered with insulation that does not perish on exposure to the atmosphere. There are several proprietary and inexpensive brands of aerial wire that comply with this requirement.

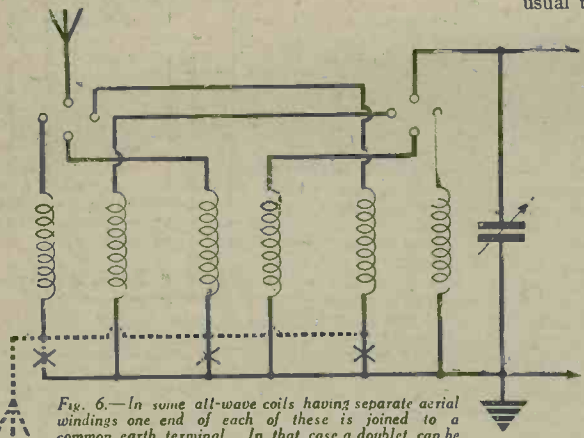


Fig. 6.—In some all-wave coils having separate aerial windings one end of each of these is joined to a common earth terminal. In that case a doublet can be used by breaking the leads marked X and connecting them together, as indicated by the broken line, and to earth.

By following this course, the aerial can be stretched between two posts at the end of the garden, or between the house and a mast. The down-lead can be brought vertically from the aerial to the fence, to which it might be attached with ordinary staples, as shown in Fig. 2. Due to the balanced lead-in, losses due to closeness of the twisted lead to the earthed fence are negligible, and the system is particularly neat and unobtrusive.

A Vertical Doublet

Where an outside position is inconvenient the aerial can be mounted between two corners of the roof inside the house, and the down lead brought either down the wall on the inside or, better still, dropped through a hole in the boarded projection of the eaves and kept fairly close to the outside wall. Another idea that can sometimes be adopted when the receiver is in a room above ground level is to attach the aerial to the eaves and to an insulator connected to a spike fixed into the ground, the lead-in being taken from the centre straight into the room, as shown in Fig. 3. Generally, however, it is necessary to use a shorter aerial than that referred to above—say two 33ft. spans.

When the aerial can be mounted in a more exposed position, across the garden for example, bare wire can be used throughout, the two down leads being carried in so-called transposition blocks, as shown in Fig. 4. These blocks should be arranged at approximately 1ft. 6in. intervals to ensure that the two leads are sufficiently close and transposed to neutralise each other. The leads to the set itself can be by means of ordinary twin flex, taken from a pair of ebonite lead-in tubes of the usual type passed through the window frame.

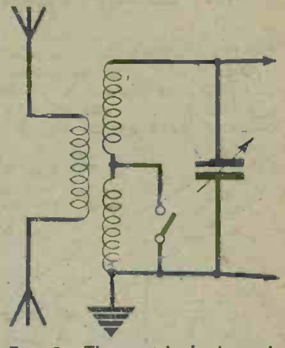


Fig. 5. The two leads from the dipole or doublet should be joined one to each end of a separate winding on the aerial coil, as shown here.

One difficulty which sometimes arises in following this system is that the lead-in might be very short. In practice it seems that efficiency is lost if the lead-in is less than the length of one of the aerial arms, so it is worth while to contrive that a fair length is obtained.

Receiver Connections

In order to use a doublet or dipole, the aerial coil of the receiver should have a separate aerial winding, as shown in Fig. 5. Unfortunately, many receivers do not incorporate a coil of this type, so some provision must be made. If six-pin plug-in coils are used it is an easy matter to modify the connections. Also, when using an all-wave coil with connections similar to those indicated in Fig. 6, it is generally an easy matter to break the lower connection from the aerial coupling windings and to bring out a lead to an extra terminal.

In other cases, it might be necessary to modify the coil by adding an extra aerial winding. With air-core coils this can be done by winding about 30 turns of wire over the medium-wave section and 80 turns over the long-wave section, and fitting an extra wave-change switch as shown in Fig. 7.

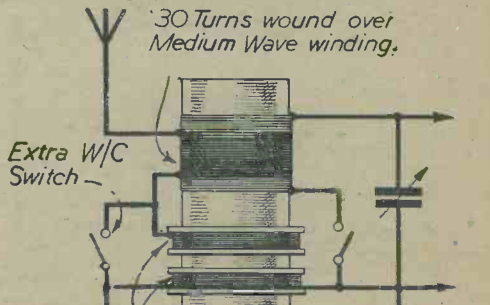


Fig. 7.—How a normal two-range coil, without separate aerial winding, can be modified for use with a doublet.

Voltage Amplification and Stage Gain

With Particular Reference to Valve Coupling Circuits

MOST of us, when we build a new receiver, like to think of it as highly efficient. But if efficiency were measured as the power taken out in relation to the power put in, the resulting figure would be disappointing to most experimenters. Just by way of simple example, consider an average mains-operated superhet with an output of two watts. If there were four valves these would have a heater consumption of 16 watts. Then there would be the rectifying valve, also having a filament or heater taking another 4 watts. In addition to this, there is the H.T. consumption of, say, 250 volts, 100 mA, which gives us another 25 watts. Thus, we see that the input is around 45 watts for an output of 2 watts—an efficiency of about 4.0 per cent.! In this simple calculation we have not taken into account the signal input, but as that can be expressed in microwatts it would not affect our final figure.

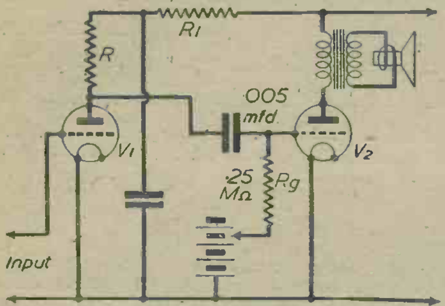


Fig. 1.—Simplified circuit of a two-valve amplifier with R.C. coupling.

Valve-cathode Losses

The efficiency of a steam engine is about three times that of our wireless receiver, and the efficiency of a power transformer is in the region of 80 per cent. So we begin to wonder where all our power is lost. The answer cannot be given in a few words, although it is evident that enormous loss takes place in the valves. These require a considerable amount of electrical power to provide the heat which is necessary before the cathode will act as as an emitter of electrons. If we could make use of a cathode coated with a radio-active substance, such as radium, our losses would be reduced enormously. But that we cannot do—not at present, anyway.

We must therefore "cut" our losses on the heater side of the balance sheet. When we have done that there still remains a low percentage efficiency, though. To a large extent it occurs in the circuits employed to couple together the valves; there are also losses which occur in the components themselves, of course.

An interesting picture is obtained by studying the losses in a simple resistance-capacity-coupled amplifier stage, as shown in Fig. 1. Suppose the input is 1 volt of A.F. and that the amplification factor of the valve is 20. At first glance it would seem that an output of 20 volts would be obtained to pass on to the next valve. Unfortunately, that is not the case, as can be gathered from Fig. 2. This is an equivalent circuit, where the valve is represented by an A.C. generator and the resistance marked R_a. The anode load resistor is marked R.

Effect of Anode Load Resistance

It will be seen that the expected output from the valve (shown as μV_g, which means the input or grid voltage multiplied by the amplification factor of the valve) is applied to R_a and R, which are in series. And it is only the voltage developed across R which we can employ to supply the following valve. Thus, if R and R_a were of the same value, only half the total output from the valve would be capable of being usefully employed.

A few figures will make this clear. We will again assume that the valve has an amplification of 20, and that the A.F. input to it is one volt. The apparent output would, therefore, be 20 volts; this is the figure for our expression μV_g. Since this voltage is divided between the two resistances, that appearing across R would be only 10. If R were twice the value of R_a the voltage across it would be two-thirds of the total available voltage. We can evolve a simple formula to show the voltage across R; it is $V=\frac{\mu V_g R}{R+R_a}$

Numerical Examples

Let us work out a few values from this. Suppose R_a, the anode resistance or internal impedance of the valve, is 20,000 ohms, and that R is 30,000 ohms. We can see that our V will be equal to 12, or only three-fifths of the available 20 volts. Now try values for R of 20,000, 40,000, 50,000 and 100,000 ohms. The results obtained are 10, 13.3, 14.3 and 16.7 respectively. If a number of other figures are taken in the same way, it is a simple matter to plot a graph which will show the voltage across the resistance R for various values of R. This has been done in approximate form in Fig. 3, and it will be seen that the curve does not start to level out until the load resistance R is about nine times the anode resistance R_a of the valve. No matter how large the load resistance is made, the voltage across it can never quite reach μV_g.

But it can be seen that there is little advantage to be gained by making the load resistance more than nine times the anode resistance of the valve. For maximum efficiency with R.C.C. coupling, therefore, the load resistance should be nine times the internal resistance of the valve. It may now appear that all we need do to ensure a high degree of efficiency is to make the resistance, in the example quoted above, 180,000 ohms or thereabouts.

Practical Difficulties

But that is not the end of the story. A resistance of such high value will seriously cut down the H.T. voltage applied to the anode of the valve. If the valve required only one milliamp at 60 volts the H.T. supply would require to have a voltage of 240 volts, and if it were necessary to give the valve 3mA at 100 volts the H.T. supply would need to have a voltage of 640!

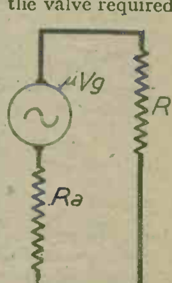


Fig. 2.—The equivalent circuit for V1 in Fig. 1. Ra is the internal resistance of the valve, R is the anode load resistance and μVg the theoretical output voltage from V.1

It is obvious, therefore, that we must steer a middle course between maximum efficiency and practical limitations. This we do by choosing a valve which takes a reasonably low anode current, and by using a load resistance as high as possible, bearing in mind the available H.T. voltage. Whenever possible it is highly desirable that the anode resistance should be not less than four times the anode impedance of the valve. Thus, for a valve having an internal resistance of 25,000 ohms we should use a 100,000 ohm anode resistor. In assessing the voltage drop, by the way, it is necessary to remember to take into consideration the value of the decoupling resistor as well as the load resistor.

In the case of choke-capacity or transformer coupling the amplification curve is slightly modified, as shown by a chain line in Fig. 3. For the ohmic resistance of the load we substitute the reactance of the choke, which is $2\pi fL$, where f is the frequency in cycles per second and L the inductance of the choke in henries. The curve in this case starts to level out when the reactance is about five times the internal resistance of the valve, and a high degree of efficiency is obtained when the reactance is between two and three times the valve resistance.

But we have not finished with the losses which occur in the simple circuit under discussion. Of the total A.F. voltage developed across the load resistance or reactance only a portion is applied between the grid and cathode of the following valve. The reason for this will be understood by referring to Fig. 4. The load resistance R is in parallel with the grid condenser C and the grid leak R_g, which are in series with each other. Thus, a potentiometer is formed, and it is only the voltage across the grid leak which can be usefully employed.

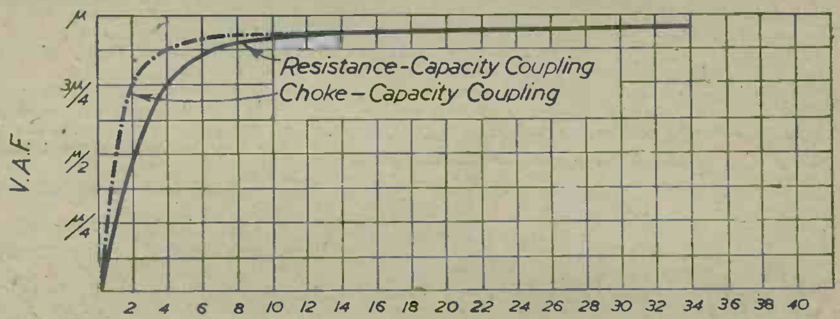


Fig. 3.—Curves which show how the amplification provided by a valve varies with the resistance or reactance of the anode load.

Effect of the Grid Condenser

Values have been assigned to the components shown in Fig. 4, that of 30,000 ohms to the grid condenser being the figure for a capacity of .005 mfd. at a frequency of 1,000 cycles per second. It will be seen that this is fairly low by comparison with the 100,000 ohms for the anode resistor and .25 megohm for the grid leak. Consequently, it can be ignored for most practical purposes. Neglecting the reactance of the grid condenser, the effective reactance of the two resistances in parallel can be found from the usual formula: Effective $R=\frac{RR_g}{R+R_g}$. To find the real stage gain we must substitute this expression for the term R in our original formula for voltage amplification, which was: $\text{V.A.F.}=\frac{\mu R}{R+R_a}$.

Some Simple Mathematics

Mathematically minded readers will very soon see that this gives us the final formula:

$$\text{Stage Gain}=\frac{\mu RR_g}{RR_g+R_a\ (R+R_g)}$$

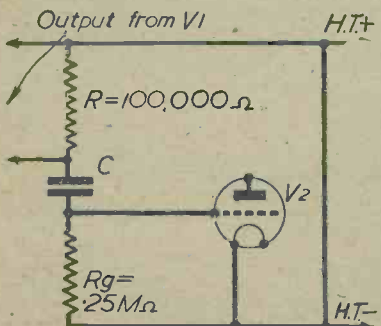


Fig. 4.—This diagram shows that only a percentage of the voltage appearing across the load resistance of V1 is applied to the grid of V2.

Those who do not care to do the little substitution must accept the formula as correct, and will probably not find any difficulty in using it. Let us try it, taking the figures previously given. These are repeated for convenience: R=100,000 ohms; R_a=20,000 ohms; R_g=.25 megohm, or 250,000 ohms; μ=20. Using these figures we get the equation:

$$\text{V.A.F.}=\frac{20\times 100{,}000\times 250{,}000}{100{,}000\times 250{,}000+20{,}000\ (100{,}000+250{,}000)}$$

This gives an answer of approximately 15. In other words, the valve alone has an amplification factor of 20; when the load resistance is taken into consideration the amplification falls to 16.7, and when the effect of the leak is also allowed for the amplification falls still lower to 15. Even this does not take into account losses due to incidental capacities across the resistances and the dielectric losses in the grid condenser. Moreover, this figure is obtained when using component values which approach very closely to those which are theoretically perfect.

When choke-capacity coupling is employed the calculation becomes a little more involved, because for R we have to substitute $2\pi fL$ and for the expression $R+R_a$ we have to substitute $\sqrt{(2fL)^2+R_a^2}$.

Those who are interested from the mathematical point of view may like to have the complete formula for the true voltage amplification factor, when taking into account the reactance of the grid condenser. It is:

$$\text{V.A.F.}=\frac{\mu RR_g}{RR_g+R_a\ (R+R_g)}\times\frac{R_g}{\sqrt{R_g^2+\frac{1}{(2\pi fL)^2}}}$$

If you find the formula too much of a handful it is suggested that you take it for granted and leave it at that.

Notes from an Amateur's Log-book

2CHW Has Now Completed His Meter, the Final Constructional Details of Which are Given in These Notes

THE component parts of the meter under discussion are shown in the accompanying illustration. They consist of two shaped pole-pieces, a cylindrical core, a light metal rectangular former for the coil, two small hair-springs made from non-ferrous metal and two pivotal bearings held in position by cross-members, the exact shape and location of which will depend on the general structure of the mechanism of the meter. Although the parts shown are ideal for the job, it must be understood that, in general, many modifications are permissible, therefore if one is unable to make or obtain the exact items depicted in the diagram, the design can be altered to suit the capabilities of and resources open to the constructor, providing the essential principles of the meter are retained. For example, the shaped pole-pieces could be dispensed with, the coil could be wound on a fibre or even a wooden former, and it is possible to do without the metal core. These rather drastic modifications are not to be recommended, as they will directly affect the efficiency, scale spacing and movement of the needle pointer, but they are quoted to show that under conditions which prevent a proper design being made, it is possible to make a meter which, once its characteristics are known, would be better than no meter at all.

Dimensions

For guidance as regards proportions of the parts used in the assembly with which I have been concerned, here are a few measurements. The diameter of the circle enclosed within the shaped pole-pieces is 0.8in. The diameter of the core is 0.7in. thus allowing a gap between pole-pieces and core of $^1/_{20}$in. In this small space, the coil former has to move freely, therefore it is obvious that the pivots and bearings must accurately be aligned.

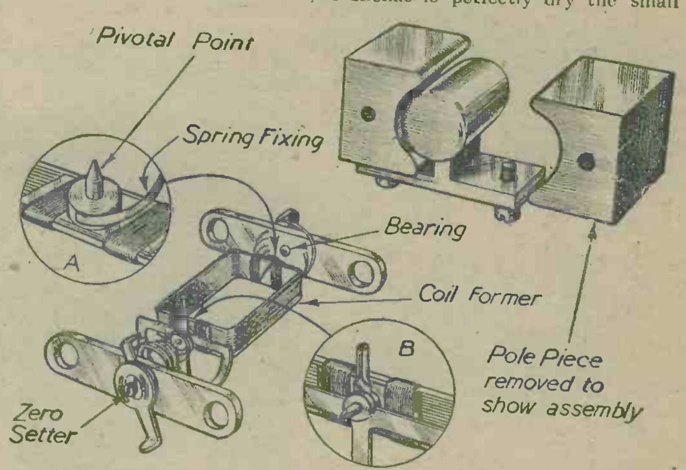
The coil former is 1.1in. in length and 0.75in. wide, that is, its rectangular shape dimensions. The material used in its construction is 0.25in. in width and, approximately, 0.15in. thick, the metal being aluminium.

The length of the core and pole-pieces is exactly 1in. The assembly of these parts is clearly shown in the diagram.

The items which call for delicate handling are the fixing of the two pivots on the coil former, the connection and adjustment of the hair-springs and the alignment of the bearings. In the instrument in question, the short pieces of pointed rod, used for the pivots, are fixed to small pieces of very thin strip brass and then placed on top of the coil winding and bound in position by fine thread. Between the winding and the brass, a thin strip of mica is inserted, to prevent any possibility of the turns being short-circuited. I found it necessary to make a small jig to enable the pivots to be located at the correct positions, and I used a thin coating of adhesive to hold them—whilst the coil former was in the jig—and did not make any attempt to add the binding until the adhesive had set. If the pivots are not fixed dead centre, it will be impossible for the coil former to rotate in the small magnetic gap.

Winding the Coil

As regards the actual winding of the coil, I made a former out of wood, over which the metal former was just a nice push-on fit. The wood I left long enough to form a handle so that the winding operation would not be so difficult; the most satisfactory way of doing this I think, is by hand. A light and even coat of pure shellac is applied to the former before commencing winding; let it become tacky so that it will hold the wire, as this saves anchoring the free end—if too much tension is not applied—and holds each turn in position as it is wound on. Take care to place the wire so that each turn is tight up against the previous one as it is necessary to get an even and smooth finished coil. When sufficient turns are on, leave two or three inches of spare wire before cutting off. Keep the wire under tension until it is held by the shellac, and then apply another thin coating making quite sure that it is *a thin and even* covering. The start and finish of the winding should be on opposite narrow ends of the metal former, so that before the shellac is perfectly dry the small



A. How the pivot point plate is bound to coil former. B. Shows the pointer holder and part of counter-balance.

pieces of mica can be placed in position prior to the thin brass plates holding the pivoting points being fixed. When these are secure, the binding with thread can be done, which in addition to holding the plates will also make fast the ends of the coil. I was able to get 40 turns of 38 S.W.G. enamelled wire on the metal former described above and these gave a maximum scale reading for 1.5 mA.s.

The two hair-springs can be made from copper or brass foil cut to a width of approximately $^3/_{64}$ in. coiled round an $\frac{1}{8}$in. diameter metal rod until the desired shape is obtained. The inner ends of the springs are soldered *together with* the starting and finishing ends of the coil to the body of the pivoting points, i.e., one spring and one wire to each pivot. This provides the necessary flexible electrical connections to the coil, and the delicate force required to return the coil to its zero position. When the bearings have been fixed and the coil is in position, the free end of one of the springs can be anchored to the most convenient point. The end of the other should be fixed to a small lever so arranged that with a slight movement of it the tension on the spring can be varied. This enables the zero setting to be adjusted, thus providing compensation for any variation in that direction.

Pointer and Counter-balance

The pointer, a suitable length of light non-ferrous metal, is also fixed to one of the brass pivot plates, and it should be remembered that it is necessary to provide a counter-balance in line with, but on the opposite side of, the pivot. This can take the form of a small semi-circular piece of thin brass or a short rod having sufficient weight to balance the pointer.

Mounting the completed instrument is a matter best left to individual ideas and requirements, but it is advisable to house it in a neat case to protect the movement from dust, etc., and provide a means of having the scale securely fixed. The latter should be calibrated by checking readings against a reliable commercially produced meter, the meter scale then be marked and subdivided. A stiff piece of Bristol-board is best for the scale, and indian ink should be used for the markings.

Log-books

To obtain the best from any S.W. receiving station, and this covers efficiency, instruction and interest, it is essential for the operator to keep up to date an informative log-book. Although I have always held this vew, I came up against a striking example this week of just how much is lost by the failure to keep records of transmissions received. I was visiting another S.W. enthusiast; his den and equipment were certainly very good, and he was able to handle his Rx and bring in the stations. I expected to see a log embracing the world, but when we started talking about certain transmissions, changes, weather periods and, well, those things which are always cropping up and which add a certain air of intrigue and, shall I say, mystery to the game, I found—much to my amazement—that he had no record to hand to refresh his memory, or provide any data for comparison. When we parted, I think he realised that he was only playing at the game —in spite of his fine rig, etc., and that he was not really taking any useful part in the amateur movement, for the simple reason that he had failed to compile the slightest information which might be of some use to other S.W. listeners in general. Minor examples of what I mean frequently appear in the "Open to Discussion" pages of PRACTICAL WIRELESS, when readers want some data abont various transmissions.

Even with my temporary war emergency station, to which I have not been able to devote the number of listening hours I would like, I have kept a log and here is but one of the many uses to which it will be put. Owing to the absence of a wavemeter, I have been unable quickly to identify any particular transmission by checking its frequency. This often means hanging on to a station for quite a while to get its call sign, and then finding that it is not the one you thought. Again, conditions might be such that the call sign is QSA1, and more time has to be spent before a QSA4 signal is obtained.

Calibration

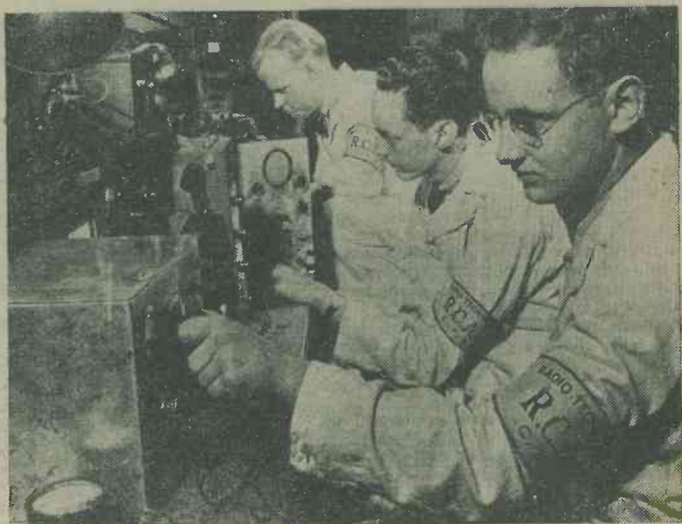
To compensate for the lack of a wavemeter, I decided to calibrate the Rx, but to do it meant compiling an accurate log of station call-signs, frequency, dial settings and coils in use. The process takes a fair amount of time, unless, of course, one is able to devote an hour or two each day on the Rx. This I was unable to do, so the whole thing has taken me much longer than usual, and even now, there are many gaps.

With the set in question the tank condenser is the special Eddystone 10 x 14 mmfd. type. In other words, it has ten definite stop settings on the spindle, and each stop or movement represents a capacity of 14 mmfds. or picafarads. The band-spreader has a capacity of .00002 mfd. or 20 picafarads, thus making—with the all-in capacity of the tank of 120 picafarads—a total capacity of 160 mmfd. or 160 picafarads, according to which units you like to use. The spreader is fitted with a dial marked 0 to 100 degrees in single degrees over a semicircle, thus giving, in conjunction with a very smooth slow-motion drive of approximately 3.5 : 1, quite a fine adjustment, bearing in mind the capacity of the condenser.

The reaction control has a slow-motion drive of 6 : 1, and a semicircular scale marked 0 to 10, therefore the whole process of recording settings for any given frequency and signal is simplified considerably.

Procedure

On receiving and getting the identification of a transmission, including its frequency, I tabulate the data in the following manner. Ten columns are ruled off in the log-book having the headings, Coil, Tank, B/Spreader, Reaction, Frequency (kc/s), Call-sign, Station Name, Location, Time, Date. In the first, the number of the coil is placed; in the second, third and fourth, the *exact* settings of the three controls are recorded. The frequency in kilocycles goes down in the fifth, and the other data under their respective headings. These items are in a book separate from the normal log-book, which contains more complete details such as date, reception conditions, weather, etc. The arrangement of



Canada's contribution of radio mechanics. A training class in progress prior to trade test, which, if passed successfully, enables the men to join the R.C.A.F.

the columns is open to discussion. Some might fancy frequency first, but bearing in mind that the data is to enable the frequency of a station to be determined from given settings of the controls, I think the first item should be the tank reading followed by b/spreader, etc.

It is not advisable to make the entries in ink on logging a station for the first time. The better plan is to make two or three checks on the transmission, by picking it up on various days, noting all the settings each time, and then taking the average as being correct. This may seem unnecessary, but it will take into account any of the strange variations which do take place, and eliminate—or, rather reduce—the possibility of errors in reading dial settings. One should always take great care when reading off pointer or dial settings; with S.W. work, when a fraction of a degree may mean a lot, it is advisable for one to get in the habit of having the head in one position with relation to the dials when reading the figures, thus reducing the possibility of error due to parallax.

The Component Problem

How to Make the Best Use of Components That Are at Hand. By S. BRASIER

DURING these difficult times all readers have, no doubt, been affected by the lack of available parts with which to build their receivers.

In some instances, where a part may be unobtainable, it is possible to substitute some other component without sacrificing performance.

It should be understood, however, that this treatment may not usually be applied to a short-wave receiver, as in this case the "extras" are very often essential.

Comparison between the two circuits shown in Figs. 1 and 2 will show how Fig. 1 can be stripped of its "frills," so to speak. For instance, the pre-set series aerial condenser C1 and shorting switch may quite conveniently be replaced by two fixed condensers of .0001 and .00025 mfd., thus making three optional aerial terminals as in Fig. 2.

With regard to the H.F. decoupling condensers C3 and C4, valves of .01 mfd. to .1 mfd. may be utilised, and in the case of C2 up to .25 mfd. It is not usually possible to omit any of these components.

H.F. Resistances

This also applies to the resistances in the H.F. section, where R1 and R2 form the potentiometer feed to the

Transformer Coupling

If such a part is not procurable, the difficulty may be overcome by adopting H.F. transformer coupling as in Fig. 2. For this circuit the primary coil is not connected to earth, but if it is found to be so in the actual coil unit, it can very simply be severed from the earth terminal.

The condenser C2 may then be used to isolate the primary from the earth line and also to act as decoupling.

By using transformer coupling the H.F. choke and the coupling condenser C5 in Fig. 1 are eliminated. While on the subject of coils, it is as well to remember that if the long waves are not to be used, the wave-change switch or switches may be dispensed with, by permanently shorting out the long-wave windings.

Upon reference to the reaction circuit of Fig. 1, it will be noted that a resistor is included between the detector anode and coil, the purpose of which is to cure erratic control or dead spots, etc. It should be rarely necessary in any well designed receiver and may, in most cases, be omitted. The circuit to earth is completed by the reaction condenser C6, but if one is not to hand it may be replaced by a variable resistance of about 20,000Ω.

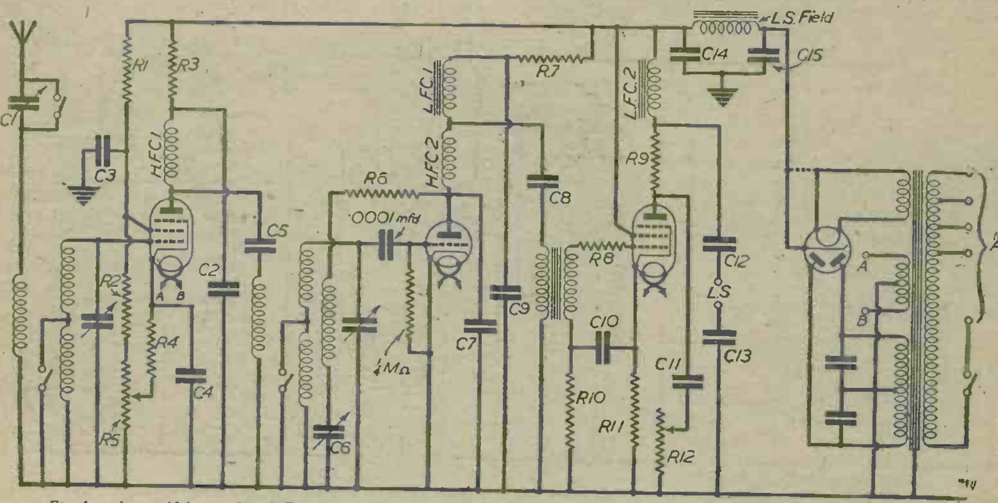


Fig. 1.—A typical four-valve A.C. circuit; but many refinements have been added in order to illustrate points in this article.

screening grid of V1, R3 the decoupling resistance, and R4, R5 the biasing resistors. These latter must, of course, be of such a value that will provide the correct minimum and maximum grid bias.

The lower arm of the potentiometer R2 may in many cases be dispensed with, in which case the value of R1 will need to be altered so that the correct voltage is applied to the screening grid. This may be calculated by making use of the formula $R=\frac{E}{C}\times 1000$, where E = voltage to be dropped, and C = current passed by the S.G. of V1. The decoupling resistance R3 is usually in the region of 5,000-10,000Ω, but here, again, it is rather dependent on the anode voltage of the H.F. valve.

An H.F. choke to be used in the position shown in Fig. 1 (H.F.C.1) must be of high inductance and low self capacity. In other words a really good quality component is essential.

It will then become essential to include a fixed condenser in the position shown in Fig. 2. The capacity would be the same as that required for the variable reaction condenser in Fig. 1. As a matter of fact, the resistance control is very smooth, and is often preferable to the more orthodox method.

Referring again to Fig. 1 and to the H.F. choke (H.F.C.2) it would seem that there is no alternative to this component, but actually it is quite possible to use a resistance, as shown in Fig. 2. A suitable value would be 10,000Ω.

A fixed condenser, C7 in Fig. 1, is an essential part of the reacting detector system and must not be omitted. Capacities of .0001 to .002 mfd. may be used, but there is always an optimum value relative to the valve characteristics and reaction circuit.

Choke Feed

The coupling between the detector and output valve in Fig. 1 will be recognised as choke-feed-transformer system. Now the inductance of this choke, L.F.C.1, needs to be in the region of 200 to 300 henries, and under present conditions is probably unobtainable. A simple way of getting over the difficulty would be to employ our old friend the resistance, but there is a slight disadvantage here, inasmuch as the voltage on the detector anode would be somewhat reduced, due to the fact that the load resistance would need to be about 50,000Ω.

The alternative to parallel feed is to use straight transformer coupling, as in Fig. 2, which is quite efficient provided the L.F. transformer used is capable of carrying the anode current of the detector valve. These types are usually of larger and heavier construction, such as the A.F.3, A.F.5, etc., and most models are capable of maintaining their inductance at a current of 5 m/a or so.

The coupling condenser C8 calls for some comment inasmuch as its value may lie between .003 and 1.0 mfd. There is scope for tone control here as the smaller capacities will emphasise the high notes, while the bass response is strengthened by using the largest values.

Decoupling System

The decoupling system, made up of R7 and C9, is indispensable for the stable operation of most receivers, and average values are 30,000Ω and 4 mfd.

It may be of interest to note that for convenience' sake the capacity may be increased at the expense of resistance. For example, a combination of 10,000Ω and 8 mfd. would in all probability prove to be just as effective as, say, 30,000Ω and 4 mfd. The advantage of the lower resistance should be obvious, as it allows of greater voltage to reach the anode.

it will be seen to include a choke filter system (L.F.C.2, C.12 and C.13). In spite of this, however, it would still become essential to use an output transformer (assuming that a low-resistance speaker is employed), therefore the filter components are somewhat superfluous for normal requirements.

There are advantages in this form of coupling, though, since elimination and simplicity are the keynotes of this article, the ordinary output transformer method is shown in Fig. 2.

Tone Control

Tone control can be effected at various points in a circuit, but in Fig. 1 the common method is used whereby a variable resistance R12 controls the effective capacity of C11 from anode to earth, but use of a variable resistance is a luxury and the fixed type would be quite effective. Assuming a capacity of .05 mfd. for C.11, the lower the resistance the more will the high notes be attenuated. Most pentodes need some form of high note control, owing to their naturally shrill reproduction, but it does reduce the apparent output, so that if one prefers this rather crisp type of quality R12 and C11 maybe removed.

It would be advisable in this case to include a small condenser of .001 mfd. in the position shown in Fig. 2.

Voltage Dropping

Such mains transformers as are available these days mostly have H.T. outputs of 350-0-350 volts.

Under these circumstances it becomes necessary to employ some form of voltage dropping device in order that the correct voltage is applied to the valve anodes. For this purpose the mains-energised type of speaker is ideal. In addition to providing very efficient smoothing,

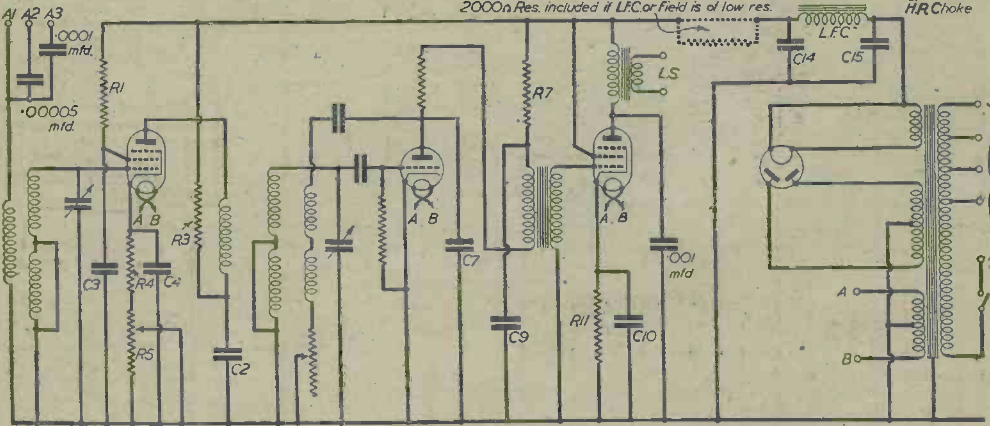


Fig. 2.—Although the basic principles of Fig. 1 have been retained, this circuit is much more simple.

Returning to the L.F. transformer in Fig. 1, it will be seen that a resistance (R8) is interposed between one end of the secondary winding and the grid of the output valve. It is known as a grid stopper and is included in some circuits in order to prevent unwanted oscillations from finding their way to the pentode grid. It is purely a precautionary measure and need only be used if trouble is experienced in this direction. The value is not critical and may be between 50,000Ω and ¼MΩ. The same remarks apply to R9, which is an anode stopper—usually of 100Ω.

Decoupling of a grid bias system is not usual, but is included in Fig. 1 in order that it may be recognised where necessary. R11 is the actual bias resistance, the inclusion of which is essential. R10 and C10 combine to provide decoupling, ½MΩ and 2 mfd. being average values. The circuit diagram of Fig. 2 shows the normal simple arrangement which is usually adopted, R11 and C10 being as in Fig. 1.

It is of some advantage, however, to employ for C10 an electrolytic condenser of large capacity, say, 50 mfd.

Turning now to the output circuit in the first diagram,

thus saving a smoothing choke, a field coil of 2,500Ω also drops the voltage to the required amount. If, however, one is in the position of having to use a permanent-magnet speaker in conjunction with a 350-volt transformer, there are two alternatives. One is to obtain, if possible, a field replacement choke. This is an ordinary smoothing component, having a high resistance of 2,000 to 2,500Ω, which would replace the speaker field. (See Fig. 2.)

The other method is to use the usual choke of, say, 300-400Ω, in series with a resistance of 2,000Ω.

This is shown by the dotted lines in Fig. 2.

Rectifier

The final consideration with regard to Fig. 1 concerns the rectifier, where two condensers in series are connected across the anodes, and the junction taken to earth.

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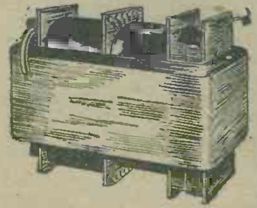

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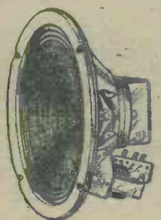

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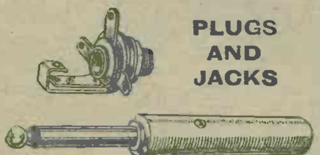

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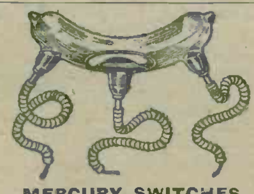

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The Cathode-ray Oscilloscope

Time Base Considerations

(*Continued from page 352, July issue*)

ANOTHER arrangement suitable for the tube supplies is shown in Fig. 7; in this instance a voltage doubling valve circuit is used, and the transformer winding need have a rating only half that of the required potential. Although a single valve is shown in the diagram (an example of which is the Cossor 225 D.U.) a couple of half-wave rectifiers may be employed instead with identical connections. C_1 and C_2 are generally in the region of 0.25 μF, and in some cases the time base supply can be taken from their centre point, P. Apparent lack of balance by this method, i.e., the voltage across C_1 being less than that across C_2 due to the increased load of the time base circuit, might give the impression that the results obtained would be unsatisfactory, but it has given excellent results in practice and can be thoroughly recommended.

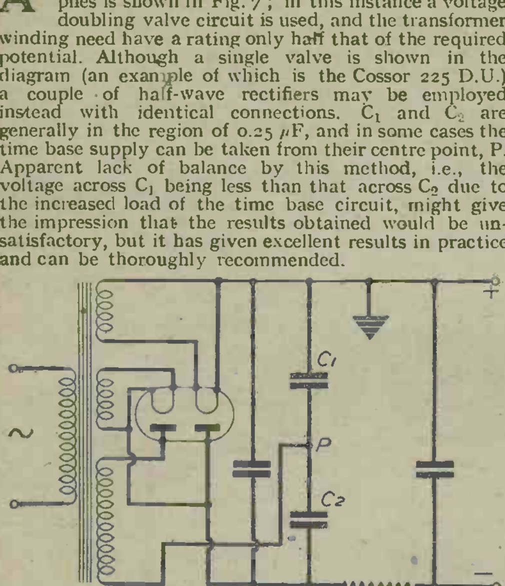


Fig. 7.—A valve voltage doubling rectifier circuit, using a Cossor 225D.U.

Other circuits are much on the same principles, and are quite conventional apart from the voltage supplied. With power packs of this nature the usual precautions must be taken to safeguard against shock and insulation and components must be above suspicion.

Purpose of the Time Base

In order to observe changes in electrical potential in relation to time, it is necessary to bring into use an arrangement whereby a uniform movement of the cathode beam can be made in the horizontal plane with a relatively rapid return to its initial position at the end of the movement. Such a uniform motion is generally referred to as a linear time base, and represents a base sweep of a given duration on which can be represented variations of potential which occur during that period.

In general, for the application of a linear time base deflection to the horizontal controlling plates of a cathode-ray tube, it is desirable to obtain what is known as a linear saw-tooth voltage variation, a voltage which varies uniformly with time and is restored at the end of a given period to its initial value. This return period is a very much shorter one than the forward increase and is referred to as the fly back or back stroke period.

The majority of such voltage waveforms are obtained from so-called squegging or relaxation oscillators, and depend for their formation on the charge of a condenser through a resistance, the condenser being discharged after a given interval by short circuiting. If the horizontal deflectors of the tube are connected across the condensers they will thus have applied to them a gradually increasing potential which abruptly falls to zero.

The most elementary form of saw-tooth oscillator, controlled by mechanical rather than electrical means, is shown in Fig. 8. Here it will be seen that a condenser C is connected in series with a resistance R_1 across a source of D.C. supply of voltage E. The condenser will charge through the resistance until the voltage across its terminals is equal to the e.m.f. of the battery. If now the switch S is closed the condenser will discharge through the resistance R_2, and if this resistance is of negligible value or very small as compared with R_1, the discharge will be extremely rapid. If S is now opened again, the condenser will begin to recharge. If then the switch S is regularly opened and closed, the condenser will be alternately charged through R_1 and discharged through R_2 and, if the component values are properly arranged and the making and breaking of the switch is correctly timed, the voltage across the condenser will be represented by a waveform similar to that shown in Fig. 9.

The rise in volts is a comparatively slow one, linear only on the earlier part of each cycle, the rate of charge being expressed by the well-known formula:

$$E_o = E\left(1 - \epsilon^{\frac{-t}{CR}}\right)$$

and the time of charge or time constant being determined by the product of CR. Any alteration of C or of R will, therefore, alter the periodic time of charge, and in an electrically controlled time base the periodic time of discharge.

Since the charging curve of a condenser (Fig. 10) is exponential, it follows that any time base stroke obtained from this method would be linear over only a certain percentage of the complete charging period, with a resulting distortion of any vertically applied potentials at the extreme end. An obvious means of overcoming this defect is to use only the linear portion of the charging curve, that is, to allow only partial charge of the condenser, discharging it before the exponential characteristic becomes plainly marked. Consequently the resultant waveform across the condenser is more nearly pure saw-tooth (Fig. 11) only a small amplitude being developed and the voltage being substantially linear.

The fly-back time corresponds, of course, with the discharge of the condenser, and depends on the product

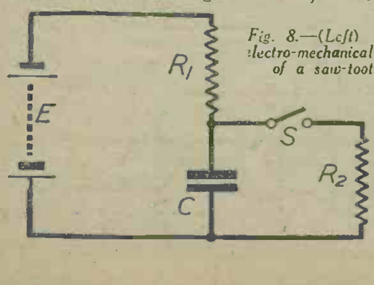
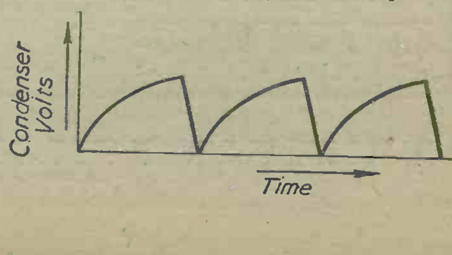


Fig. 8.—(Left) An elementary electro-mechanical arrangement of a saw-tooth oscillator.

Fig. 9.—(Right) The waveform produced by Fig. 8 when the switch operation is correctly timed.



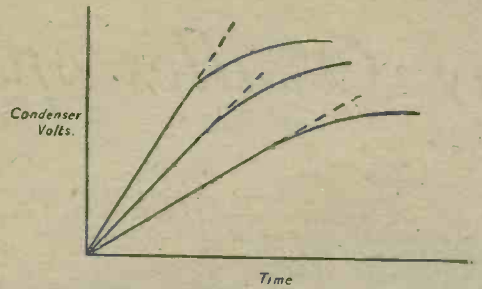


Fig. 10.—Charging curves showing departure from linearity.

of CR_2. As explained previously, the time of discharge must be much smaller than the time of charge, consequently R_2 must be smaller than R_1.

The Neon Circuit

In practice the switch S and the resistance R_2 are replaced by a valve, or combination of valves, so that the saw-tooth voltage waveforms are entirely electrically controlled. Consider a simple arrangement of components, consisting of C and R and a neon lamp connected across a source of D.C. as shown in Fig. 12.

On switching on, the condenser charges through the resistance until the potential across its terminals has risen to the striking potential of the neon, usually in the region of 150 volts. As soon as this happens the condenser discharges through the conduction of the lamp and the

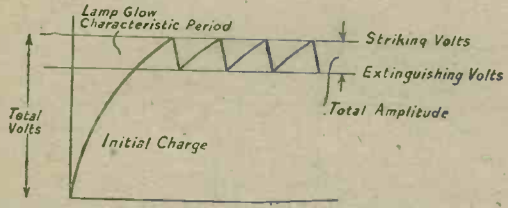


Fig. 13.—Showing the difference between striking and extinguishing volts for a neon lamp.

potential commences to fall. Due to the characteristics of the neon lamp the voltage will fall to about 120 before the discharge is no longer maintained, and the lamp will go out. The condenser immediately recharges and the cycle repeats. The voltage variation across C, therefore, is a comparatively slow build up, followed by a rapid fly-back to its initial position as the condenser discharges. The essential conditions of a saw-tooth waveform are therefore obtained, although if the D.C. voltage is barely above the striking voltage of the neon the charge on the condenser will be practically completed, with the resultant loss of linearity. If, however, the D.C. voltage is made sufficiently high in relation to the neon striking voltage, the working portion of the curve is contained in the initial linear section, and the waveform becomes essentially linear.

As will be seen from a study of the diagram and the above notes, this form of time base possesses a severe disadvantage in that the difference between the striking and extinguishing voltages of the neon lamp represents the maximum voltage variation across the condenser, i.e., the amplitude of the saw-tooth waveform. With the values already mentioned it will be seen that the maximum charge across the condensers is only in the region of some 30 volts, which, without suitable amplification, is entirely unsuitable for use as a deflection voltage in electro-statically controlled cathode-ray tubes (Fig. 13).

Actually, the periodic time of the neon circuit is the total of charge time, and discharge time, and as this is reduced by lowering the product of C and R, the neon lamp will eventually strike and remain conductive independent of the other components. As this limiting value of speed is determined by the time taken by the neon lamp to lose its conductivity it follows that this circuit becomes very erratic at time base speeds, which are below the order of 100 micro-seconds, and is absolutely useless at speeds under 20 micro-seconds.

It is because of these defects of the neon discharge circuit that neons and gas-filled valves are seldom used in modern oscilloscope designs, thus the development of various forms of linear time base circuits in which hard (high vacuum) valves are used to provide the necessary discharging pulses.

The advantages obtained by the use of these valves are, that the time base can be used at much higher sweep frequencies, due to the fact that loss of conductivity or "de-ionisation" time of the gas-filled tube does not come into the problem at all; and the operation of the circuit being practically unaffected by temperature or similar variations, and coupled with the efficiency of modern valves, makes it possible to calibrate the time base directly in time and frequency.

Hard-valve Time Base Circuit

A typical, simple one-valve oscillator which may be used for the production of saw-tooth waveforms is shown in Fig. 14, and is known as the squegging or blocking oscillator. The circuit is very similar to that of an ordinary leaky grid detector, except that the condenser C and leak R are on the earthy side of the grid coil,

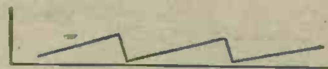


Fig. 11.—The resultant waveform, using only the linear portion of charging value.

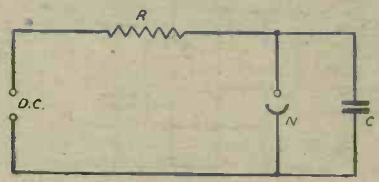


Fig. 12.—A simple electrically controlled oscillator using a neon lamp.

although this is merely for convenience in obtaining the output. The coupling between L and L_1 is made very tight, with the result that the valve oscillates violently. Grid current consequently flows, with the result that the grid-plate of condenser C is driven negative and the valve is cut off. The condenser then discharges exponentially through R until the grid potential again approaches earth, when again the valve oscillates and the cycle repeats. In this case, as compared with the neon lamp circuit, the fly-back period is provided by the rapid charge of the condenser while the actual "scanning" stroke is obtained from the exponential discharge, which is actually the same thing as before, except that the processes are reversed. The output of this arrangement is, of course, decidedly non-linear, because the output is

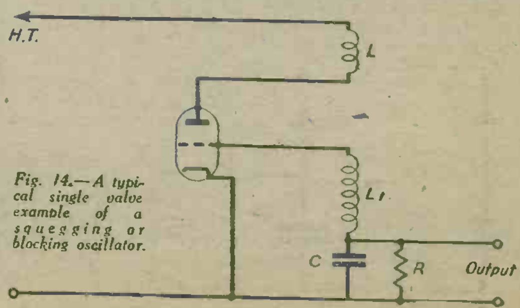


Fig. 14.—A typical single valve example of a squegging or blocking oscillator.

practically equal in amplitude to the total H.T. voltage present in the circuit.

Another form of squegging oscillator is shown in Fig. 15, where once again the saw-tooth waveform is produced across C. No use is made of this directly, however, as the output waveform to be used is produced across C_1. The function of the circuit is similar to that of the previous one; tight coupling between anode and grid coils cause violent oscillation, grid current flows and charges C, carrying the grid rapidly negative, and cutting the valve off. During this period of quiescence condenser C discharges exponentially through R_1, while C_1 charges

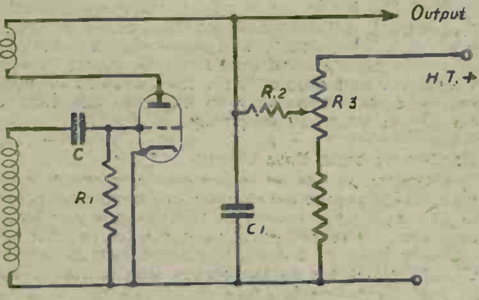


Fig. 15.—Another form of squegging oscillator, having a slightly different operation to Fig. 14.

exponentially from the H.T. supply through R_2. The grid, therefore, is returning to zero potential as the anode voltage approaches the full supply, and at length the valve commences again to oscillate. Anode current is drawn from C_1, discharging it, while C is again driven negative, cutting the valve off.

The frequency at which this operation recurs is determined mainly from the product of CR_1 and the amplitude of the output waveform by the voltag of the H.T. supply which can be varied by a potentiometer R_3. Again in this circuit, if the amplitude is brought sufficiently high the waveform loses its linearity.

Reduction of Fly-back Time

It can be seen from an inspection of the foregoing simple oscillators that there is one disadvantage with them, in that in both of the circuits a coil is included in the charge or discharge path of the condenser. When the condenser is in the grid circuit the charge which constitutes the fly-back period passes through the grid coil; in the second circuit the discharge for the fly-back passes through the anode winding. In both cases the resistance of the coils increase by a definite amount the time of the fly-back.

A simple arrangement for overcoming this defect can be made by using two valves, connected as shown in Fig. 16.

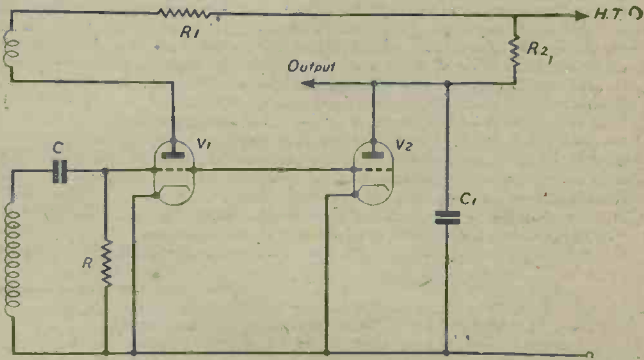


Fig. 16.—An improved circuit designed to overcome the time increase of the fly-back due to the resistance of the coils.

Again V_1 is similar to the circuit shown in Fig. 15, and is simply a squegging oscillator, frequency controlled as before by the values C and R. As will be seen the grid of V_2 is directly connected to the grid of V_1 and will therefore assume any potential present on the grid of the latter. When this grid is negative both valves are biased beyond cut off, and condenser C_1 is charged from the H.T. supply through the resistance R_2. When V_1 again oscillates and becomes conducting V_2 does likewise, discharging C_1. The action of the circuit is exactly similar to that of Fig. 15, except that there are no coils or resistances in the path of the discharge. One way of looking at this arrangement is to consider V_2 as an oscillator-controlled discharge valve, where the oscillations of V_1 act similarly to synchronisation pulses in triggering off the time base.

The Kipp Relay or Multi-vibrator

A special form of oscillator which can be adapted and used for the production of time-base potentials, and is worthy of mention here, is the arrangement known as a Multi-vibrator or Kipp Relay. It is an oscillator which can be made to cover a wide frequency band, consistent with excellent stability. Briefly, it consists of two valves, resistance capacity coupled in a form of back-to-back circuit, with the output of the second valve returned to the grid of the first. The circuit diagram is shown in Fig. 17, simplified for clarity.

The H.T. lead is common for both valves, and the anode of V_1 is connected to the grid of V_2 through the coupling condenser C. The anode of V_2 is returned to the grid of V_1 through the coupling condenser C_1. Grid leaks are taken from each grid to earth line, R and R_1.

The working of the circuit is as follows: Considering that both valves are accurately matched, together with the circuit components, the anode current of each will be the same, but the circuit will be unstable. Any variation in anode potential of either valve, however small, will cause the circuit to go into oscillation. Suppose for the moment that a small positive potential, of immaterial duration, is applied to the anode of V_1. The pulse is transferred via coupling condenser C to the grid of V_2, driving it slightly positive and consequently causing an increase in the anode current of this valve. This produces an increased voltage drop across the anode load, and

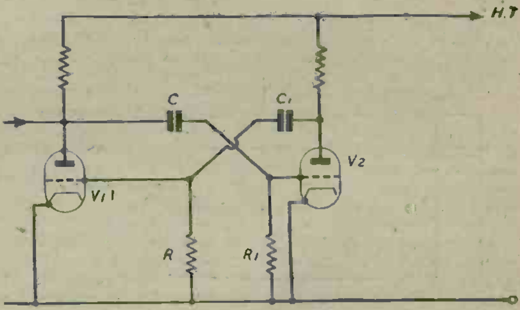


Fig. 17.—Simplified circuit of the Multi-vibrator or Kipp Relay.

this decrease in potential on the anode of V_2 is communicated to the grid of V_1, via C_1, driving it more negative. Anode volts of V_1, therefore, increase due to the decrease of anode current through the load resistance, and this increase is again fed to the grid of V_2. The effect is cumulative and the initial pulse will be increased almost instantaneously to a much greater value.

(To be concluded.)

ON YOUR WAVELENGTH

By THERMION

Our Economic Advisers

IN a recent Parliamentary reply Mr. Dalton, President of the Board of Trade and formerly Minister of Economic Warfare, said if the B.B.C. Home and Forces Programmes were closed down at 10.30 p.m. and listeners turned off their lighting and went to bed, 250,000 tons of coal *might* be saved during the winter months. Now Mr. Dalton has achieved fame like John Hilton (I am referring to the Prof., not the Band Leader) as an expert on Economics. I fail to see how anyone without practical experience of industry can advise Governments. Certainly Mr. Dalton's new scheme for fuel rationing based on the Beveridge report has been criticised by all.

It is impossible to conjecture what would happen if we had not a Ministry of Economic Warfare at all. Many may argue that the war might have taken a different course. In the early days of the war the Minister of Economic Warfare advised us that Germany in three months would be short of this, that and the other; that she could not possibly last for more than six months, and the economic advisers to the Government with that bland disregard for worldly affairs for which they are renowned, based their opinions on the geographical position of the war at the time they made them, never realising that Germany herself realised what she was likely to be short of, and would grab the countries which contained these very things. That is the sort of economic advice which theorists have been handing out to the Government.

There is always the bright schoolboy who has won a scholarship and has learned like a parrot that jet comes from Whitby, that the best oysters live at Dover, whilst the *cognoscenti* of kippers positively revolt at the thought of residing in the sea off Brighton, preferring the more salubrious waters of Yarmouth. They know, these Economic Advisers, that if all the tanks we possess were placed end to end, they would encircle the globe many times, and that by increasing production to the *n*th degree Germany would be beaten in X years. Look back through the files of your newspapers of the past two years and read some of the statements made over the air. Something rather more than holding a chair at a University is required to make a man an expert at Economics. All that is required to lecture upon the subject is a knowledge of the basic principles; it does not require a knowledge of practical application. A lecturer in mathematics could not design a bridge; therefore I wonder how it is that the B.B.C., that has the powerful advice of the Brains Trust, can devote programme space to purely empyrical views of economic lecturers.

Their views are interesting, but in my view unsound, for they lack the superimposition of that experience in the affairs of the world which alone make views worth listening to. I like to listen to the voice of experience. I acknowledge that Mr. Dalton and Prof. Hilton are interesting. Perhaps that is sufficient justification for their talks.

B.B.C. Pronouncers

THE B.B.C. announcers, with the exception of the one who has resigned, are to take a general hand in announcing, apart from the news. We have by this time grown accustomed to their voices and to their names. We must admit that they all have most attractive prænomens, but I do think that as announcers it is only necessary for us to know their surnames. It is quite sufficient to say, "This is the news, and this is Pickles, Howland, Liddell, Belfrage, McLeod or Phillips reading it." When fear of invasion was great it was thought that the public should be accustomed to their voices so that the genuine as distinct from the spurious broadcast could be detected. I do not want to know the Christian names, Frank, Alvar, Bruce, Joseph, Alan, or Wilfrid. Incidentally, why is it that Liddell pronounces his name as Al Varliddell, with accent on the Var?

Cleaning Up the Ether

[The B.B.C. has announced its intention to clean up the ether by deleting from its programmes such words as "Damn" and expletives like "Good Heavens!" And, in future, references to alcoholic refreshment, known in vulgar parlance as "booze," are to be forbidden.]

The B.B.C is shocked,
And may go off the air
If a careless comedian
Lets off a healthy swear.

The transmissions may break down,
And get in an awful jam,
If the daring miscreant foul
Gives vent to a fearful "Damn."

Plainly have the B.B.C. seen
How all at sixes and sevens
Their uplift programmes would be
If he whispered "Good Heavens!"

The Bible, and Shakespeare, too,
Must now both be taboo,
For surely they contain some words
Which really will not do.

The B.B.C. on this point are fixed,
As always they have been,
To ignore such things as entertainment
So long as they keep the party clean.

And one other subject
They evidently mean to abjure,
All reference to good old English beer
Which they call the "Devil's lure."

Sir Kingsley Wood has done his best
To see that we shan't get it,
But the B.B.C. must go one better
By bidding us to forget it.

Don't they need an odd glass or two
During those fearful, cheerful chats,
To help swill down those camels
And drown those natty, choking gnats?

Our Roll of Merit

Readers on Active Service—Twenty-fifth List

P. T. Haskell (L/Cpl. R. Signals).
F. W. Towson (F/Sgt., R.A.F.).
S. Allison (Staff Sgt., R.A.).
J. Oldale (L.A.C., R.A.F.).
H. Adams (Cpl., R.A.F.).
W. A. Rowe (Gnr., R.A.).
L. J. Mutton (Sapper, R.E.P.S.).
E. Hanson (L/Cpl., R.E.).

Radio Examination Papers—9

More Questions, With Suitable Answers, Provided by THE EXPERIMENTERS

SPECIMEN QUESTIONS

1. *What is the usual cause of "howling" and general instability in a public-address or gramophone amplifier, and how would you attempt to cure this trouble when experienced?*
2. *Explain briefly what is meant by the expression "sidebands."*
3. *Describe the principle of the super-regenerative type of receiver.*
4. *Give a simple description of the method of "lining-up" a typical super-het, mentioning the equipment required.*
5. *What is the effect on the output from a mains unit of: (a) reducing the value of the smoothing condenser wired immediately "after" the valve rectifier; (b) using a lower voltage primary tapping on the mains transformer?*
6. *Find the decibel change in gain when an amplifier is modified so that the output voltage is 15, as compared with an output voltage of 5 before carrying out the modification.*

1. L.F.-Amplifier Instability

THE prime cause of instability in a public-address or similar amplifier is feed-back between the output and input circuits. When feed-back occurs there is a risk of the valves falling into self-oscillation; the position is similar to that of applying reaction to a detector valve. In the case under consideration, however, the valves tend to oscillate at audio frequency instead of at radio frequency. The tendency is greatest in a high-gain amplifier, where the output is high in proportion to the input.

Feed-back may occur due to coupling between the loudspeaker and microphone leads, the coupling being magnetic in character. Alternatively, it may be due to sound waves from the speaker striking the microphone, when the coupling may be said to be acoustic. Sometimes a similar form of trouble is due to the sound from the speaker striking one of the valves, whose electrodes are insufficiently rigid; such a valve is said to be microphonic.

When instability or "howling" occurs, which cannot be traced to acoustic feed-back, the first step should be to examine the microphone leads to make sure that they are properly screened, and that the screening is earthed. This is of especial importance should the leads be long.

If these leads are correctly screened it is necessary to look for feed-back coupling inside the amplifier, and then to move or screen leads which are suspected of causing the coupling to take place. The next step should be to check the valves, preferably by substitution, one at a time; in many cases it is the first valve which is at the root of the trouble, since this normally provides a greater voltage amplification than do the others.

Sometimes a makeshift "repair" can be carried out by reducing the overall amplification. This may be done by slightly increasing the bias voltage, by reducing H.T. voltage, or by shunting the anode-coupling component of the first valve with a fixed resistor.

2. Sidebands

When a carrier wave is modulated with audio-frequency the resultant consists of three separate frequencies: one of carrier-wave frequency, one equal in frequency to that of the carrier wave plus the audio-frequency, and one equal to the carrier frequency minus the audio frequency. It is the second and third of these which are described as side bands or sideband frequencies, due to the fact that they occur one on each side of the carrier, and because the three frequencies together produce a certain "band" of frequencies.

It is for the reason just mentioned that a broadcast station covers a certain band width in the tuning range. By comparison, a C.W. transmission is heard at one "spot" frequency and does not spread.

It is actually possible to separate the side-bands from the fundamental frequency, and in certain systems of semi-secret transmissions only one sideband is broadcast. To make the reception intelligible it is necessary to provide a means of "reinstating" the other sideband.

As a numerical example of sideband production, it may be explained that if a carrier of 5,000 kc/s be modulated by an audio frequency of 2,000 cycles, there are produced three frequencies, of 4,998, 5,000 and 5,002 kc/s, and the resulting transmission would require a bandwidth of 4 kc/s. In practice, the modulating audio frequency is normally varying over wide limits and therefore the frequencies of the sidebands are constantly changing. To permit of good transmission and reception of audio frequencies up to 5,000 c/s it would be necessary to cover a tuning band of 10,000 c/s or 10 kc/s.

3. Super-regeneration

A super-regenerative receiver is one in which the detector valve is allowed to oscillate during the reception of radio-telephony. In the ordinary way this would result in non-intelligible reproduction and "howling." This is prevented, however, by breaking-up the oscillation at a frequency above that of audibility—normally at a frequency in the region of 20,000 cycles per second.

This is ordinarily done by means of a second valve acting as a 20 kc/s oscillator, the output from which is applied to the grid of the detector valve. At each negative half-cycle of the 20 kc/s oscillation a negative bias is applied to the detector, and this is of sufficient amplitude to prevent that valve from oscillating for a minute fraction of a second. Fig. 1 shows a simple type of super-regenerative circuit, where V.1 is the oscillating detector valve, and V.2 is the 20 kc/s oscillator. Because of its action in intermittently stopping the detector from oscillating, the second valve is known as a "quench" or "quenching" valve, and the grid and reaction coils associated with it are described as "quench coils."

It is possible to employ a single valve in a super-regenerative circuit, this being so arranged that the valve shall oscillate at two frequencies simultaneously. Sometimes the quenching is arranged to damp the anode instead of the grid circuit, but the general principle remains the same.

The chief advantage of the super-regenerative circuit is that it provides extreme sensitivity with a minimum number of valves. Unfortunately, it has the disadvantage of being very unselective, and it is, therefore, rarely used at the present time. It has the further disadvantage of producing a fairly high background noise.

4. Superhet Alignment

The first essential is to trim or align the I.F. transformers, and this can best be done by the use of a modulated radio-frequency oscillator which will tune to the required intermediate frequency. Leads from the output of the oscillator—which has been accurately tuned to the I.F.—are connected to the primary of the first I.F. transformer. The primary and then the secondary of the transformer are then tuned by means of their pre-set trimming condensers until the oscillator note is heard at greatest strength in the 'phones connected to the receiver. A better method is to compare the output at different settings by means of an output meter.

After adjusting the first I.F. transformer, the second should be trimmed in a similar manner, and then the third, and so on. When 'phones, or a speaker, are used for comparing the output it is important that the output volume should frequently be adjusted, by means of an L.F. volume control. Output should be reduced so that the note is only just audible; with this setting it is far easier to discern any increase in volume.

Having adjusted the I.F. transformer a modulated oscillator, tuned to a frequency within the normal reception band, should be coupled to the receiver input circuit. The main receiver tuning control should be set until maximum output is obtained. The volume control should next be turned down as before, and the oscillator trimming condenser carefully adjusted, constantly reducing the volume-control setting as output increases.

When the best setting has been found, the trimmers on the pre-selector circuits (if fitted) should be adjusted. While this is being done the main tuning control should be slowly and carefully "rocked." After this, it may be necessary slightly to readjust the oscillator trimmer; further slight adjustment of the pre-selector circuits should next be tried.

It is a good plan to check the settings of the oscillator and pre-selector tuning circuits at another signal frequency, or even at a number of frequencies, but the I.F. trimmers should not be touched after initial setting.

5.—Power-unit Alterations

Provided that the smoothing condenser originally fitted was of the capacity specified by the manufacturer of the rectifying valve, the result of using a lower capacity would be to reduce the output voltage. The condenser has the effect of smoothing the "peaks" of rectified voltage and so increasing the average smooth, D.C. voltage. If this smoothing is done inadequately the mean output is reduced.

Tapping-down the primary brings about an increase in secondary voltage. This is because the ratio of secondary turns to primary turns is increased; the voltage ratio is increased proportionately. As an example, a transformer having four turns per volt on both primary and secondary would have a total number of turns on the primary of 1,000 if the input were to be 250 volts. If there were a tapping for 200 volts, this would be taken at 800 turns.

Now if the secondary were to give an output of 500 volts it would have 2,000 turns. Suppose the 200-volt tapping were used for 250-volt A.C. input, the output would be $\frac{2,000}{800}$, or two and a half times the input, which is 625 volts.

In practice this output voltage may not be fully realised due to the greater losses in the transformer resulting from the use of a smaller number of turns per volt than that for which the component was designed. It is sometimes permissible slightly to increase the output voltage by tapping-down slightly on the primary, but this must be done with care.

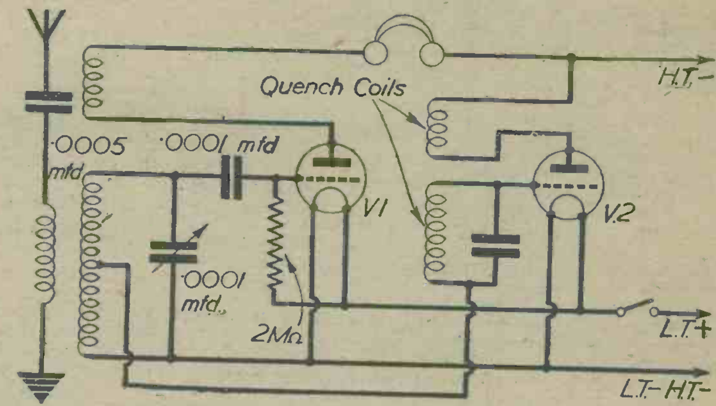
6.—Decibel Attenuation

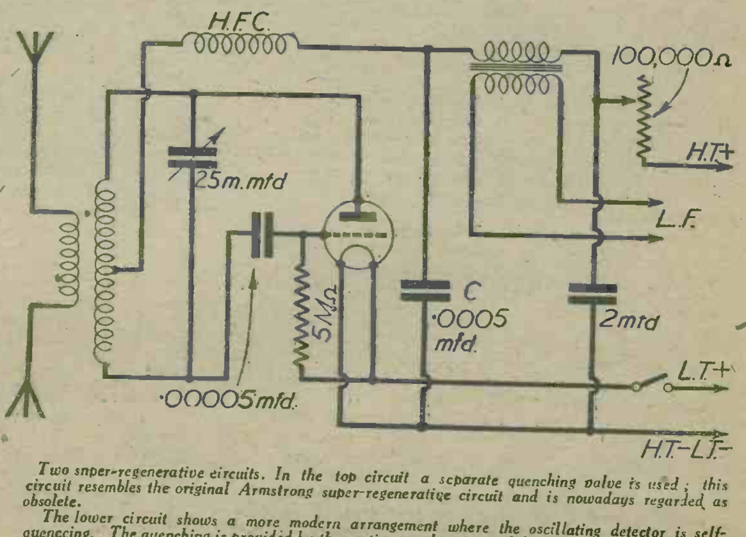
There is a simple formula which shows the decibel change (gain or attenuation) for a known change in output voltage. This is: Decibels$=20 \log \frac{E_1}{E_2}$, where E_1 is the new output voltage and E_2 is the original output voltage. The ratio between the two voltages is first calculated, and then the logarithm of this figure is found from ordinary log tables. The answer so obtained is multiplied by 20.

If we substitute the figures given in the question we have: Decibels$=20 \log \frac{15}{5}$, which is equal to 20 times the logarithm of 3. From tables it can be found that the logarithm of 3 is 0.4771, and when this is multiplied by 20 we obtain the answer as 9.542.

Thus, the decibel gain after modifying the amplifier is nearly 10.

Should the rates be less than unity it is an indication that the power change is a loss, or that attenuation takes place. When the ratio is greater than unity it is known that there is a gain in amplification.





Two super-regenerative circuits. In the top circuit a separate quenching valve is used; this circuit resembles the original Armstrong super-regenerative circuit and is nowadays regarded as obsolete.

The lower circuit shows a more modern arrangement where the oscillating detector is self-quenching. The quenching is provided by the continuous charging and discharging of the .0005-mfd. condenser marked C. This circuit is more modern and is intended for ultra-short-wave reception. As may be seen, the Hartley circuit is used for the oscillating detector.

Why the

Cone Movement. Elimination or Cancellation.

By L. O. S

ASSUMING a good speaker—without any form of baffle attached—is connected to an equally good L.F. amplifier, and with the speaker resting on its magnet so that its cone is pointing upwards and the circuit is put into operation, the results will be most disappointing; in fact, if the operator is not experienced in such matters, he would immediately condemn the amplifier and/or the speaker on the score of poor tonal response. The reproduction would be both weak and thin, and the low-note response would be noticeable by its absence. If the speaker is now tilted so that the edge of the cone frame rests on the table, a marked improvement will be obvious. The signal will have more body, better balance and appear to be louder. This simple test should be sufficient to prove that baffle-board does do more than provide a means of mounting the speaker. It does not, however, tell one why; that is the purpose of this article.

Cone Movement

Ignoring for the present the higher technicalities connected with the behaviour of the cone when reproducing a wide range of frequencies, it can be likened—at low frequencies—to a piston working in an imaginary cylinder.

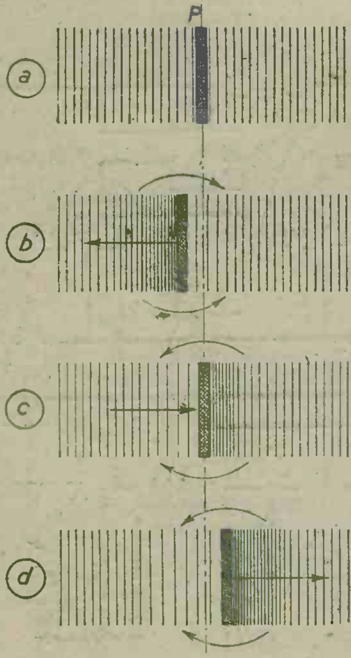


Fig. 1.—The effect of cone movement on the surrounding air.

Let P in Fig. 1a represent the piston, and the vertical lines the surrounding air. Fig. 1b shows what happens when P moves forward; the air immediately in contact with the front of P is compressed, and that behind P is rarefied or a partial vacuum is produced. When the piston or cone returns to its normal position, the effect shown by Fig. 1c is produced. The air behind now becomes compressed, that in front rarefied, and the original front compression moves forwards. The third movement of the piston is back beyond its position of rest, and this brings about further compression as shown by Fig. 1d.

It is not possible to portray the complete air movement, but if one imagines the vertical lines to represent wave form, a fair idea will be obtained of the effect produced by the compression and rarefication.

When the speaker, used in the first simple experiment, was vertical on the table, the air pressure brought about by the movement of the cone was, to a great extent, neutralised or lost, thus the poor volume and tone. This was brought about in the following manner. When the cone moved forward, the air compressed in front was at a much greater pressure than at the rear, where we have seen a partial vacuum was produced. The air in front, therefore, takes the line of least resistance and, instead of passing on along its correct direction, it flows round the cone into the vacuum area, thus equalising the pressure on each side of the cone. If we assume that the air in front of the cone takes the form of a column—to make matters more clear—it can be said that no sound will be produced if no pressure is created or exerted on the column. Again, all speaker users are aware that sound is radiated from both sides of the cone—Fig. 1 shows that—but, if the sound waves from the rear of the cone are allowed to meet those from the front at a phase difference of 180 degrees, theoretically, complete cancellation of sound radiation would result. In practice, say, during the experiment mentioned in the opening of this article, one would notice a marked falling off in the volume and response, or a decided dip in the response curve. The need for and the purpose of a baffle-board should, therefore, be obvious, as it is the most simple means of preventing the inter-action between the two sets of sound waves or air pressures created by the cone.

Fig. 3.—Thick felt forms ... and sound damper wheh...

Effects of Baffle.

The fitting of a small baffle, say, 18ins. square, to a 7ins. cone speaker, will produce a noticeable improvement generally, but the low-note response would still be poor. This is due to the fact that the cancellation

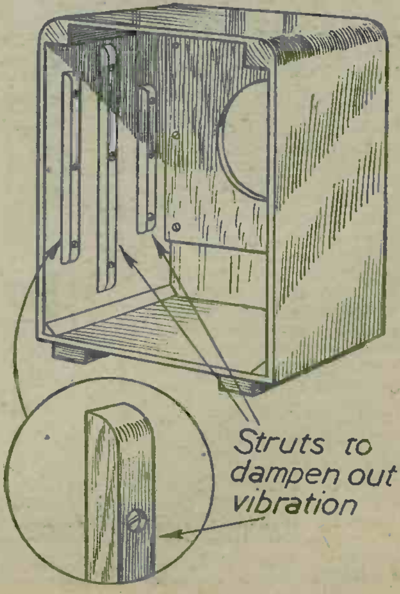


Fig. 2.—Using struts to damp out or eliminate case vibration. They should be fixed firmly in position by screws and glue. Note uneven lengths.

e Baffle ?

Speaker Cabinet Defects. Resonance and Boom

O. SPARKS

is more pronounced at low frequencies and less with the higher frequencies, the latter radiating from the cone more in the form of a beam which produces a definite directional effect. To provide what could be termed a reasonable baffle area for the average speaker when one desired good all-round response, it would be necessary to make one, at least 6ft. square and 1in. thick. This is rather too large for normal domestic purposes, therefore use is made of what might be called a folded-back baffle, in the form of a cabinet or speaker-box. If 324 sq. ins. (18 by 18ins.) is the area of the *front* of a cabinet, which has sides 12ins. by 18ins., then the total baffle area will be in the region of 1,188 sq. ins. against the 324 sq. ins. of the single board.

This would seem to be a simple and effective way of obtaining the desired results; it is, up to a certain point, but, unfortunately, other unwanted effects are usually introduced and it is necessary to take certain measures to ensure their elimination, otherwise results will be worse than when using a plain baffle of even smaller dimensions.

forms an efficient resonance when used as shown here.

Cabinet Boom

The air contained in any vessel—we can think of a cabinet as that for the moment—will resonate at some definite frequency, known as its fundamental frequency. If the vessel is constructed of material which will also readily respond to vibrations then the resonance will assume more complex characteristics. The first is often referred to as "box" resonance, and the latter as "cabinet" resonance, but they are closely related in both effects and remedies.

If a good loud-speaker, fed from a first-class amplifier, was mounted in a box having the dimensions previously mentioned, and constructed from plain wood having a thickness of, say, ⅜ in., the results would, no doubt, be marred by pronounced "booming," woolliness and definite peaks in the reproduction. This would be due to the items described above.

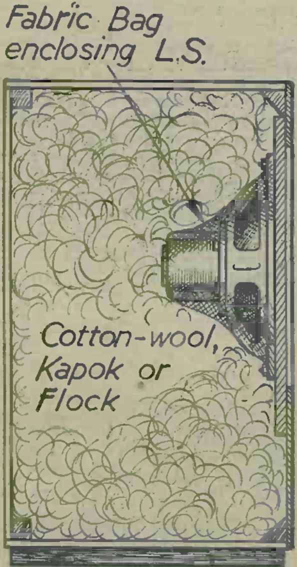


Fig. 4.—"Killing" the air column contained within the cabinet.

Remedies

To overcome these defects it is necessary to make the box or cabinet of stout wood, strengthen the sides by the use of rigid wooden members of irregular lengths screwed firmly in position and damp down or eliminate the air column. In addition to these preliminary items the interior of the cabinet should be lined with thick felt, paper-compound boards, cotton-wool, "kapok," flock or other similar sound-absorbing material. When fixing this in position it should be secure, but not tightly packed. The essential requirements during these modifications are to eliminate anything that will vibrate or rattle, and provide the maximum sound absorption possible.

If the rear of the speaker is protected by a cloth covering—muslin will do—the whole of the interior of the cabinet can be filled, loosely, with cotton-wool or similar material, and, if a wooden back is fitted, a large hole should be cut in it, practically the size of the interior of the cabinet, and covered over with a further piece of muslin or open-weave fabric. The above will not only eliminate—to all intents and purposes—the column of air, and thus prevent resonance from that source, but it will also act as a most efficient sound absorber.

Infinite Baffle

This is a term often used in conjunction with speaker cabinets of certain design, as it is claimed that the full effects secured by the use of a baffle of infinite area can be secured. In the main, the design consists of a cabinet having but a single opening for the speaker, the construction being such that there is no possibility of vibration being set up in the sections forming the assembly. The interior is best lined with a thick layer of sound-absorbing material, but the actual shape of the cabinet is not of major importance, provided that its cubic capacity is such that the resonant frequency is well below the lowest frequency of the speaker.

Fig. 5.—A recessed baffle-board plus short horn is very effective, as better loading of the cone is obtained and cabinet troubles are reduced.

Apart from the "infinite" baffle arrangement the writer has found that much can be done with an ordinary cabinet, treated in the manner mentioned under cabinet boom, to improve general response and reduce cancellation by offsetting the speaker from the centre of the cabinet face or speaker baffle. Various tests were carried out with boards of irregular shape, and fixing the speaker

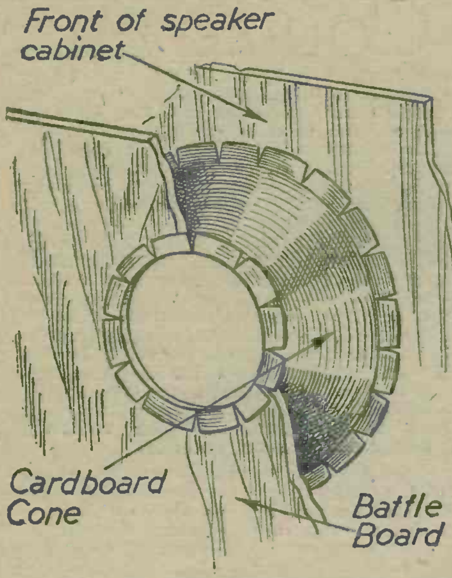


Fig. 6.—The method used for fixing the flare, which the writer made of cardboard.

off the centre point, and results were most certainly improved. The idea behind it all was to try to break up the paths between back and front of speaker-cone into irregular lengths. This has the effect of levelling out the general response curve by broadening, as it were, the band of frequencies effected by the cancellation process.

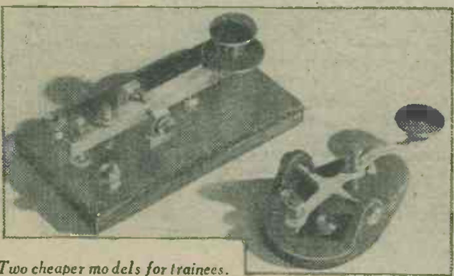
Before finishing with simple cabinets there is one more system which is well worth trying, and that is to combine a short flare or horn with the cabinet. This can quite easily be achieved by mounting the speaker on a baffle which is securely fixed inside the cabinet, say, 6 ins. away from the front. The hole in the latter is cut to a diameter of approximately 3 ins. larger than that of the cone, the idea being to remove a circle having a diameter the same as that which would be produced if the angle of the cone was extended to the front. The baffle-board opening and the one in the front of the cabinet are then linked together to form a short section of a horn by a suitably shaped piece of soft cardboard, and the surrounding space filled in with cotton-wool or "kapok." The method is more clearly explained in Figs. 5 and 6.

When assembling, the cardboard—or stiff paper—horn is glued around the opening in the cabinet. When set, lay the cabinet on its face and arrange cotton-wool around horn, and then fix partition in position, taking care to see that inner end of horn projects through the opening. Screw the partition to fillets and stick down edges of horn—as shown in Fig. 6. The speaker—mounted on its own small baffle—is then screwed to the partition, so that the cone registers with the opening of the horn. Complete by filling rear of cabinet with cotton-wool.

(To be continued)

New Range of Morse Keys

CONSIDERABLE attention is now being given to Morse Keys, therefore it was with great interest that we examined four keys recently submitted by Messrs. Webb's Radio, of 14, Soho Street, London, W.1. The outstanding model—from the point of view of workmanship and unique design—was the well-known McElroy "Bug" Key, which operates on a semi-automatic principle. Whilst this type of key is widely used in America, and is, of course, directly connected with the record breaking achievements of McElroy, the American Morse specialist, Messrs. Webb point out, that the key is now unobtainable in this country, and has been submitted solely out of interest and to form a comparison with those of the more standard types.



Two cheaper models for trainees.

The other model appearing in the same illustration is a heavy bar type following the standard P.O. design, and is exceptionally well constructed and finished. It is priced at 28/-, and it is to be recommended where a precision key is required which will stand up to continuous service.

In the second illustration, two cheaper models are shown, one, an all-metal assembly having a swan-neck bar and known as the "Stream" key, costs 8/6. It is fitted with heavy silver contacts and is extremely light in operation and adjustment. The other model has been designed for British trainees and is known as the "Trainer," its price also being 8/6. Both of these keys represent good value and should prove of great assistance to those who wish to perfect their Morse sending.

An interesting note from Messrs. Webb is the fact that the American keys are really designed for operation when the arm and elbow are resting on the desk or table, whereas the British types are more concerned with manipulation when the arm is kept, so to speak, in the air without a resting surface, all movement being obtained from the wrist.

The McElroy "Bug" Key and the P.O. type.

A Refresher Course in Mathematics

By F. J. CAMM

(Continued from page 363, July issue)

Simple Equations, Simultaneous Equations, Permutations and Combinations, the Binomial Theorem

THE perimeter of a rectangle is 14 yds., and if 3 yds. be taken from one side and added to the other the area will be doubled. What are the lengths of the sides?

Answer: 1 yard, and 6 yards.

At what time between three and four do the hands of a watch coincide?

Answer: $10^{10}/_{11}$ mins. to 4.

What number is that which when multiplied by 4 will be in excess of 50 as much as it is now short of it?

Answer: 20.

A dry cell has an E.M.F. of 1.03 volts, and it is connected into a circuit whose resistance is 16 ohms. What is the current sent through the wire? The internal resistance of the cell is 3 ohms.

Answer: .0542 amperes.

Two tanks contain a mixture of alcohol and water. In the first tank the ratio of alcohol to water is 7 to 3, and in the second tank the ratio is 3 to 1. How many gallons from the tank containing the 3 to 1 ratio must be put with 5 gallons from the other tank in order to give a ratio of alcohol to water of 11 to 4.

Answer: 10.

Smith can complete a given piece of work in 9 days. Jones takes twice that time, whilst Robinson does three-quarters as much work as Smith in one day. How long will it take Smith, Jones and Robinson working together to complete the piece of work?

Answer: 4 days.

The value of a fraction is $\frac{1}{2}$ when 4 is added to its numerator. The value of the fraction is $^1/_5$ if 7 is added to the denominator. What is the fraction?

Answer: $^5/_{18}$.

If Smith gives 10s. to Robinson, the latter will have twice as much as Smith; but if Robinson gives 10s. to Smith the latter will have three times as much as Robinson. What money has Smith and Robinson?

Answer: 22/- and 26/-.

Assuming that a battery containing 13 cells, each cell yielding 1.8 volts, and also assuming that the resistance of each cell is .3 of an ohm, what current will be passed, assuming that the battery is connected into a circuit having a resistance of 16 ohms.

Answer: 2.16 amperes.

Simultaneous Equations

An equation which contains two unknown quantities (usual x and y) is a *simultaneous equation*. By giving values to one of the unknown quantities values which correspond can be found for the other unknown quantity.

For example:

$$4x-3y=2.$$

This really means that we must find two numbers of such a value that three times the second, subtracted from four times the first, equals 2. Now we have previously seen that we can *transpose* from one side to the other, and thus $4x-3y=2$ is equal to $4x=3y+2$.

Now give successive values of 1, 2, 3, and so on to y, so obtaining corresponding values of x. Thus:

$$y=1,\ 4x=5;\ \therefore\ x=\frac{5}{4}$$

$$y=2,\ 4x=8;\ \therefore\ x=\frac{8}{4}$$

$$y=3,\ 4x=11;\ \therefore\ x=\frac{11}{4}$$

$$y=4,\ 4x=14;\ \therefore\ x=\frac{14}{4}$$

Similarly, we can give values to x and find corresponding values of y. Later on we shall see the value of this when we come to plot graphs.

In the above equation we have found corresponding values, and so if we had a second equation, such as $6x-5y=2$ and give values to either x or y, corresponding values of the other unknown quantity will be obtained, and we can compile a similar table or values of x and y, as above. A comparison of the two sets of values will show that only one pair of values of x and y satisfies both equations.

Equations such as

$$4x-3y=2,$$

in which the same values of the unknown apply are as we have seen *simultaneous equations*.

To find the value of two unknown quantities we have established that it is necessary to have two equations.

In the solution of simultaneous equations we must have as many independent equations as there are unknowns to be found. Therefore, if there are three unknowns we should require three distinct equations; if there are four unknowns as w, x, y and z, we should require four equations.

Elimination

When these equations are given it is possible by a process of *elimination* to obtain other equations, in which some of the unknowns do not occur. There are two methods generally adopted in solving simultaneous equations containing two unknown quantities. The first is *to find the value of one unknown in terms of the other unknown, and then to substitute the value so found in the other equations.*

The second is by *multiplication or division*, to make the co-efficients of one of the unknowns the same in the two equations, when by subtraction or division one of the unknown quantities is eliminated, thus leaving only one unknown, the value of which will be found by the methods already described.

Example:

$$5x-2y=10$$
$$3x-\ y=7$$

Applying the second method, multiply the first equation by 3, and the second by 5. This will produce:

$$\begin{array}{rr} & 15x-6y=30 \\ \text{Subtract} & \underline{15x-5y=35} \\ & -\ y=-5 \\ \text{Divide throughout by } -1 & y=\ 5 \end{array}$$

Now substitute the value of 5 in the first line, and we have

$$5x-10=10$$

from which $5x=20$ (transposing the -10 to the right-hand side of the equation to produce 20).

Hence, $x=4$.

By the first method $5x=10+2y$

$$\text{and}\quad x=\frac{10+2y}{5}$$

$$\text{From this}\ 3x=\frac{30+6y}{5}$$

Now substitute this value in the second quation $3x-y=7$.

$$\frac{30+6y}{5}-y=7$$

Next multiply both sides of the equation by 5 to get rid of the fraction.

$$30+6y-5y=35$$
$$\text{from which } 30+y=35$$
$$y=5$$

Substituting this value the value of x can be found by the method already described.

It is very necessary to become adept at solving simultaneous equations. Here are some examples:

$$6x+15y=63$$
$$8x-6y=14$$

Answer: $x=4$. $y=3$.

$$2x+\frac{2y-22}{3}=30$$
$$\frac{3x-15}{4}+6y=108$$

Answer: $x=13$, $y=17$.

$$\frac{2}{x}+y=1$$
$$\frac{1}{x}+2y=1\tfrac{1}{4}$$

Answer: $x=4$, $y=\frac{1}{2}$.

$$(a-b)\,x+(a+b)\,y=a^2-b^2$$
$$(a+b)\,x-(a-b)\,y=2ab$$

Answer: $x=\frac{1}{2}\,(a+b)$, $y=\frac{1}{2}\,(a-b)$.

If 5 be added to the numerator of a fraction its value will be $\frac{1}{2}$, and if 1 be subtracted from the denominator, its value will be $\frac{1}{5}$. Find the fraction? The fraction is thus $\frac{x}{y}$. Add 5 to the numerator

$$\frac{x+5}{y}=\frac{1}{2}$$

Now subtract 1 from the denominator

$$\frac{x}{y-1}=\frac{1}{5}$$

Therefore $\frac{2x+10}{y}=1$

By cross-multiplication $2x+10=y$

Or $2x-y=10$

From the second equation $5x=y-1$

By transposition we obtain $y-2x=10$

and $y-5x=1$

$$3x=9$$
$$x=3$$

Substituting this value in any one of the equations we find that $y=16$, and hence the fraction is $\frac{3}{16}$.

Permutations and Combinations

I now deal with the question of permutations and combinations, since, before the principles of the binomial theorem can be understood, it is necessary to understand this branch of calculation. A *permutation* is the number of different arrangements that can be made of a number of quantities.

If V represents the variations of n things taken r together:

$$V=n\,(n-1)\,(n-2)\,(n-3) \text{ to } r \text{ factors.}$$

Here is an example:

A licence is numbered Ba3456; how many licences are there? Counting the digits and letters we can regard the number as being composed of six compartments. The first two can be occupied by letters, and the remaining four by digits. It is obvious that the first compartment can be filled in 26 different ways, because there are 26 letters in the alphabet. If we put A in the first compartment there are 26 ways, similarly, of filling the second compartment, and similarly with B in the first compartment, and so on. Therefore, there are $26+26+26+26\ldots$ or 26×26 different ways of filling the first two compartments. The digits are 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, and therefore it is apparent that there are 10 different ways of filling each of the four remaining compartments, or 10^4 ways of filling the whole four compartments. Hence the licences, using four digits and two letters as in the example given, can be numbered in $26^2\times10^4$ different ways. The answer therefore is that in this series of licences there are 6,760,000 differently numbered licences. Here is another example:

A manufacturer wishes to make three sizes of tin box using five different colours for each size. How many variations?

Answer: $3^2\times5^3$.

Another example:

There are four signalling flags. In how many ways can these be arranged one above the other?

Obviously any flag can be placed at the top, and when a particular flag has been so placed there are three ways of filling the space below. Therefore, the two upper positions for the flags can be filled in 4×3 different ways, and hence the whole series of flags can be arranged in $4\times3\times2\times1$ different ways, or 24 different ways in all. In other words the arrangement is *factorial* 4, and is usually written mathematically as $\lfloor 4$. Sometimes the product of a series such as $4\times3\times2\times1$ is written $4\,!$, and the latter is frequently used.

$$\text{Thus, } 3\,!=3\times2\times1=6.$$
$$4\,!=4\times3\times2\times1=24.$$
$$5\,!=5\times4\times3\times2\times1=120.$$
$$6\,!=6\times5\times4\times3\times2\times1=720.$$

Now the factorial symbol ! or $\lfloor$ can only be used in conjunction with a positive integer, but if n is a positive integer greater than 1 $\lfloor n = \lfloor n-1$.

It is convenient to define $0\,!$ or $\lfloor 0=1$.

Another example:

If there are six tin boxes, in how many different ways can any four of them be placed one above the other?

From our previous reasoning it is obvious that the answer is $6\times5\times4\times3$. Thus the number of permutations of six things taken four at a time and arranged in a row, or one above the other, is 360.

Usually the permutations of n things taken r at a time is written ${}^nP_r$, which means the product of r factors decreasing by one at a time and beginning with n. The last factor will be $n-r+1$. and so we may re-write the formula given above:

$${}^nP_r=n(n-1)(n-2)(n-3)\ \ldots\ (n-r+1).$$

It is convenient in calculations involving factorial notation not to multiply large products, but to leave them in factorial form. Here are some examples:

The index number of a motor car is ABY430. How many such numbers are there containing three letters and one digit, three letters and three digits, and three letters and two digits?

Answer: (1) $26^3\times9$; (2) $26^3\times900$; (3) $26^3\times90$.

A factory has n football teams. Each team plays every other team once; how many matches do they play?

Answer: $\frac{1}{2}n\,(n-1)$.

A bus service has 10 ticket stages. How many different stage tickets must be printed for this service?

Answer: 90.

Combinations

If there are seven equally good men out of which a team of three are to be provided, how many different teams could be selected? It is apparent here that the arrangement of the men within the team does not matter. Therefore it becomes a problem involving the selection of different *groups* and not the formation of *different arrangements*. Each of these groups is hence termed a *combination* of n things taken r at a time. The number of such combinations is written ${}^nC_r$.

$${}^nC_r=\frac{{}^nP_r}{\lfloor r}=\frac{n(n-1)(n-2)(n-3)\ \ldots\ (n-r+1)}{\lfloor r}$$

It is very necessary that the reader should understand the *difference between a combination and a permutation.*

Summarising, *a permutation is the order in which things are taken into account, whereas in a combination the order does not matter.* Hence, xyz, xzy, yxz, yzx, zxy and zyx are different permutations of the same combination.

Example: How many different selections of four letters can be made from the letters u, v, w, x, y, z, without restriction, and secondly, if u must be in each selection?

Also, if u and y must be in each selection.

Answer: (1) 15; (2) 10; (3) 6.

In a game of whist 52 cards are dealt in four hands of 13 cards. How many different arrangements of the cards are possible?

Answer: $\dfrac{\underline{|52}}{(\underline{|13})^4}$

The Binomial Theorem

We have already seen that $(a+b)^2=a^2+2ab+b^2$, and that $(a+b)^3=a^3+3a^2b+3ab^2+b^3$.

Similarly $(a+b)^4=a^4+4a^3b+6a^2b^2+4ab^3+b^4$.

Proof: $(a+b)^2=(a+b)(a+b)$

$$\begin{array}{l} a+b \\ a+b \\ \hline a^2+ab \\ \quad +ab+b^2 \\ \hline a^2+2ab+b^2 \\ \hline \end{array}$$

$(a+b)^3=(a+b)(a+b)(a+b)$

$$\begin{array}{l} a^2+2ab+b^2 \\ a+b \\ \hline a^3+2a^2b+ab^2 \\ \quad a^2b+2ab^2+b^3 \\ \hline a^3+3a^2b+3ab^2+b^3 \\ \hline \end{array}$$

$(a+b)^4=(a+b)(a+b)(a+b)(a+b)$

$$\begin{array}{l} a^3+3a^2b+3ab^2+b^3 \\ a+b \\ \hline a^4+3a^3b+3a^2b^2+ab^3 \\ \quad a^3b+3a^2b^2+3ab^3+b^4 \\ \hline a^4+4a^3b+6a^2b^2+4ab^3+b^4 \\ \hline \end{array}$$

Observe from these examples that the numerical examples in the *expanded forms* (*expansions*) are similar to expansions of $(1+x)^2$, $(1+x)^3$, etc., and this must be so for all powers of the expression.

For example $(1+x)^3=1+3x+3x^2+x^3$
and $(1+x)^4=1+x$

$$\begin{array}{l} \hline 1+3x+3x^2+x^3 \\ \quad x+3x^2+3x^3+x^4 \\ \hline 1+4x+6x^2+4x^3+x^4 \\ \hline \end{array}$$

In this product take any coefficient, 6 for example. It is obvious that this is the sum of 3, the coefficient of x^2 in the product of $(1+x)^3$, and 3 the coefficient of x in $(1+x)^3$. It will now be seen that the coefficients of x in $(1+x)^4$ may be found from the coefficients of $(1+x)^3$.

Hence $1+3=4$
$3+3=6$
$3+1=4$
and unity as a coefficient at each end.

Now, a *binomial* is an expression consisting of two terms, as $x+y$, and the *binomial theorem* is the rule or formula by means of which any power of a binomial may be found without performing the successive multiplications.

Pascal's Triangle

The order of the coefficients in $(1+x)^3$ and $(1+x)^4$ will be seen to follow a rule:

1 3 3 1
ΛΛΛΛ
1 4 6 4 1

By this method we can thus find, without calculation, the power of $(1+x)^5$, or any other power of it. Pascal's triangle gives the rule for the coefficients. Thus in $(1+x)^5$ the triangle would be

1 1
ΛΛ
1 2 1
ΛΛΛ
1 3 3 1
ΛΛΛΛ
1 4 6 4 1
ΛΛΛΛΛ
1 5 10 10 5 1
ΛΛΛΛΛΛ
1 6 15 20 15 6 1
ΛΛΛΛΛΛΛ
1 7 21 35 35 21 7 1

Readers will here see the connection between permutations, combinations and the binomial theorem.

Thus, the binomial theorem is $(1+x)^n$ or $(x+y)^n$ = expansion of $1+x$ or $x+y$.

Take the product of the n factors of $(1+ay)$ $(1+by)$ $(1+cy)$. . . . It is obvious, at a glance, that

$$(1+ay)(1+by)=1+(a+b)y+aby^2$$
$$\text{and } (1+ay)(1+by)(1+cy)$$
$$=1+(a+b+c)y+(ab+bc+ca)y^2+abcy^3,$$

and

$$\begin{aligned} &(1+ay)(1+by)(1+cy)(1+dy)\ \ldots \\ &=1+(a+b+c+d+\ \ldots)y \\ &\quad+(ab+bc+\ \ldots)y^2 \\ &\quad+(abc+bcd+\ \ldots)y^3+\ \ldots \\ &=1+(\Sigma a)y+(\Sigma ab)y^2+(\Sigma abc)y^3\ \ldots \end{aligned}$$

Σ = the summation of the products of ab, etc. We have seen earlier, when dealing with combinations, that all products such as ab are all the combinations possible by selecting two of the letters of the n series, and, as we have seen, they may be designated by ${}^nC_2$.

Therefore, ${}^nC_1$ is the number of terms in Σa.
${}^nC_2$ is the number of terms in Σab.
${}^nC_3$ is the number of terms in Σabc
and so on.

Summarising: $(1+x)^n$
$$=1+{}^nC_1x+{}^nC_2x^2+{}^nC_3x^3\ \ldots\ {}^nC_nx^n$$

This only applies, of course, when the index is a positive integral.

For fractional and negative values of n a different rule applies, and it is outside the scope of these articles to deal with it.

Simple Interest

Money which is paid for the use of money loaned for a certain time, or invested at a fixed rate per cent., is known as *Interest*.

Let P = the *principal* or money lent (expressed in pounds).
R = *Rate per cent.*, or the interest on £100 for one year.
A = the *Amount*, or principal + interest.
I = *Interest*.
T = *Time* in years.
Then:—

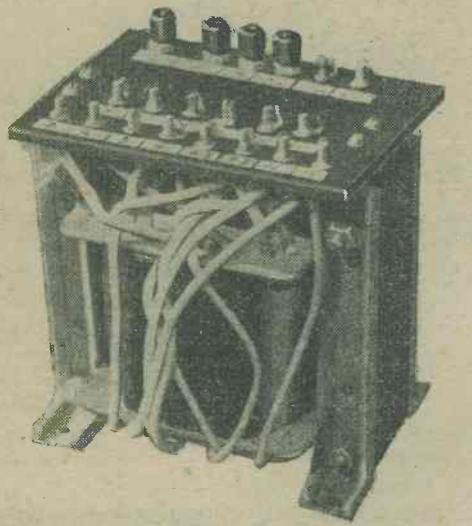
$$A = P+I = \frac{P(100+RT)}{100}$$
$$I = \frac{PTR}{100}$$
$$P = \frac{100}{RT}$$
$$R = \frac{100\,I}{PT}$$
$$T = \frac{100\,I}{PR}$$
$$P = \frac{100\,A}{100+RT}$$

It should be remembered that if the time is given in days, weeks, or months, the 100 in these equations should be multiplied by 365, 52 or 12 respectively.

(To be continued.)

A Universal Filament Transformer

Constructional Details of a Useful Unit



The completed component, showing how the tapping leads are taken to the terminal board.

IN the issue of PRACTICAL WIRELESS dated February 24th, 1940, a design for a Valve Tester was described which necessitated a transformer capable of giving all valve voltages from 2-40 volts. This was for the purpose of heating the filament of any valve likely to be tested. This is, of course, a specific requirement of any universal tester.

In an attempt to procure the component the writer had considerable difficulty. At first the ready-made transformer was sought, but no shop or dealer seemed to have heard of it. An attempt to get it wound proved to be no more helpful. Either they were too busy to do it or the price for the job was far more than the writer was prepared to pay. All these difficulties were overcome, however, by deciding to wind the transformer at home. After all, with patience and care it is possible to wind any transformer, and this one certainly did not prove to be so difficult as was anticipated.

The specification and design were worked out from data supplied by that very useful handbook, "Coils, Chokes and Transformers," and all the essential details are here given in the accompanying data panel.

In order to get the stampings a short tour was made of the radio "junk" stores where a burnt-out transformer of the size required was soon procured. This was dismantled, but as the bobbin was of cardboard and slightly damaged, a new one had to be made, this time in wood. Dimensions of this are given in the diagram, and the wood may be two-ply. This is thick enough to make a strong former, which is rather necessary in this case.

First glue up the square-section tube, and carefully put it in a vice or clamp till set. The end pieces are then glued on and should be a good tight fit over the tube. The bobbin may then b shellaced or painted.

Winding

This is best accomplished with the aid of a hand-drill fixed in a vice—many simple but ingenious methods can be devised. The writer has made quite a useful coil winder, using a hand-drill as the main drive.

The primary is put on first, consisting of 1,500 turns, and is tapped for 210 and 230 volts (see data panel). It is advisable to interleave each layer of turns with thin waxed paper, rice paper, or even tissue paper, but if this is found to be too tedious, then every five layers

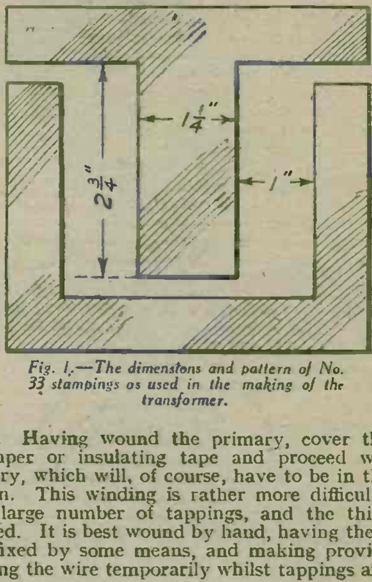


Fig. 1.—The dimensions and pattern of No. 33 stampings as used in the making of the transformer.

will do. Having wound the primary, cover this well with paper or insulating tape and proceed with the secondary, which will, of course, have to be in the same direction. This winding is rather more difficult owing to the large number of tappings, and the thick wire employed. It is best wound by hand, having the bobbin firmly fixed by some means, and making provision for anchoring the wire temporarily whilst tappings are being made

Here are a few tips concerning the winding which should be noted. Tappings must be taken at the *exact* number of turns. The junction of the tapping should be

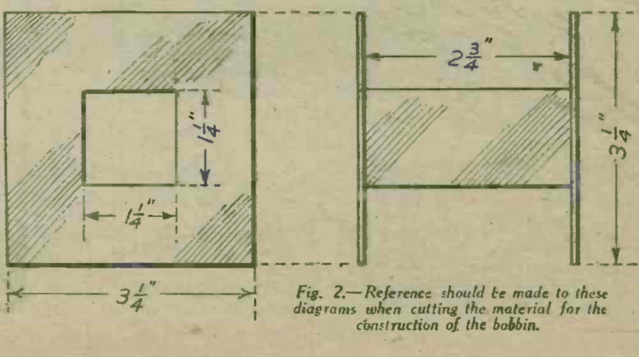


Fig. 2.—Reference should be made to these diagrams when cutting the material for the construction of the bobbin.

soldered and covered with a small piece of insulating tape, also where it traverses the winding. If this is not done, the pressure of the following layers will, in time, invariably produce short circuits. Try to even up the bulk of the winding by taking the tappings out to either side of the bobbin (see Fig. 1). In this connection, also, it is of the utmost importance to note that tappings should not be made or taken out from those sides of the bobbin which the core surrounds, as it will be impossible to assemble the stampings.

If the hand-drill method is used for winding the primary, and no form of revolution counter is available, it is a good idea to arrange a light springy piece of wood so that it clicks loudly at each revolution of the hand-drill. By this method one can concentrate on the job of winding, while someone else counts the clicks and indirectly the turns. For example, if the drill is geared say 4—1 and 1,260 turns are needed, then 315 revolutions of the actual drill handle will be necessary.

Do not use gummed paper strip for interleaving, as this will cause trouble at some time or other.

Label all tappings as they are made in order to avoid confusion upon completion.

WINDING DATA.

Primary. — Input, 200/250 volts A.C.
Turns per volt, 6.
Total number of turns, 1,500.
Tapping points at 1,380 turns for 230 volts: 1,260 turns for 200 volts.
Wire gauge, 26 S.W.G. enamelled.

Secondary.—Outputs, 2, 4, 5, 6, 6.3, 7.5, 13, 14, 20, 24, 25, 26, 30, 35, and 40 volts.
Total number of turns, 240.
Tapping points at 12, 24, 30, 36, 37.8, 45, 78, 84, 120, 144, 150, 156, 180, 210 turns.
Wire gauge, 20 S.W.G. enamelled.
Current output, 2 amps.

Core Assembly

The stampings may now be assembled. The method is to keep placing pairs (U's and T's) in the bobbin from alternate ends, i.e., first a T and U in from one end, then a T and U in from the other end, and so on. So long as the stampings are packed tightly it does not matter if there are a few left over from the six dozen pairs.

All that remains is to fix four strong brackets or clamps to the core and mount the terminal panel on top, as shown. The panel may be engraved very simply by cutting channels in the ebonite, which are filled in with plaster of Paris. When set and trimmed off the voltages, etc., can be printed in with Indian ink.

Although the transformer gives 2 amps at all voltages, this heavy current is seldom needed in valves above, say, 6.3 volts. The wattage was maintained, however, in order that small motors, models, etc., may be operated.

The secondary voltages, if measured with no load, will be rather higher than specified, but this is as it should be.

The transformer has been designed on very generous lines and should give some very useful service. If it is used as a separate unit, i.e., by not incorporating it in a valve tester, a rotary switch could be mounted on the panel. One end of the secondary winding and the switch arm respectively would then be brought out to two output terminals.

In conclusion, it is hoped that this description will encourage readers to construct an accessory which otherwise they would probably have to do without.

Component Tolerances

Where Accuracy is Important. Values of Components in a Typical Circuit

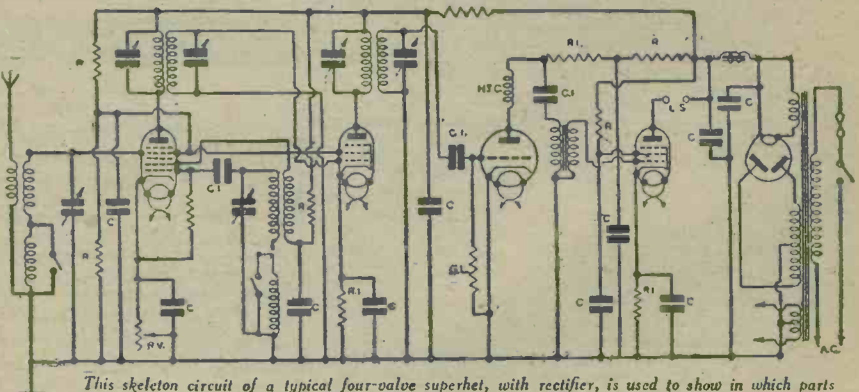
ACCURACY is always comparative, and with many wireless components it does not closely approach the absolute. And yet, in other components inaccuracy of two or three per cent. might be sufficient to render a receiver completely unsatisfactory. It is clear from this that it would be worth while to study the question more closely with a view to finding approximately what degree of accuracy is required in the values of different components.

As most readers are no doubt aware, fixed condensers and fixed resistors of good quality are generally accurate to within plus or minus 10 to 15 per cent. That is, the makers do not guarantee a fixed condenser with a nominal value of .001 mfd. to be exactly that value, but they do guarantee that its exact capacitance will lie between .0009 and .0011 mfd., if the "tolerance" is given in the catalogue as "± 10 per cent." In the same way, a fixed resistor with a rated value of 100,000 ohms will have a resistance of not less than 85,000 ohms nor more than 115,000 ohms, if the tolerance is plus or minus 15 per cent.

To Special Order

Of course, if for any reason a greater degree of accuracy than this were required, most of the well-known makers would supply the part on special request, but a slight extra charge would be made. The component would probably not have to be made specially, but the tester would have to choose it from the thousands passing through his or her hands.

From this it might appear to the casual observer that radio must be a very inaccurate science, but that is by no means the case. For example, if you were to buy a high-grade, all-wave tuning unit, the sections would probably be matched to an extremely high degree of accuracy; they must be if the unit is to be efficient over the full range of wavelengths covered. Valves, on the other hand, are looked upon as extremely delicate and accurate assemblies. They are to a certain extent, but if the principal characteristics are within 10 per cent. of the published figures the user would rarely detect any difference between two valves with the maximum permitted variation in characteristics.



This skeleton circuit of a typical four-valve superhet, with rectifier, is used to show in which parts of the circuit values are most critical.

Useless Super-accuracy

Now let us look at the skeleton circuit of a four-valve superhet, with rectifier, shown in the accompanying illustration. As long as trimmers were provided on the two-gang tuning condenser, the coils and condenser sections need not, initially, be balanced to a degree of accuracy finer than about 10 per cent.; in fact, in most cases any greater degree of accuracy would confer no advantages. That is because the matching of the two tuned circuits could be upset to a fairly considerable extent by the use of long leads, especially if some of these were shielded by means of earth-connected screened braiding. But if the coils and condenser sections were made to tolerance limits of 10 per cent. or thereabouts, quite small trimmers would be adequate to ensure almost perfect balance.

By-pass Condensers

Among the fixed condensers there is a large number whose purpose is merely to provide an easy by-pass for H.F. and L.F. currents. These are marked C in the circuit. Provided that their impedance is low in relation to their corresponding resistors at the average frequency of the currents in their circuits, it is unnecessary that their capacitances should be within at least 50 per cent. of the average values. That explains why you often see values varying from .01 mfd. to 1 mfd. for the condenser, connected between the screening-grid of a pentagrid or H.F. pentode and earth. Taking an average frequency of 1,000 kc/s (300 metres), the impedance of a non-inductive condenser of .01 mfd. is about 16 ohms. This is considerably lower than the value of resistor generally used in the lower arm of the fixed screening-grid potentiometer.

At 10,000 kc/s (30 metres) the impedance (strictly speaking, the reactance, which is almost the same for most practical purposes) would be only 1.6 ohms, and therefore the value of .01 mfd. would be adequate. In the same way, increasing the value to .1 mfd. would be equivalent to dividing the effective impedance by ten, which means that a .1 mfd. condenser has an impedance of only 1.6 ohms at 300 metres, or 16 ohms at 3,000 metres. Generally speaking, therefore, it will be seen that the lower of the two values mentioned would be perfectly suitable in a short-wave set, whereas .01 mfd. would be better on the medium-wave band, and 1 mfd. might be better on long waves. We can thus say that .1 mfd. would be suitable for use in most all-wave receivers.

Unwanted Inductive Reactance

It might be thought that it would be better to be on the "safe side" by using the largest of the three condensers. But it must be remembered that even a so-called non-inductive condenser of normal type has a certain amount of inductance. As inductance produces increased impedance, and as its value varies in direct proportion to the rated capacity, it is best to use the lowest capacity that gives a reasonably low impedance.

Similar rules apply to the H.F. by-pass condenser between the bottom of the oscillator anode winding and earth, although in this case the impedance should be considered in relation to the voltage-dropping resistor between the coil and H.T.+. If the value of resistor is not less than 25,000 ohms, a .1 mfd. by-pass condenser is suitable; if the value exceeds 50,000 ohms it would be possible to use a condenser of lower value.

Grid-coupling Condensers

These condensers are marked C1, these being coupling condensers. One is the grid condenser for the detector, a second is the oscillator grid condenser and the other is in the grid circuit of the L.F. valve. The two first could have a value of .0001 mfd., but the latter should not be less than about .01 mfd. The reason is that the detector grid condenser is dealing only with high-frequency currents, the frequency of which would be about 500 kc/s in a modern superhet. At that frequency a .0001-mfd. condenser has a reactance of just over 3,000 ohms, which is low in comparison with the almost infinite impedance of the secondary circuit of the I.F. transformer and with the grid-leak resistance of about 2,000,000 ohms.

The L.F. grid condenser, however, has to handle low frequencies from about 50 cycles up to 5,000 cycles. If we take the average as 500 cycles we say that the average impedance of a .01-mfd. condenser is just over 30,000 ohms; this is low in comparison with the impedance of the two resistors in the detector anode circuit. In consequence, the L.F. currents will pass into the L.F. transformer far more easily than they can "leak" through the H.T. circuit to earth.

Among the other by-pass condensers we have those for by-passing the decoupling resistors for the anodes of the first three valves and that for the auxiliary grid of the output pentode. To prevent the building-up of audio voltages in the H.T.-supply circuit these should offer far less impedance than the decoupling resistors. That is why a value of about 1 mfd. is generally suitable, such a capacity offering an impedance of about 160 ohms to frequencies of 1,000 cycles. It will be quite clear, however, that the condensers would still be reasonably effective if their impedance were doubled. In other words, their precise value is not very important.

Bias By-pass

Other by-pass condensers are those across the bias resistors of the first two and fourth valves. In the case of the first two valves the condensers have to by-pass H.F. currents, so that a value of .1 mfd. is ample. But the last-mentioned condenser is in the L.F. circuit besides being in parallel with a resistor having a value of, say, 250 ohms. Thus its value must be higher, and as slight inductance has little effect on low frequencies it has become customary to use an electrolytic condenser of about 25 mfd. This might appear unduly high when it is remembered that its impedance to currents of 1,000 cycles is only about 6 ohms, but it should not be overlooked that there might also be present a mains frequency of 50 or 100 cycles—and that the impedance to 50 cycles is over 120 ohms! An appreciable "hum" voltage could be developed across a condenser of lower capacity, and in some cases, particularly when the set is operated from 25-cycle mains supplies, it is desirable to increase the capacity to 50 mfd. to avoid mains hum.

Smoothing the H.T.

The two other principal condensers in our circuit are those used for smoothing the H.T. supply. That adjacent to the rectifier should be of fairly critical capacity, since it influences the output voltage obtained by the rectifier. Most valve manufacturers advise 4 mfd. electrolytic, but for some valves 8 mfd. is suggested. The other smoothing condenser could have any value, and the higher it was the greater would be the degree of smoothing. In practice, however, a capacity of 8 mfd. is nearly always the best compromise.

Turning now to resistors, the values of those marked R are determined entirely by the voltage which it is required to drop, and calculation is dependent on the well-known Ohm's Law. The detector anode resistance marked R1, however, should have a value related to the impedance of the detector valve, the value being roughly twice that of the valve impedance. The values of the bias resistors (also marked R1) are generally critical, especially in the case of the output valve. If the resistance is too high the valve is over-biased, which means that it cannot operate at maximum efficiency and, in the case of the L.F. valve, that distortion will probably be caused. If the value is too low the H.F. valves will become unstable, while the L.F. valve will pass too high an anode current and its life will be shortened. It is important that the bias resistor used should be of the value recommended by the valve-maker for the particular type of valve in use.

Accurate Voltage

It is not always realised that the mains transformer should have a degree of accuracy greater than that of many of the other components in the set. Thus, for example, if the voltage supplied to the valve heaters is too high, the heaters will be run at too high a temperature and will therefore have a shorter life than they should. What is not always as obvious is that if the voltage is too low the valves might be still more seriously affected. The reason is that if the heater is not raised to the correct temperature, the "sucking" of the electron stream from it causes gradual disintegration. This is, of course, most pronounced in the case of large-power output valves and rectifiers, the anode current of which is comparatively heavy. It is very easy to ruin a high-efficiency output valve taking a high anode voltage by under-running the filament or heater. It is still more easy to cause the early demise of a cathode-ray tube by the same means, for the H.T. voltage in that case runs into thousands of volts.

PRIZE PROBLEMS

Problem No. 434.

PTE. ASKWELL had a Midget A.C./D.C. receiver which he was able to use in his hut. The volume was quite good when the set's throw-out aerial was used but, as there was a special programme due one evening, to which all the boys wished to listen, Askwell decided to use an outside aerial. This he made with the wire off an old coil, and when he tested the set in the afternoon, everything was satisfactory. When evening arrived—cold and pouring with rain—the boys settled down for the treat and Askwell switched on. The next moment the hut was in darkness—the fuse had blown. Was Askwell and his set responsible—if so, why?

Three books will be awarded for the first three correct solutions opened. Entries should be addressed to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 434 in the top left-hand corner, and must be posted to reach this office not later than the first post on Monday, July 13th, 1942.

Solution to Problem No. 433.

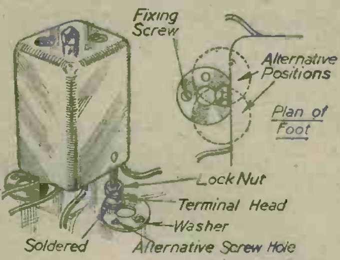
The initial cause of the trouble with Smith's receiver was due to the bias condenser developing a short-circuit, thus cutting out the bias resistor which, in turn, caused zero grid bias on the grid of the valve. This allowed the output valve to consume excessive current which overloaded the rectifier, and, before Smith had time to switch off, the primary of the speaker transformer, also broke down under the heavy current load. When this happened, the overload ceased and the voltages on the other valves naturally increased.

The three following readers successfully solved Problem No. 432, and books have accordingly been forwarded to them: A. Bartholomew, 7, Auairy Knowe, Chapel by Kirkcaldy; H. N. Caley (R.A.P.C.), c/o 30, Park View Road, New Eltham, S.E.9; G. T. Edwards, 77, Savile Park Street, Halifax, Yorks.

Practical Hints

Experimental Fixing Feet for I.F. Transformers

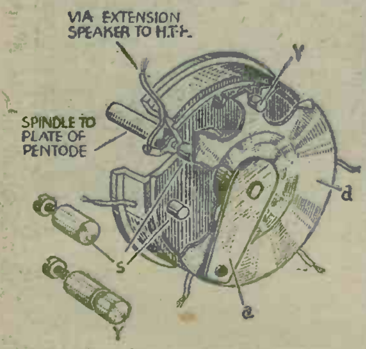
EXPERIMENTING recently on a superhet layout, primarily for short-wave reception, I found it preferable to mount the I.F. transformers in such a manner that the leads from the latter could be connected to components above and below chassis easily, and also to allow of easy removal of the transformers when necessary. The sketches show how simple feet were added to the fixing shanks of the transformers to allow of this. Large copper washers were used for the feet, to which were soldered terminal heads as shown, the height from the chassis and position of feet being fixed by lock nuts.—R. L. GRAPER (Chelmsford).



Simple method of fixing I.F. transformers.

Using Pentodes and Extension Speakers without Choke-filter Output

I HAVE found it possible with this idea to effect an alternative to the more usual choke-filter output stage, when employing a pentode and having a number of extension speakers in circuit. As is generally known, an open or intermittently open-plate circuit in the pentode stage will cause the emission of the pentode to depreciate in time, and in utilising this idea the normal plate-speaker-H.T. circuit can be used, and in switching in and out the various speakers the operation is as follows: The disc (d) is depressed by the arm (a) and contacts with each of the five studs (s) in turn, but before the contact of each stud in turn is broken the next one is made, this maintaining continuity of load throughout the complete revolution of the rotor arm. The contact studs (s) were made out of ⅛in. brass rod and taper tapped to take 8B.A. screws as shown. Owing to the volume control used for this model having the spindle common to the disc, it was necessary to insulate with an ebonite bush when mounting in a chassis.—A. H. JONES (Putney).

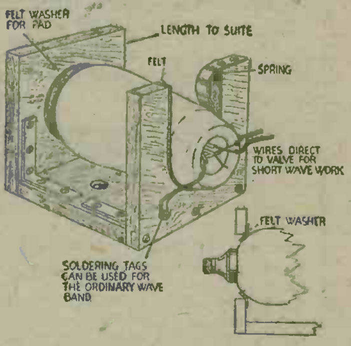


A novel switching arrangement for use with pentodes and extension speakers.

A "De-based" Valveholder

WHILE pondering over the best method to adopt with a couple of valves having loose bases I decided on the dodge illustrated, and at once realised the benefit of retaining the valves as de-based for short-wave work, thus eliminating the usual dielectric losses attributed to the ordinary valve bases and holders.

As will be seen, on referring to the illustration, there is little work required in the construction, and the assembly is clearly depicted and self explanatory. No doubt a number of readers will devise modifications and improvements to suit their valves and circuits.—S. T. PRESCOTT (Wallasey).



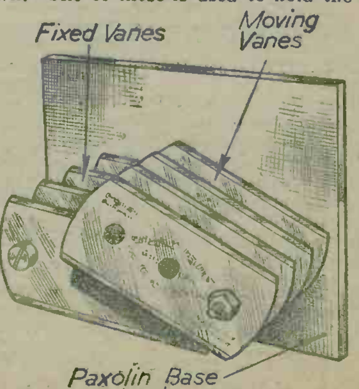
A useful dodge for using valves without bases.

Stability and A.C. Receivers

IN an examination into the causes and cures of certain types of instability, it has been found that certain so-called "rules" are not infallible. For instance, it is generally admitted that decoupling condensers should be joined to the cathode, which in an ordinary battery valve is the earth line, but in a receiver employing indirectly heated A.C. valves is a separate connection. Sometimes the cathode is joined direct to earth, but more often than not there is a bias resistance and by-pass condenser in the cathode lead, and thus the decoupling condenser, if joined to the cathode, will be in series with the biasing components. Stability is not ensured when the decoupling condenser is so connected, and it has been found that in many cases the removal of the condenser from this position, and the connection of it direct to the earth line (H.T.—) will cure an otherwise obstinate receiver.—W. D. (Hendon).

A Razor-blade Variable Condenser

IF a short-wave condenser is needed and one is not to hand, here is a method whereby one can easily be constructed from old safety-razor blades. A piece of paxolin is used to form a base. Holes are drilled to locate two bolts, as shown. One of these is used to hold the fixed blades, the correct spacing being obtained by means of washers. The other bolt is passed through a bush in the paxolin, and on it are mounted another set of blades to form the moving section. A little care should be taken with the spacing to make sure that the two sets of blades do not foul each other.—F. U. CAPSTICK (Glasgow).



An improvised condenser made from old razor blades.

BRITISH LONG DISTANCE LISTENERS' CLUB

MANY members have asked if it is not possible to publish addresses of members whose letters or remarks are given in these columns, the reason behind the majority of the inquiries being the desire to contact the writers of the letters. In the past, unless otherwise requested, we have refrained from giving full addresses, but that was not intended to stop contacts being made, as that is always possible via these offices. There are various reasons why members' full addresses should not be published; one of them—easily the most objectionable—is that such information is often exploited by unscrupulous persons having fraudulent or "cadging" intentions. If members adhere to the original system of making contacts it will help to eliminate a lot of delay and, what is also very important during these days of economy and staff shortage, some of the work thrown on the staff of PRACTICAL WIRELESS by the preliminary arrangements for Group formations. All you have to do if you wish to contact a member is to put your *membership number, name, address* and a request for contact, on a *stamped* postcard, and then send it to us in an envelope in the normal manner. You need not write any covering letter; we shall know what to do and will see that the member concerned gets your card. Results should be mutually satisfactory, and if all follow out this simple procedure it should result in Group formation being speeded up considerably. There is one request we have to make, please keep us informed—a postcard will do—if the meeting results in a desire to contact others with the object of forming a Group. To give an actual example, Member 6,187, of Handsworth, Birmingham, 20, writes to let us know that he has contacted Member 8,681, of Hall Green, Birmingham, and they are both keen on getting a Group going. Now if other members in that area wish to get in touch with 6,187 something might be done about forming a Group, but before that can be achieved we must have full details, and we would remind all concerned about what we said on this page in the April issue.

Horwich, Nr. Bolton.—Member 8,143, of Horwich, is keen to help form a Group. He says: "It would seem that the nearest Group area is at Bromley Cross, Nr. Bolton, and I am wondering if it would be possible to form one nearer my town, as I would not be able to get into Bromley too frequently."

Southport.—Member 7,131, of Southport, in a very interesting letter concerning his experimental activities, states that he would like to get in touch with other members in his area.

West Hartlepool.—A "lone wolf" calling from this town is Member 1,139, Ex G3LS, whose QRA is Seaton's Carew, West Hartlepool, Co. Durham. He is particularly keen on the Group idea, so we hope that his call will result in sufficient contacts being made to enable a formation to be started.

Tottenham.—North London members in the region of Tottenham might like to contact Member 7,158, of N. 15. He agrees that the Group movement is a fine idea, and that it should be the means of bringing the amateurs together. In his letter he extends an invitation to other members in his area to call on him or drop him a line.

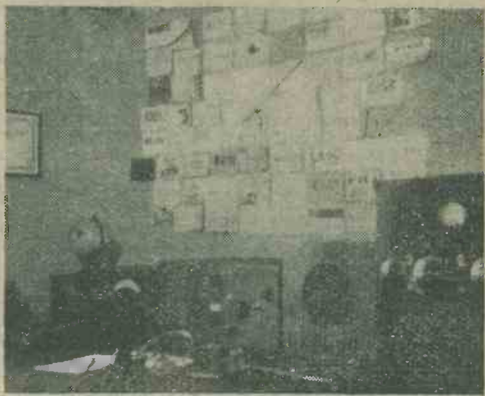
Littleworth, Stafford.—A good account of the activities—and the progress made through the help of articles appearing in PRACTICAL WIRELESS—of Member 8,047, comes from Littleworth. He is yet another "lone wolf" anxious to make contact with other members about his own age (17 years) or, of course, link up with others, in his area to get busy on the Group scheme. He started as he says, from scratch just twelve months ago, and now—according to his letter—he has a fine little den and a good amount of gear.

Kenley, Surrey.—Member 7,217, of Kenley, Surrey, would like to contact others in his or the Purley district, as he is very keen on that area being able to form a Group. He also inquires about a blueprint of a good S.W. four or five-valver, but does not say whether he wants it battery or mains operated.

[What is the matter with our Blueprint No. W.M.383—for battery operation—or W.M. 391 for A.C. supplies. This receiver is a four-valver and is known as the Standard Four-valve Short-waver. It is very efficient and its valve sequence is 1-v-2. Hon. Sec.]

Wareham, Dorset.—Member 7,007, of Wareham, asks for contacts, and his request reminds us that we do not seem to hear from many members in the county of Dorset. Perhaps before the next issue of PRACTICAL WIRELESS is prepared, we shall hear from some, as Dorset used to be particularly lively as regards amateurs.

Cirencester, Glos.—Member 7,148, who we must remind that it is important to quote membership number on all correspondence, would like to get in touch with others in or around his town. His QRA is Cirencester, Glos.



The station owned by Member 6,173. The details are given in his letter printed below.

Bournemouth.—The illustration on this page comes from Member 6,173 of Southbourne, Bournemouth, from whose letter we take the following extract:

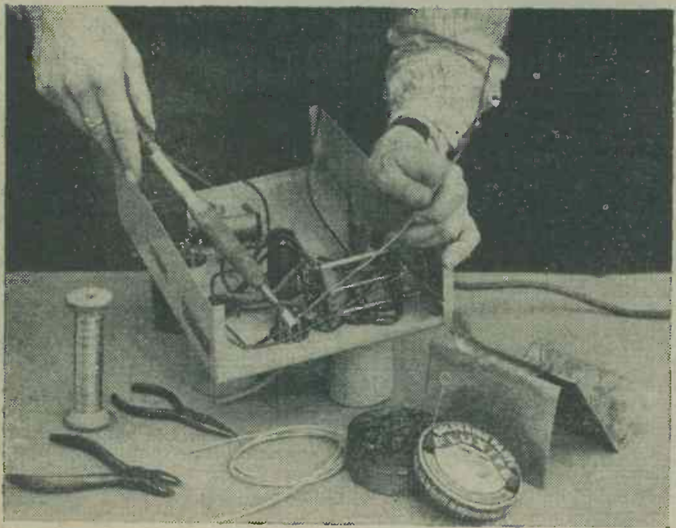
"In the foreground can be seen the skeleton of the transmitter which was nearing completion at the outbreak of hostilities. Next to it is a Hammarlund communications receiver and its associated speaker. This receiver employs eight valves and such refinements as a crystal gate, beat oscillator, etc., and covers all bands from 7 metres upwards by means of plug-in coils. The performance is also improved by the addition of a single stage predilector which can be seen next to it. On the foremost end of the line can be seen a semi-automatic frequency meter. The morse key on the table is a semi-automatic 'Bug' type. I have been a member of B.L.D.L.C. for three years and visitors are always welcome."

Medium Wave Dx.—In response to our requests for members to send in information about their medium wave DX work, Member 6,992, of New Mills, Nr. Stockport, Derbyshire, has sent in the following interesting account of his activities in that direction.

"I noticed in the May issue of PRACTICAL WIRELESS your request for experiences in M.W. DXing. As readers will have noticed from previous letters appearing in PRACTICAL WIRELESS, I have quite a good log of DX stations, Americans and quite a few Canadians and Cubans. I am afraid the list would take up too much space, so if any reader would care to drop me a line, I would be only too pleased to supply it. I have kept a careful log of the weather conditions, direction of wind, position of the moon, etc., and the best nights for transatlantic reception, I would say, are those between September and April, when the weather is wet, no moon, slight east breeze, low clouds and a low barometer reading. In fact, to anyone other than a wireless enthusiast, an utterly deplorable night. The usual time to hear DX broadcasts is between about 12.30 a.m. and 4.30 a.m. Sometimes these stations can be heard earlier, but owing to the high power of the European stations very little can be picked up.

"As regards the programmes, during the latter part of December and the beginning of January reception was so good that I used to listen regularly to the 11.45 p.m. news on CBA, 282 m. I also heard an actual broadcast of President Roosevelt on WHM, 285 m. at 12.20 a.m. My RX is only an ordinary three-valve battery set using a horizontal aerial, 20ft. high and about 40ft. ong, running S.W. to N.E."

Rotherham, S. Yorks.—Lack of space prevents us from publishing the very fine log sent in by that active member No. 6,773, of Canklow Rotherham. We must say—



although we believe we have said it before—he certainly knows how to compile a log, and, judging by the transmissions reported, he is evidently keeping his hand in, in spite of restricted spare time. Can anyone help with more details of the following transmissions which 6,773 has been unable to identify?

Frequency 12.2 mc/s. Time 22.50 hrs. Signal R9 plus. Programme: Dance tunes, mainly French tango bands. Frequency 4.6 mc/s, 3.27 mc/s and 4.4 mc/s. Time 22.35, 22.41 and 22.45 hrs. respectively. Signal R7, R5 and R8. Bad QRM. Finally, a transmission in a language similar to Yugoslav on a frequency of 5.5 mc/s at 22.47. Signal R6. QSA4.

[Perhaps those members who can supply any information will get in touch with 6,773.—Hon. Sec.]

Stowmarket, Suffolk.—Member 8,027 mentions how he has overcome the shortage of 6-pin S.W. coils. Here is his letter:

"I regret I have been unable to write to you before, but my S.W. activities have been restricted to week-ends throughout the winter, and there has been little of interest to report. I have, however, erected an inverted-L aerial, which I find is better for all-wave reception than the vertical type previously used.

"My S.W. receiver is still of the 0-v-1 type, and covers 11-90 metres with three coils. Six-pin coils not being available, I constructed equivalents by using 4-pin formers with a loose coupled winding, one end of which was connected to an extra pin in the centre of the former. The other end was connected to the same pin as the earthed end of the grid coil. Some experiment was necessary in order to eliminate aerial series condensers but this was finally achieved.

"I am in full agreement with your Group scheme, but have been unable to trace any fellow-members in this district. I have discovered many radio enthusiasts at our local A.T.C. meetings, however, so perhaps some of them could be induced to join, and thus form a Group for this area.

"Could you please give some official information *re* QSL cards? Some listeners seem to be obtainingthem nowadays, although such activities are supposed to have been banned.

"I have been keeping up morse practice, and can now receive at about 12 w.p.m. I have purchased a good P.O. type key, and have had plenty of practice with this in conjunction with a two-valve oscillator. As an effective tone control for this, I have used a .0005 reaction condenser."

Cardiff.—Member 7,229, of Llandaff, Cardiff, would like to make contact with other members in or around his district.

Arnold, Notts.—No. 7,116 sends in an interesting log, and asks: "Has any other member heard a station on the 29 metre band, at around 07.40 hrs., announcing 'This is Melbourne, Australia, calling London'?" Those who wish to answer the question can make contact with No. 7,116, via Headquarters.

SOLDERING

Every member should make a point of becoming efficient with the soldering iron. It is the only satisfactory means of making reliable joints when wiring any piece of radio apparatus. It is not difficult, provided that the following simple rules are observed: See that surfaces to be soldered are free from grease and dirt. A light application of emery-cloth will produce the bright metal surface which is really essential. Don't make the iron too hot; see that it is well tinned and kept clean. Use a reliable non-acid flux, but use it sparingly; excessive flux will not make up for dirty surfaces or a cold iron. If new to soldering keep practising until perfect.

Tunbridge Wells.—A request for contacts in this area comes from No. 7,200.

Kelso.—Here are some remarks from Member 8,040 concerning his recent activities:

"I have been using a 2-valve Eddystone battery set with much success lately. In the past few weeks I have logged: Batavia, which is now broadcasting on approximately 16.5 metres, news in English is given at 12 p.m. G.M.T., signal strength was R5. VLG7, Melbourne, is broadcasting on a wavelength of 19.79 metres, news in English is at 9.45 p.m. G.M.T., reception is often very good. TGWA, Guatemala, 19.78 metres, broadcasts a programme of tango music every Sunday night at 9.15 p.m., reception usually R7-8. COK, Havana, broadcasts on a wavelength of 25.82 metres, tango music is broadcast at 10.30 p.m. C.G.M.T.

"I saw the note in 'Round the World of Wireless' in last month's issue (July) about 'Command Performance.' Readers may be interested to know that this programme is also broadcast over stations WRUL (25 metres) at 10.30 p.m. G.M.T., and WCBX (19 metres) at 3.30 p.m."

Comment, Chat and Criticism

Patriotism v. *Nationalism in Music*

Notes on the Works of Some of the Great Masters By Our Music Critic, Maurice Reeve

NATIONALISM has inspired very little, if any, great art. That statement may seem to throw out a challenge and may on first reading sound provocative. I can hear many readers roused to quick reply with "but what about Henry V's speech before Agincourt," or "Messonier's paintings of Napoleon in many of his triumphant moments," etc. Some will quickly quote the more patriotic verses from the Bible, whilst yet others would cite Macaulay's "Lays of Ancient Rome" or "this corner of a foreign land that is forever England."

Musically, Tschaikovsky's "1812" Overture would be held up, and rightly, as a fine example of noble patriotism, and Wagner's "Kaisermarsch" as another. But before any reader should want to mention a variety of compositions ranging from "Rule, Britannia" to "Land of Hope and Glory," I would like to say a few words to distinguish, or differentiate, between a blatant, vulgar nationalism which perpetrates the worst vices in any people, e.g., the orations of Adolf Shicklegruber and Benito Mussolini, or the paintings one finds in boys' books on martial splendours and deeds of sacrifice, and the noble sentiments and the finest hopes and aspirations for a people's honour and fame as are exemplified in Cromwell's or Pitt's speeches, Milton and the best Shakespeare, the aforementioned "1812" or Vaughan Williams' "London" Symphony, and the novels of Scott or the poetry of Burns.

Such works breathe a love of one's country, a pride in its achievement as they concern its contributions to the improvement and betterment of mankind as a whole, and a pride in the fact that such and such a man was a great Englishman, Frenchman, or German, as well as being a great citizen of the world. Because, in glorifying the fact that, say, Elgar, John, or Wells are English, we do not grudge or belittle the genius of their opposite numbers in other countries.

Provincial "Patriotism"

This is quite a different thing from the narrow minded, provincial "patriotism" of those who, in their unwisdom, decree that, because a thing is English, or what you will, it *must* be the best; the sort of "patriotism" that says our fighting forces must win when they go into battle just because they are English and in complete disregard of how they are led, equipped, or to what plans they are working. These notes being concerned with music, I will try to show how easily these characteristics can be detected in various examples.

A typically "patriotic" work—one which symbolises, in the opinion of its composer, the might, majesty and altogether superior virtues of his own country over all others is Wagner's "Kaisermarsch"; written in celebration of the German victory over France in 1870. The pomp and glitter of this brilliant work are overwhelming; flags, bunting and rejoicing pervade every bar whilst quotations from various Wagner operas only serve to intensify its glorification of all things German. It was always a favourite with "Prom" audiences.

"Marche Slav"

Another work of this type, but one in which, I think, the sentiment is on a nobler plane, is Tschaikowsky's "Marche Slav," written to commemorate the victory of Russia over Turkey at Plevna in 1877, and the liberation of many Balkan Slavs. Pride of race (note the title in contrast to Wagner's) takes precedence over pride of country, and the work, like "1812," contains some of those charming and haunting Slav folk tunes that Tschaikowsky knew how to use in such a masterly manner. The work closes with a magnificent presentation of the old Russian national anthem; a pardonable piece of pride in his country's sacrifices on behalf of others.

Berlioz' "Rakovsky March"—on a Hungarian martial theme—is another notable example, and Haydn has used the anthem "Deutschland, Deutschland über Alles" in the slow movement of his "Emperor" quartet with magical effect.

Patriotic music, as quoted above, would seem bound to include in its texture either a national anthem, or some other theme symbolising a nation's valour in arms. But now we will turn to nationalistic music, something quite different and far more worthy. In fact, this class contains many of the master works of all time, from Bach and earlier, to Elgar and later.

Folklore

In this music a composer displays his nationality, through the use of native folk tunes and dance rhythms, with less consciousness and certainly without any boastful or arrogant pride. All the great masters have turned to the rhythmic and folklore of their native lands for inspiration, and the results have been marvellous in the extreme. Bach and Beethoven freely drew on these sources of inspiration, but their classicism never allowed them to completely free themselves from the fetters of form and convention. Beethoven's unsurpassed originality lay in expanding, rather than overthrowing existing forms so as to include ideas and material hitherto found impossible. He it was who paved the way for the brilliant and exotic nationalists of the succeeding century.

Borodin and Moussorgsky were the leaders of the great Russian school, followed by Balakirev, Rimsky-Korsakov, Tschaikowsky, and lesser lights. Then we have the two Czech masters Smetana and Dvorak. In Hungary was the incomparable Liszt, with two worthy successors in our own time, Dohnanyi and Bartok. The Frenchmen Fauré and Débussy, the Spaniards Albeniz, Granados and de Falla, and our own Peter Warlock, Cecil Sharp (a source of inspiration for others), Vaughan Williams, Holst, and a host of others from all lands and ages.

These men were true "nationalists" in music as were Shakespeare and Wordsworth, Scotland's Burns, Hogarth and Constable. They delved into their country's past for their inspiration, seeking beauty in all that made up their history and folklore. With more than one foot firmly rooted in the past, most of them had an eye looking out to the future as well. And the greatest of them gave us new and original ideas on harmony and form of which their successors have not always made the worthiest use.

Chopin, a nationalist if ever there was one, wrote "absolute" music in the purest meaning of the term. He imparted his country's character to his music, chiefly through his incomparable use of the Polish Mazurka and Polonaise dances and rhythms. But he was not a landscape painter, like the others.

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).

L.T. Supply from Dry Cells

SIR,—I have been wondering as to the correctness of applying only 1½ volts to the filaments of valve which were intended by their designers to receive 2 volts; that is, the running of ordinary battery valves by dry cell instead of accumulator. Mr. D'Arcy Ford has been kind enough to help me concerning this question; nevertheless, I would draw your attention to the answer to a query of mine which appeared some years ago and which suggests that it is inadvisable to use a single dry cell for the filament supply of 2-volt battery valves. The question asked was whether a pentode L.F. stage could be volume-controlled by means of a filament rheostat. Answer. It would not be advisable to control volume by reducing the filament voltage as you suggest. *With ordinary modern valves the emission would be destroyed if run for a long time below the makers' recommendation . . .*" (The italics are mine.)

In view of this I have always used, when dry batteries are desirable, a 3-volt supply with a series resistance to reduce it to 2. In the portable receiver described a few months ago in your paper 1½ volts were applied to the 2-volt valves used.—F. G. RAYER (Longdon).

[*Our answer to your original query is quite correct, and you are wise in using a series resistor with the 3-volt supply rather than a 1½-volt battery with 2-volt filaments.* —ED.]

Optical Analogy

SIR,—In the July issue, on page 350, a diagram on Optical Analogy is published which appears to be incorrect.

When light, passing from a source situated at the principal focus of a plus lens is emitted parallel, but after passing a minus lens, as in published sketch, it is rendered divergent, not convergent, as shown. I am raising this point as I think many whose optical knowledge is restricted may get the wrong impression.—G. WEBB (West Wickham).

SIR,—In reply to Mr. G. Webb, of West Wickham, I would point out that his point is quite a legitimate one, but that in preparing this type of analogy I did not necessarily intend it to be accurate in an optical sense.

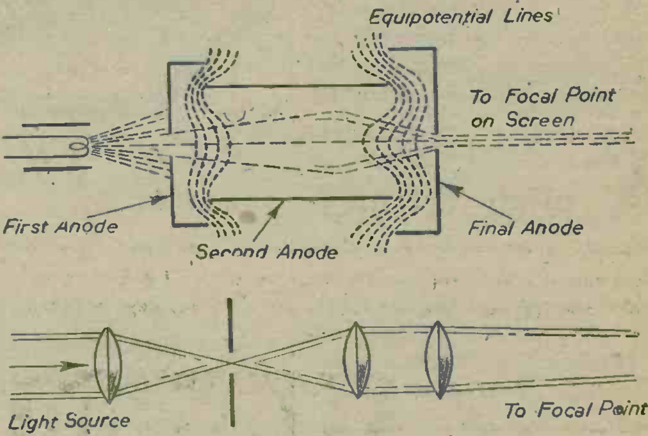
The only thing intended to be impressed on the readers regarding this particular comparison, is that the spot on the fluorescent screen of the C.R. tube is caused by the convergence of the electrons to a very fine point in much the same way that a ray of light may be focused by accurate adjustment of a suitable lens or system of lenses.

Actual convergency of the electron beam depends on the curvature of the equipotential lines formed by the various anode potentials and the fact that an electron will always tend to travel perpendicularly to these equipotential lines.

I am extremely sorry, however, if my analogy may have caused any wrong ideas or impressions to be created regarding the precise function of the cathode-ray tube focusing system, and I append a sketch showing the operation in more detail.—S. A. KNIGHT (Bury).

Colour Coding

SIR,—I strongly disagree with Thermion's remarks on the Colour Code (p. 345, July issue). Having resistors of both types, I have found that the figures on those so marked are much more liable to be rubbed off or become indistinct, and, even if they are marked on in two places, they are often extremely difficult to read when surrounded by a mass of wires and other components in a set. With colour-coded components, however, the values can be read very easily and quickly in any position and from a far greater distance, this latter fact proving very useful when looking for a required value among several resistors. If any of the colour does come off it very seldom makes any difference to the ease with which the value can be read. But I certainly wish that all set manufacturers would use the standard colour code for marking their components.—R. V. GOODE (York).



Diagrams illustrating the function of a cathode-ray tube focusing system. (See letter from S. A. Knight.)

Station WOWO

SIR,—In reply to Mr. J. W. Macvey's letter in the July issue of PRACTICAL WIRELESS concerning station WCW, I think the station he heard was WOWO broadcasting on a wavelength of 19 metres. This station gives the dialogue "News Broadcast in English every hour on the hour." News is also broadcast in German, French and Italian every quarter, half and three-quarters, in this rotation.

The station is in Cincinnati, Ohio, and is very clear. I have heard the signal on two nights running, 5-6-42 and 6-6-42.—K. T. WHITHORN (Worcester).

"Accumulator Rating"

SIR,—May I suggest that the reply to I. P. R. (Watford), in the July issue, on "Accumulator Rating," tends to be a little misleading.

It is stated that a 70 A.H. cell discharged over a period of 1,000 hours, will give .7 amp. discharge and over a period of 100 hours, .42 amp. The .7 amp., I presume, is a printer's error, as it should be .07 amp.

But my point is that the capacity of the cell will depend mainly on the current taken and not on the time of discharge.

In other words, if the cell is discharged at .07 amp., then it will deliver this for 1,000 hours, and if discharged at .42 amps., then it will supply only for .100 hours. Thus the time depends on the current, and not vice versa.—E. SHIMMIN (Salisbury).

[*You are quite correct regarding the values. It is, unfortunately, one of those cases where the decimal point has gone astray. Concerning the capacity of a cell, this will, of course, depend on the current load, but we—in our reply—treated the matter in its theoretical sense by giving the maximum current permissible for a 1,000-hour period from the cell in question.*—ED.]

DX Transmissions

SIR,—The following particulars concerning DX transmissions may interest other readers. EQB Teheran (48.74 m.), news in English at 20.50; FXE Beirut (37.34 m.), in English, 18.00-18.40, news at 18.30; VLR2 Melbourne (25.27 m.), Australian National Programme, 08.00-10.15, relays London 08.15-08.45. Interval signal chimes; VLQ2 Sydney (25.27 m.), 17.00-17.45 for Western States of U.S.A. (instead of VLQ6); "Radio Metrepol," English records, news, etc., 11.45-12.30 on 19.69 m., 19.00-19.45 on 25.56 m.; EAQ Aranjuez 30.43 m.), in English at 19.00; Batavia (17.63 m.), 13.00-16.30, news, music, etc.; VUD Delhi, 09.00-11.00 on 19.62 m., 14.30-19.00 on 31.28 m., news at 10.00, 14,30, 17.50; ZOY Accra (49.78 m.), broadcasts in French in evenings; WCB (19.30 m.) New York, 19.00 onwards; VRAT (31.06 m.), 21.00-23.15, broadcasts in French and English; "Voice of Free India" (26.93 m. and 31.92 m.), 16.00-18.00, last half hour in English; Ankara (31.7 m.), news at 20.15; Bucharest (32.03 m.), late evenings in French, English and German; WCBX (19.65 m.), Wayne, begins at 12.00, and at 12.15, details of the day's programmes are given. All times are D.B.S.T.—S. R. SMITH (Crewe).

Station KGEI

SIR,—I have just received an official reply from the G.E.C. of the United States regarding their powerful short-wave station, KGEI, in San Francisco, and some of the details may interest readers.

The station is situated on "Treasure Island," a vast man-made island which was constructed off the coast to house the International Exposition, while the studios are located in San Francisco proper. It was designed chiefly to serve the Orient, although its powerful signals do sometimes reach Occidental listeners. News is presented in English and in Cantonese and Mandarin dialects, and a large amount of broadcast time is given to Chinese music. One of the principle programmes is known as the "Chinese Good Neighbour Hour," and is reported to be immensely popular in those parts of China under Japanese domination. Many eminent Chinese speakers resident in the United States avail themselves of the microphones of KGEI to bring messages of encouragement and hope to their long-oppressed countrymen. It was only recently that a broadcast from this station was instrumental in finding two Chinese boys who had been lost in the interior of the country.—JOHN W. MACVEY (Forestfield).

Back Numbers Wanted

SIR,—I shall be grateful if any reader who has copies of PRACTICAL WIRELESS for January and March, 1942, to spare would kindly forward them to me, via the Editor. Postage will be refunded.—F. ASHURST, Whittingham, Lancs.

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

THE recording of Koussevitsky and the Boston Symphony Orchestra, playing Sibelius's "Tapiola," ranks as an outstanding contribution to this year's recorded orchestral works. It is not a composition which will be appreciated by all, but to the imaginative music lover it will be one of the greatest works in the whole range of symphonic music.

The title of the work is taken from Tapio—the god of the forest in Finnish mythology—and the composer interprets the very soul of the ancient forests of the north, as only Sibelius could. "Tapiola" (Symphonic Poem) *H.M.V. Nos. DB*5992-3.

A superb recording which H.M.V. offers in the same list is that on *H.M.V. C*3287. This is the orchestral rhapsody, "A Shropshire Lad," composed by George Butterworth, who derived his inspiration from the poems by A. E. Housman. The work is performed by the Hallé Orchestra, under the conductorship of Sir Adrian Boult, and the record is one which should be included in every collection.

Webster Booth was in fine form when he recorded—with piano accompaniment by Gerald Moore—"Come Back My Love" and "Will You Go With Me" on *H.M.V. B*9271. "Hutch"—with orchestra—offers this month "Absent-minded Moon" and "Someone's Rockin' My Dreamboat" on *H.M.V. BD*1006.

"The Jap and the Wop and the Hun" is the title of one of the contributions from Ronald Frankau on *H.M.V. B*9267. On the other side of the disc he records another Frankau-Crick creation, "Oh, You Ladies in the Forces." In the Dance Section I have picked out Joe Loss and his Orchestra playing "Deep in the Heart of Texas." This record is *H.M.V. BD*5746, and has on the other side "How Green Is My Valley."

Columbia

"PRINCE IGOR"—the work of the famous Russian composer, Borodin—was actually orchestrated by Rimsky-Korsakov and Glazounov, and it was not until three years after the death of Borodin that the first production was staged. The overture is brilliant, exciting music, and this, combined with the magnificent performance of the Hallé Orchestra, under the baton of Leslie Heward—foremost among British conductors—provides a recording of worthy note. *Columbia DX*1078 (Parts 1 and 2), *DX*1079 (Part 3) and "The Sleeping Beauty"—waltz, also played by the Hallé Orchestra, conducted by Dr. Malcolm Sargent.

"Tonic Tunes"—two parts—are provided by the Albert Sandler Trio on *Columbia DB*2077, and I recommend this record to all. The tunes awake happy memories of the days when tunes were melodious and pleasing to the ear.

Turner Layton will, I am sure, be telling many gramophone enthusiasts that "This Is No Laughing Matter"—"Strange As It May Seem" when *Columbia FB*2795 is played and he is heard, at the piano, singing the two numbers mentioned. "Whispering" makes a delightful composition for Felix Mendelssohn and his Hawaiian Serenaders. This is recorded on *Columbia FB*2798, together with a typical enchanting melody of the Southern Seas, "Hula Blues."

Victor Silvester and his Ballroom Orchestra give us "How Green Was My Valley" and "Miss You" on *Columbia FB*2801. These are slow foxtrot and quickstep respectively, played in strict dance tempo.

Parlophone

THE high light of Parlophone releases is *RO*20512, on which Richard Tauber renders the late Sir Landon Ronald's fine ballad, "O Lovely Night," and Leoncavallo's "'Tis the Day." These two songs reveal the full beauty and charm of this popular artist's rich tenor voice, and I recommend the record to all who appreciate vocal renderings of outstanding merit.

Joe Daniels—offers his Hot Shots playing two numbers, "Lady Be Good" and "When You're Smiling," on *Parlophone F*1909.

For those who like their dance music with super-rhythm there is Harry Parry and his Radio Rhythm Club Sextet playing "Sweet Georgia Brown" and "Doggin' Around" on *Parlophone R*2842.

"Tin Pan Alley, Medley No. 45," *Parlophone F*1911, is another example of the neat team work between Ivor Moreton and Dave Kaye at two pianos, and the string bass and drums.

Geraldo and his Orchestra give a fine performance of "Someone's Rockin' My Dreamboat," and "Tica Ti Tica Ta," on *Parlophone F*1908.

Decca

FROM the latest Decca releases it is possible to make a selection to satisfy varied tastes, so here are those which I would recommend.

The Band of H.M. Grenadier Guards, playing a fine Sousa March, entitled "The High School Cadets," on *Decca F*7931; on the other side of which they give us that old favourite by Oscar Straus, "My Hero."

Edward German's "Merrie England" Dances, played by the Bournemouth Municipal Orchestra, conducted by Montague Birch, is a fine recording of some fine music. It is in two parts on *Decca F*7998.

For a vocal interlude I would put on Sidney Burchall—baritone—singing that ever popular ballad, "Until," and follow that with his rendering of "Oh, Promise Me," both of these being on *Decca F*7912.

In a lighter vein there is Gracie Fields—with orchestra accompaniment—singing in her own inimitable style "Rose O'Day" and "O'Brien Has Gone Hawaiian." These are well up to Gracie's standard, *Decca F*8132.

Before turning to the dance recordings, Charlie Kunz offers you "Charlie Kunz Piano Medley No. D53," on *Decca F*8135. The Royal Air Force Dance Orchestra, on *Decca F*8139, have made a fine recording of "Blues of the Night"—blues—and "Who'll Buy a Rose From Margareeta"—quick-step.

"The Waiter and the Porter and the Upstairs Maid" is one of the numbers played by Hatchett's Swingtette, on *Decca F*8129. The other is "The Two Little Squirrels." The first of these features Stephane Grappelly, which, needless to say, adds considerably to the presentation. Ambrose and his Concert Orchestra, on *Decca F*8122, gives us "How Green Was My Valley"—vocal by Anne Shelton—and "In Old Mexico," in which Sam Browne gives voice. On *Decca F*8121, Ambrose with his Dance Orchestra plays "I Don't Want to Walk Without You" and "Someone's Rockin' My Dreamboat."

To finish this Decca programme I have selected Edna Hatzfeld and Mark Strong—at two pianos—playing "Troika" and "Barcarolle" by Tchaikovsky. The record is *Decca F*8136, and it is a fine recording.

Brunswick

JIMMY DORSEY enthusiasts will welcome *Brunswick O*3317, on which his Orchestra plays "I Said No" and "Absent-minded Moon."

Two numbers by Bing Crosby—"Mandy is Two" and "Miss You"—are given on *Brunswick O*3312*A*. He is accompanied in both cases by Scott Trotter and his Orchestra.

Guy Lombardo and his Royal Canadians have selected "I Don't Want to Walk Without You" and "Sometimes" for their performances on *Brunswick O*3316*A*.

Maxine Sullivan, on *Brunswick O*3316*B*, makes a fine show of the "St. Louis Blues" and "My Blue Heaven."

Replies to Queries

Set Calibration

"I have an A.C. mains set which I wish to calibrate. The dial is marked off in degrees 0 to 180, therefore I would be pleased if you will send me a list of medium, long and short-wave stations that are equivalent to the numbers on the dial."—J. S. (Banstead).

WE have not published any lists covering all the transmitting stations. It is not possible for us to give you the information you require concerning calibration, as such work must be done with the receiver. We would suggest that you receive as many stations of known wavelength as possible, and compile suitable records covering dial readings for particular wavelengths.

Lissen Receiver

"Could you let me know where I can get a blueprint of a Lissen set which I think is about twelve years old? Could you also tell me where I could get a P.T.425 valve?"—R. Mc.N. (Wilton Avenue).

THE makers of the set might be able to help you, but, owing to its age, such information may now be out of print. Write to Messrs. Lissen, Ltd., Angel Road, London, N.18. Regarding the valve, it would be best to approach the makers, Messrs. The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.

Mains Transformer

"Would you please supply me with the information necessary to make a transformer to reduce 230 volts A.C. to 200 volts A.C.?"—M. B. (Welshpool).

THIS is the kind of query which no one could answer. Before the required details could be given, it would be essential to know the wattage of the output. As mentioned before, we cannot undertake to provide the constructional details of mains transformers, even if all the requirements are stated.

Colour Code

"Could you please supply me with a copy of the B.M.A. Colour Code, as I have lost mine and cannot remember all the details? I would also like the name of a firm who can supply hydrometers."—R. P. (Brixton).

COMPLETE details of the Colour Code will be found in "The Radio Engineer's Vest-Pocket Book," price 3s. 9d. post paid. Messrs. Electradix Radios might be able to supply a hydrometer, their address is 19, Broughton Street, Queenstown, Road, Battersea, S.W.8.

Metal Rectifier Temperature

"I have built a small mains set in which I am using an H.T. metal rectifier. I am running this right at its limit I know, but I do not think I am exceeding it. The trouble is that it seems to get much too hot and I am afraid of damaging it. The receiver is very similar to your A.C. Hall-Mark, and is built practically identical except for the valve types and some component values."—G. J. (Blackpool).

THE rectifier will get fairly warm if run to the limit, although it should not be too hot to touch. There is a possibility that you are using a defective by-pass or smoothing condenser which is putting an undue load upon the rectifier, or it is so arranged on the chassis that adequate ventilation does not take place. If you have the component screwed direct on the chassis, it may be found worth while to mount it on two strips of wood so that it stands up clear of the surface of the chassis and this will provide better ventilation. You should, however, take steps first to measure the total current of the receiver and make quite certain that the unit is not being overloaded.

Automatic Volume Control

"I should like to prevent fading on my three-valver and have been told that one can convert an old circuit to employ a modern device known as automatic fading or volume control. I am rather out of touch with radio matters, but should like to know how to incorporate this scheme in my set, a diagram of which I enclose."—E. W. (Peckham).

THE arrangement you refer to operates on valves of the variable-mu type, in which a variation of the grid-bias controls the amplification of the valve. Consequently, the first requirement for fitting A.V.C. is that the receiver utilises H.F. amplification. In a simple set such as yours, with only one H.F. stage, there would be insufficient H.F. to control the valves—the H.F. currents being rectified and fed back to the H.F. stage in the form of bias. Generally, this arrangement is only effective where two or more H.F. stages are employed, or where the circuit is of the superhet type, and thus the I.F. stages, as well as the frequency-changer (or signal H.F.) stage may be controlled.

RULES

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

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

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

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

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

Electrolytic Condenser Polarity

"I have an A.C. mains set and this was not giving good results so I got a friend to look at it. He told me that the electrolytic condenser for biasing the output valve was the wrong way round—I have the positive side to the chassis. Can you confirm that this is correct and what difference does it make which way round this particular condenser is joined?"—W. C. (Petworth).

THE bias resistance in the normal cathode circuit causes a voltage drop across it so that the cathode is positive in respect to the grid—which, of course, is joined to the earth line. Therefore, the grid is made so many volts negative with respect to the cathode, and the electrolytic condenser across the resistance should be joined with its negative pole to earth and positive to cathode. Reversing the connections will result in the application of reversed polarity to the condenser, which will damage it and probably destroy the condenser effect.

Reaction Control

"The receiver I am using employs an S.G. valve in the detector stage and I control reaction by means of a volume control component connected between H.T. positive and negative, with the arm joined to the screening grid. This is a 100,000 ohm potentiometer, and I find it very difficult to get smooth control. I have tried different condensers from the arm of the control to earth, but nothing seems to enable me to go into smooth oscillation, which I understood was the main feature of this type of reaction. Can you suggest how to improve it?"—W. P. (Swanage).

ALTHOUGH the circuit may be quite correctly arranged and wired, the trouble may be due to the value of the control. If the reaction comes suddenly, and you cannot get a point where there is a smooth build-up, the resistance value is probably too high. You have probably used 100,000 ohms in order to reduce the H.T. consumption as it is joined direct across H.T. and therefore we suggest that you split this into two parts, say, a 50,000 ohm fixed resistance in series with a 50,000 ohm control. This will give a more gradual effect as it will spread out the effective movement of the control. You may even find it worth while to use a 30,000 ohm variable and make up the remainder of the value by means of fixed resistors in series. To find the correct value, adjust the component now in use to the point where the set bursts into oscillation, and then measure the value of resistance which is in circuit.

REPLIES IN BRIEF

M. G. (Dalston).—No blueprint of a three-valve A.C./D.C. set is now available. We cannot supply sketch diagrams.

S. E. M. (Hounslow).—No issues containing the constructional details you require are now available. We would recommend our design, the Rapide Straight Three, P.W. 82.

W. P. (Huntingdon).—We do not know of any firm now supplying the items mentioned.

A. R. C. (Beccles).—We cannot supply a blueprint of the receiver, therefore we would suggest the Rapide Straight Three, blueprint number P.W.82, which could be modified to suit the coil on hand. The set is of the o-v-2 type for battery operation.

J. P. T. (Swanpool).—We cannot supply diagrams or blueprints of commercial receivers. The makers might be able to assist you.

W. J. C. (Dublin).—We should imagine some fault must exist in the vibrator unit, and would suggest that you check up connections by reference to the article in this issue entitled "A Vibrator H.T. Unit."

Classified Advertisements

ADVERTISEMENTS are accepted at 2s. per line or part of a line. Minimum 4s. Advertisements must be prepaid and addressed to Advertisement Manager, "Practical Wireless," Tower House, Southampton Street, London, W.C.2.

CABINETS

WE regret that, owing to all our employees having joined H.M. forces, we are unable to accept orders for cabinets except to callers. Limited stock only. We have a large stock of radio components.—H. L. Smith & Co., Ltd., 289, Edgware Road, London, W.2. Tel.: Pad. 5891.

LOUDSPEAKER REPAIRS

LOUDSPEAKER repairs, British, American, any make, moderate prices.—Sinclair Speakers, 12, Pembroke Street, Copenhagen Street, N.1.

LITERATURE, MAPS, etc.

AMATEUR Radio Handbook. Second edition now on sale. 328 pages, price 4s. —Radio Society of Great Britain, 16, Ashridge Gardens, London, N.13.

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

RADIO SOCIETY OF GREAT BRITAIN invites all keen amateurs to join. Reduced war-time subscriptions. Send 1s. for latest "T. & R. Bulletin" and details.—16, Ashridge Gardens, London, N.13.

GENERATE free electricity from the wind, build your own Wind Charger. Complete drawings, instructions for building, Mast, Head, Vane, Propeller, 2/6, post 2½d.—Pearse, P.W., Middle Taphouse, Liskeard.

NEW LOUDSPEAKERS

3,000 Speakers, P.M. and energised, 4in. to 14in., including several Epoch 18in.—Sinclair Speakers, 12, Pembroke Street, Copenhagen Street, N.1.

RECEIVERS AND COMPONENTS

SOUTHERN Radio's Wireless Bargains:—7/6.—Assorted Components contained in attractive permanent box. 9 Assorted Valve Holders, 2 Volume Controls, 12 Assorted Condensers, 6 Resistances, Choke, Wire, Plugs, Circuits, etc. 7/6, postage 7d.
ORMOND Loud Speaker Units, Balanced Armature Types. Unshrouded, 3/-; largest 4-pole type, 6/6.
ACE P.O. Microphones ready for use on any receiver, 6/6.
TELSEN Radio Magazines, complete with 4 circuits, 9d. post free. Wireless Crystals, 6d. each, 5/- per dozen. Permanent Magnet Speakers, 8", complete with multi-ratio transformer, 22/6. Many other bargains for callers. All goods guaranteed. Please add extra for postage. **SOUTHERN** Radio Supply Co., 46, Lisle Street, London, W.C. Gerrard 6653.

TROPHY 8 Communication Receiver, with matched Speaker, 12 months old. What offers?—Cleversley, Dolphin Street, Herne Bay.

F.H. WILSON

TWO-GANG .0005 mfd. variable condensers. First class precision job, ceramic insulation, with special slow-motion drive—no backlash or slip, mounted on metal frame, rubber sprung (no trimmers), new, boxed, 7/6 each.
STRAIGHT-LINE 3 wave band drives, 2/11.
TWO-SPEED 4 wave band (3 short and medium) drive and dials with chrome plated escutcheon, 5/11.
DUAL-RANGE coils, aerial and H.F.. small unscreened, with circuit, 3/6 each.
MAINS TRANSFORMERS, 80 m.a. 6.3 volts 3 amp., 4 volts 1 amp., 110-250 A.C., 17/6.
MAINS TRANSFORMERS, 350-0-350 v. 80/100 m.a. 4 v. 4 a., 4 v. 2 a. screened primary, input 200/250 v. A.C., £1 each.
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(Continued top of page 415.)

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F. J. Camm's "Push-Button" Three (HF Pen, D (Pen), Tet)	—	PW92
Four-valve : Blueprints, 1s. each.		
Beta-Universal Four (SG, D, LF, CLB)	—	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))	3.9.38	PW90
Mains Operated		
Two-valve : Blueprints, 1s. each.		
A.C. Twin (D (Pen), Pen)	—	PW18
A.C.-D.C. Two (SG, Pow)	—	PW31
Selectone A.C. Radiogram Two (D, Pow)	—	PW19
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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)	7.1.39	PW35C
D.C. Premier (HF Pen, D, Pen)	—	PW35B
Unique (HF Pen, D (Pen), Pen)	—	PW36A
Armada Mains Three (HF Pen, D (Pen))	—	PW38
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
A.C. £5 Superhet (Three-valve)	—	PW42
Universal £5 Superhet (Three-valve)	—	PW44
F. J. Camm's A.C. Superhet 4	—	PW59
F. J. Camm's Universal £4 Superhet 4	—	PW60
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Push Button 4, A.C. Mains Model		
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Two-valve : Blueprints, 1s. each.		
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The "Fleet" Short-wave Two (D (HF Pen), Pen)	27.8.38	PW91
Three-valve : Blueprints, 1s. each.		
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The Prefect 3 (D, 2 LF (RC and Trans))	—	PW63
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