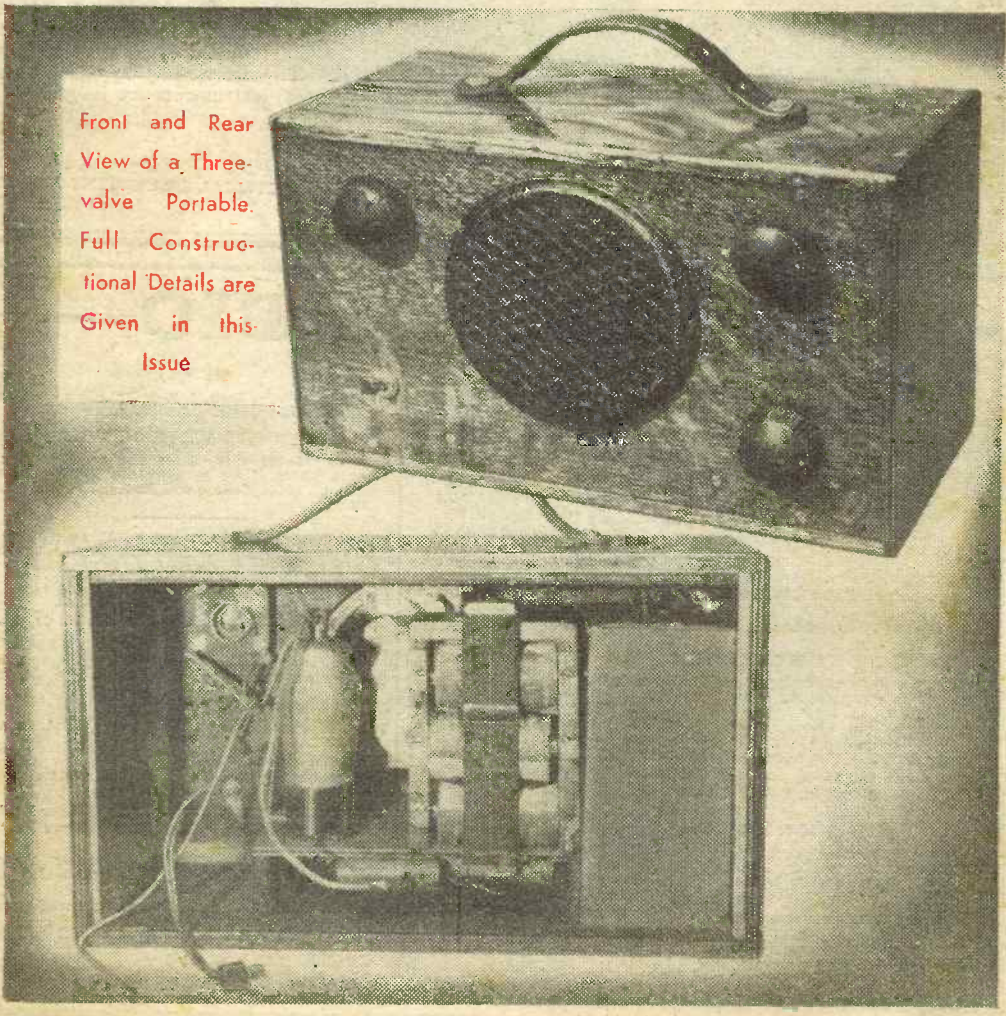
F.M. RECORD REPRODUCTION

Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

Vol. 19. No. 448 NEW SERIES. OCTOBER, 1943



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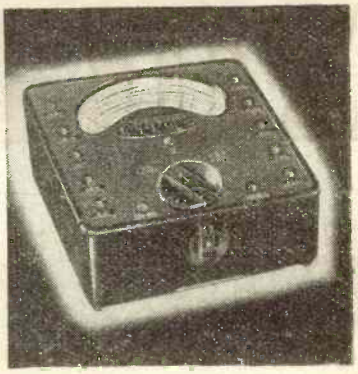

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Practical Wireless

11th YEAR OF ISSUE

and PRACTICAL TELEVISION

Vol. XIX. EVERY MONTH No. 448. OCT., 1943.

Editor F. J. CAMM

COMMENTS OF THE MONTH — BY THE EDITOR

Radio Research

MR. GARRO-JONES, M.P., Parliamentary Secretary to the Ministry of Production, had some illuminating things to say in his speech on Radio Research Production at the Radio Industries Club. He reminded his audience that research and production have their roots in university research, for modern science is the product of the wide curiosity which is the life breath of the university. He said that university research is carried to the point of application very frequently by individual enterprise, which may, as in the outstanding case of Marconi, lead to the foundation of an industry which then founds in turn its industrial research and development laboratories. Radio offers many examples of successful co-operation between the universities, the independent amateur and the industrial laboratory. The classic example is the valve. After Edison's fundamental contribution development of the valve went back to the university in the hands of Dr. Fleming, of London University, and emerged through industrial research by de Forest in America.

The Ionosphere

Research on the propagation of waves led to research on the ionosphere; research on the signal strengths required to communicate through naturally occurring noise led to research on atmospherics. The Marconi research staff carried out a world-wide research on these subjects, but the State had to provide facilities for an ever-expanding group of sub-divisions, long-wave short-distance propagation, short-wave long-distance propagation, direction finding and that great field of ionospheric structure which Appleton made so completely his own.

In future there will come great contributions from the universities, from the laboratories of industry, and from amateur enterprise. But the very general common interest of all users in the results, the need for far-reaching experimental facilities, the need for close co-operation among many workers, the wide geographical spread of the areas over which observations and measurements have to be made, have made and still make, is essential for the State to give a helping hand.

Radio Research Board

In the decade 1925-35 the State contribution came through the Radio Research Board of the Department of Scientific and Industrial Research in full activity on a programme of work which largely centred on the effects of atmospheric processes on radio. The Board and the National Physical Laboratory also did great things in an active programme of measurement and standards work. The constitution of the Board and its committees, and the conduct of parts of the work in university laboratories, maintained the essential linkage between radio research and the universities. But the system, richly productive as it was, became, as war approached, too limited in its scope. The imminence of war, and especially the emergence of radiolocation, led to a remarkable transformation in radio research activities. The radio laboratories of the defence services, under-staffed, under-equipped and under-financed, had done solid work, of a development rather than a research kind, on equipment which, like much of the military equipment here and in Germany, was doomed to be obsolete before the great clash came. Radiolocation, by far the most important national asset ever to emerge from the National Physical Laboratory, was a natural but not inevitable synthesis of techniques successfully developed within the Radio Research Board's programme. It revivified the laboratories of the defence services. The wisdom of Sir Edward Appleton and of Sir Henry Tizard and his colleagues of the Tizard Committee, supported as they were by the Government and its highest advisers, not only contributed to save our country, but to the reshaping and enlargement of the radio industry, and we must not be ungrateful to them or to the industrial and other pioneers who did the foundation work before the war.

The Younger Physicists

To-day the radio laboratories which work for the three great Supply Ministries contain the cream of the country's younger physicists. The country is greatly in their debt, but the universities which have temporarily lost them will be direct beneficiaries in the end. For these researchers have learnt much that will profoundly affect, for the better, their outlook as university teachers and workers after the war. They came to us as good physicists, they will leave us as better physicists, but also as good engineers, good organisers, great team leaders, and wise judges of policy.

The fertility of invention, the ingenuity of application, the apparently inexhaustible range of new tricks and new uses, the battle of wits with the man on the other side, which have characterised the growth of radiolocation in the hands of these young physicist-engineers, and which is still at its height, was reached on the older and slower-moving technique of radio communication. Now the modernisation of this constantly changing art of communication is under way, and the effects on radio in the peace will be very great. Television has not by any means been allowed to remain where it was in 1939.

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

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

ROUND THE WORLD OF WIRELESS

Telecommunication Association

A NEW association, connected with the telecommunication industry, is one of the recent company registrations. The new company will be known as the Telecommunication Engineering and Manufacturing Association, and is registered as a company limited by guarantee.

Objects of the Association

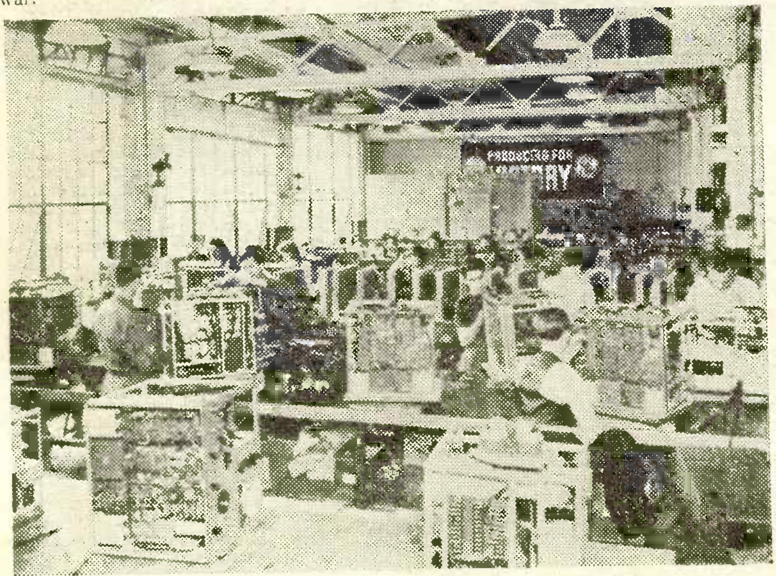
THE objects of the T.E.M.A. are to promote, encourage and develop the telecommunication engineering and manufacturing industry in the United Kingdom, to co-operate with and make representations to Government Departments, to promote co-operation and collaboration between persons engaged in the industry concerning technical manufacturing and other problems, and to participate in research work.

Electrical Industries Red Cross Appeal

THE Electrical Development Association has just issued the 13th list of Covenants and Donations in connection with the above fund, which show that the gross annual amount received from covenants is £10,430 6s., and from donations £6,218 9s. 3d. Funds for this deserving cause are still urgently needed.

B.B.C. Broadcasts to Japan

THE B.B.C. has begun a daily service of broadcasts so that Japanese listeners may have the opportunity of learning the real facts of each new phase of the war.



A view of one of the production departments in a General Electric Factory in the United States, where "Radar" sets are built for the U.S. Navy.

The B.B.C. Japanese service is transmitted on a number of short wavelengths designed to cover not only Japan but all Eastern and South-Eastern Asia. The service is in Japanese on Sundays, Tuesdays, Thursdays and Fridays, and in English on Mondays, Wednesdays and Saturdays.

One of the regular speakers will be Major C. John Morris, formerly lecturer in English literature at Bunrika University, Tokyo.

A Bouquet from India

WE have received the following interesting letter from an old contributor, now in the overseas forces:

"During the past eight months I have had to travel in South Africa and India, and I write this to let you know how agreeably impressed I was to find PRACTICAL WIRELESS on sale at most bookstalls in the big towns of both these countries. I had no difficulty in obtaining a copy, which was seldom more than a month overdue. PRACTICAL WIRELESS certainly gets around the world!

"I would also add that the contents of PRACTICAL WIRELESS are now of a very high quality; the journal has improved considerably over the past 12 months, despite the increasing wartime difficulties. It might also be of interest to you to know that your 'Practical Mechanics Handbook' has been recommended as a text book for concerned R.E.M.E. personnel, by the Military College of Science at Bury."—S. A. KNIGHT (Arm. S./Sgt. R.E.M.E.).

The Proms: Giving Talent a Hearing

ONE of the great services rendered by the Proms is that of giving composers a chance to have new works performed, and already this season there have been some striking examples of creative ability, particularly on the part of British composers.

The outstanding new work so far is undoubtedly Dr. Vaughan Williams's Fifth Symphony. This has been hailed by critics and public as a great contribution to English music. Vaughan Williams, who is over 70, shows a remarkable vitality of inspiration in this work. When listeners have an opportunity of hearing it again on the air they will be able to probe further into its beauties and felicities.

New Symphonies

TWO other new symphonies (not yet broadcast) have been performed at the Albert Hall — a first symphony by Eugene Goossens and a first symphony by Lennox Berkeley. Sir Arnold Bax's Seventh Symphony, which was broadcast on July 22nd, is another outstanding British symphonic creation. It is a notable fact that this country, so long belittled as to its musical achievements by the Continental nations, should to-day produce richer and more significant music than any other country—and so much of it. That such a work as the Vaughan Williams symphony was produced in the middle of a world war is in itself a testimony to the enduring things of the spirit for which the United Nations are fighting.

Works by composers of the United Nations—American, Russian, French, Belgian, Polish, Czech—were heard during the Promenade Season.

The Institution of Electrical Engineers

THE scrutineers appointed at the section meeting held on May 5th, 1943, have reported the result of the ballot to fill the vacancies which will occur on the section committee on September 30th next, and the full committee for next session will be as follows: Chairman, Mr. T. E. Goldup; vice-chairman, Professor Willis Jackson, D.Sc., D.Phil.; immediate past chairman, Mr. R. L. Smith-Rose, D.Sc., Ph.D.; ordinary members of committee, Mr. F. B. Best, M.Sc., B.Eng., Capt. C. F. Booth, Mr. C. W. Cosgrove, B.Sc. (Eng.), Mr. W. T. Gibson, O.B.E., M.A., B.Sc., Mr. H. G. Hughes, M.Sc., Mr. H. L. Kirke, Mr. E. C. S. Megaw, M.B.E., B.Sc.(Eng.), Mr. O. S. Puckle, Mr. J. A. Smale, B.Sc., Mr. H. A. Thomas, D.Sc., Mr. T. Wadsworth, M.Sc., Mr. R. C. G. Williams, Ph.D., B.Sc.(Eng.). Together with the following ex-officio members: The president I.E.E., the chairman I.E.E. Papers Committee, representatives of the I.E.E. Council, the Admiralty, the Air Ministry and the Ministry of Aircraft Production, the Post Office and the War Office.

Radiolocation Lead

SIR JOHN ANDERSON stated at a recent press conference that success in the war against U-boats was very largely due to improved location methods. He also said that Britain was still ahead of the Germans in radiolocation, and had it not been for the development of that technique before the war, the German air attack on Britain might have had very different consequences.

Flash Lamp Bulbs Order

THE Board of Trade, in consultation with the Central Price Regulation Committee, have made an Order amending the Flash Lamp Bulbs (Maximum Prices) Order (S.R. & O., 1943 No. 247) in the following ways:

1. As the period in which wholesalers and retailers were allowed to clear any stocks of Far Eastern bulbs bought at a higher price has now elapsed, the provisions of the schedule in the original Order which fixed these prices are now deleted.
2. The definition of flash lamp bulbs has been altered (a) to exclude bulbs used in miners' safety lamps and (b) to include only bulbs designed and manufactured for intermittent use.
3. The maximum prices for tested bulbs have not been altered, but when untested bulbs are sold by one trader to another and any defective bulbs are returned within 28 days from the date of consignment, the maximum price is to be reduced by an amount in proportion to the number of defective bulbs.

(4) When a retailer sells untested bulbs to the public, the same provision applies if any defective bulbs are returned the day after the sale.

(5) A defective bulb is defined as one which contains defects which can be discovered by any of the tests normally used in businesses handling bulbs.

This Order, the Flash Lamp Bulbs (Maximum Prices) (No. 2) Order, 1943 (S.R. & O., 1943, No. 1084), came into force on August 16th, 1943. Copies are available, price 1d., through any newsagent or bookseller or direct from H.M. Stationery Office, Kingsway, W.C.2.

Radar in the Making

IN a General Electric factory in New England, U.S.A., radar sets are in full production for the United States Navy. Radar is the American name for radiolocation, the apparatus which sends out ultra-short waves that are reflected back to receivers for revealing the presence of hidden 'planes, ships, etc., and indicates their direction and speed of travel. The device works efficiently through fog, hail, snow, or the darkest night.

B.B.C. Overseas Service

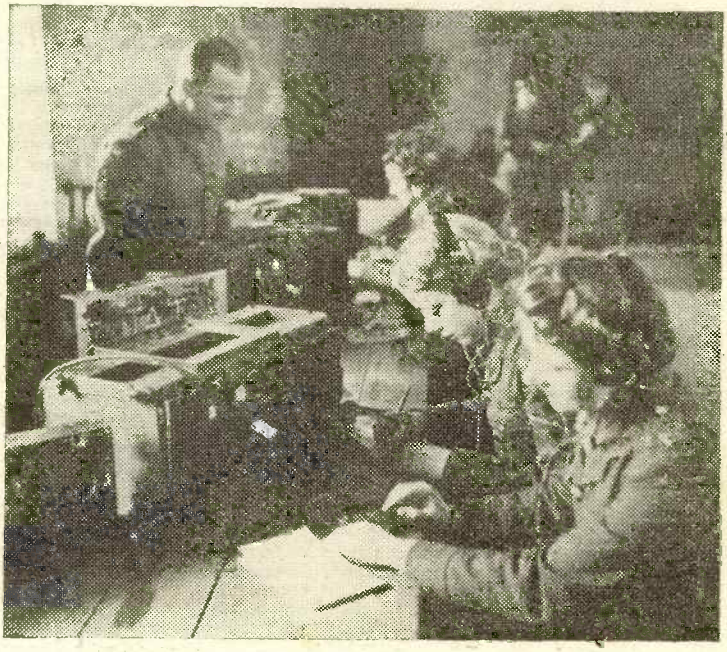
WHEN the General Overseas Service of the B.B.C. was started in June of this year as an expansion of the work of the Overseas Service, it was hinted that further developments were still to come. An addition recently announced is the daily service to Japan (see paragraph on the previous page).

The Overseas Services took more definite shape, so far as listeners were concerned, when the European Service became a separate organisation in September, 1941. How vast has been the expansion of overseas broadcasting since the war is indicated by the number of languages used, which now totals 48; while in September, 1939, the B.B.C. was broadcasting in 16.

Itinerary

Home and Forces.—Home and Forces cover the British Isles. Languages: English, Welsh, Gaelic.

European Service.—European Service covers Europe and Europeans in Africa and the East.



A sergeant of the R.C.O.S. instructing a class of trainees on the working of wireless transmitters.

Languages (daily): English, Albanian, Bulgarian, Czech, Danish, Dutch, Finnish, Flemish, French, German, Greek, Hungarian, Italian, Norwegian, Polish, Portuguese, Rumanian, Serbo-Croat, Slovene, Spanish, Swedish.

In addition, the European Service broadcasts four times a week in Luxembourg Patois, several times a month in Slovak in the Czechoslovak Service and once a week in Icelandic.

Overseas Service.—Languages: English, Afrikaans, Arabic (including Moroccan Arabic), Bengali, Burmese, Chinese (Cantonese), Chinese (Kuoyu), French (for Canada), Greek (for Cyprus), Gujerati, Hindustani, Hokkien, Japanese, Malay, Maltese, Marathi, Persian, Portuguese (for Latin-America), Sinhalese, Spanish (for Latin-America), Tamil, Thai, Turkish.

The Stroboscope

How to Make One, and Its Uses

Fig. 4.—The stroboscope and lamp fitted to a gramophone.

THE stroboscope is a most interesting instrument, possessing, apart from its utility, a source of what one might call "scientific amusement." The word is derived from two Greek words *strobos* a whirling, and *skopeo* to view, and means "an instrument for noting velocity by the intermittent lighting of the rotating object." It consists in its simplest form of a disc of paper with a number of light and dark segments arranged round the periphery, and it is fixed to some object which has to rotate at a definite speed. A source of intermittent lighting is arranged close to it, and the segments appear to remain stationary at the correct speed.

The Gramophone Turntable

Whether you use a clockwork motor or a simple electric motor, it is essential that it should be capable of rotating the turntable at the same speed as was used when the subject of the disc was recorded. This is now, for the majority of records, 78 revolutions per minute (r.p.m.). Most clockwork motors have a small speed indicator which is screwed to the motor-board, and when purchasing a separate motor this is a loose fitting.

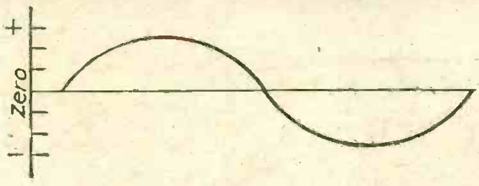


Fig. 1.—Graphical representation of A.C. current.

It may, therefore, be screwed into any position, and the figure 80 on it may actually correspond with a speed of only 65 r.p.m. Some hold that there is no need to play a record at its actual recorded speed, as the relation between notes is the same at any speed. While this is true, the pitch is definitely altered with speed, as is only too apparent when a clockwork motor commences to run down. The gradual fall in tone to an indistinguishable noise, or the fall in pitch of a man's voice, is, no doubt, well known. If, therefore, the record does not rotate at the same speed as was used for recording, the pitch of a person's voice, or the correct musical key of the instrument will not be reproduced. When it is desired to accompany a gramophone singer on an instrument in the home this is most essential. How can we get this accurate speed then? This is where the stroboscope comes in, and the only essential is an alternating current supply. From articles which have already appeared in these pages, our readers know that A.C. (alternating current) operates in a definite wave-form, having the shape shown in Fig. 1. This represents one cycle, and the ordinary electric supply mains in our houses are rated at a certain frequency, which means the number of complete cycles, or alternations, per second.

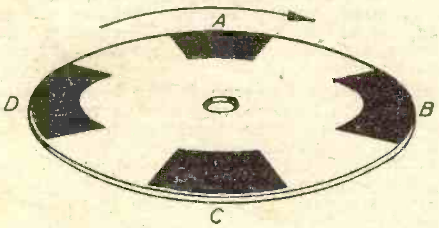


Fig. 2.—A simple stroboscope disc which, with the text, will make the theory clear.

The Formula

From the sine curve of Fig. 1, it is clear that there are two opposite peaks in one cycle, and if an ordinary electric lamp is supplied from A.C., it will light at each peak, and as the current falls to zero in the centre it will go out once per cycle. This may seem strange to many, but owing to what is known as "visual persistence," and the sluggishness of the ordinary lamp filament, the lamp appears to glow steadily the whole time. It will be shown later that this is not so, and the lamp actually flickers. As the lamp is therefore fully illuminated twice per cycle, we can multiply the frequency of our supply (which means the number of cycles per second as stated above) by two, and this will give us the number of times the lamp will light in a second. Now look at Fig. 2. This shows a disc having eight equal segments marked on it, four black and four white. If this were fitted to a shaft and gently turned the segments would appear to go round in the same manner as the spokes of a wheel. If, however, when in the position shown in Fig. 2 the disc was covered from our sight for a fraction of a second, and the disc turned so that segment A occupied the position now occupied by segment B, and then we were permitted to view the disc again, provided every segment was identical, we should not realise that there had been any movement, and the same thing could be carried out right round the disc.

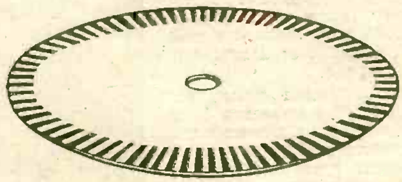


Fig. 3.—A disc prepared for checking the speed of a gramophone turntable.

This is how the stroboscope works. The disc is rotated and the light which is operated from the A.C. supply is used to illuminate the disc. When the light is on, the disc can be seen, but when the light is out the disc makes a movement, and upon being illuminated again the segments are once more visible. By suitably arranging the number of segments—according to the number of revolutions which have to be made in conjunction with the flickerings of the lamp—the disc will appear to remain stationary, due, as shown above, to the fact that one segment moves round to the position occupied by another segment during the time there is no illumination. The formula, therefore, becomes twice the frequency with which the lamp is illuminated, multiplied by 60 to convert it to minutes, and divided by the number, or revolutions per minute which are required. As the 60 of our numerator, and the doubling of the frequency will always apply, it is simpler to take the frequency and multiply this by 120 (which is twice 60), and divide this by the revolutions required. In mathematical form this becomes $\frac{F \times 120}{R}$, where F is the frequency of the supply, and R the revolutions per minute.

The Gramophone Stroboscope

It was stated that the gramophone turntable must rotate at 78 r.p.m. The majority of electric supply mains have a frequency of 50 cycles, and, therefore, the formula for this is $\frac{120 \times 50}{78}$, which gives us approximately 77. It is necessary, therefore, to arrange 77 segments of contrasting colour on our disc, and this is easily carried out with compasses and a protractor. It must be borne in mind that there must be 77 segments of *each* colour. Fig. 3. To illuminate this disc, one of the small gramophone lights may be used, such as that shown in Fig. 4, or some similar device, and if the lamp in it is operated from the heater winding of an A.C. set, it serves two purposes. It enables the needle to be placed on the first groove easily, and if the stroboscope is cut a little larger than a standard record label, it may be placed over each record in order to ascertain that the record remains constant throughout the whole of its playing time. If an ordinary battery-operated receiver is in use, an ordinary table-lamp may be held close to the turntable for the purpose, or the normal room lighting may be used if the segments on the disc are sufficiently well defined. If it is desired to get a very marked impression (due to rather poor eyesight or other cause), a neon lamp should be employed. One of the well-known Osglim or beehive night-lights will give a most definite impression owing to the fact that the neon answers so rapidly to the alternating current. The normal electric light will be found quite good enough, however, for ordinary purposes.

Midget One-valver

A Compact Portable Set, Capable of Receiving the Local Station

THE receiver is very simple, and can easily be carried in a coat pocket, as its outside measurements are only 5in. × 3¼in. × 2¼in. deep; the case is constructed from plywood, and may be varnished or covered with leatherette paper, as desired.

The battery connections to the receiver are made by means of a valveholder and an old valve-base, as shown in Figs. 1 and 2. It will be found that this is more convenient than having leads in the usual manner. The batteries—a 9-volt G.B. battery for H.T., and a large 1½ volt cell for L.T.—are carried in a separate case. No on/off switch is fitted to the receiver, as the valve-base

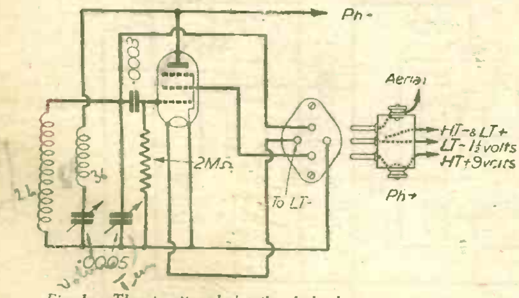


Fig. 1.—The circuit and details of the battery connecting plug.

carrying the battery connections can easily be inserted or withdrawn to switch the set on or off.

The Coil

The coil is wound on a cardboard tube approximately 2¼in. in diameter and 1½in. long. The grid winding consists of 50 turns of 26 S.W.G. D.C.C. wire; the reaction winding is 50 turns of 36 S.W.G. enamelled wire wound ¼in. from the "earthy" end of the grid winding. It will be seen that the top of the valve fits inside the coil. The valve used is of the L.F. pentode type, and will operate efficiently on the small voltages used. An American Philco 2101 was used in the original receiver; the Cossor 220 HPT is an approximate English equivalent, and will be found satisfactory.

Operation

If the receiver does not oscillate when first tried, the connections to the reaction coil should be reversed. The little set will be found surprisingly sensitive, and a few yards of flex will provide sufficient signal pick-up when used as a "throw-out" aerial. If louder signals are required, the H.T. voltage may be increased to about 20; this was not found necessary in any of the localities where the receiver has been operated, but would give better reception when using the set in areas where conditions are poor.

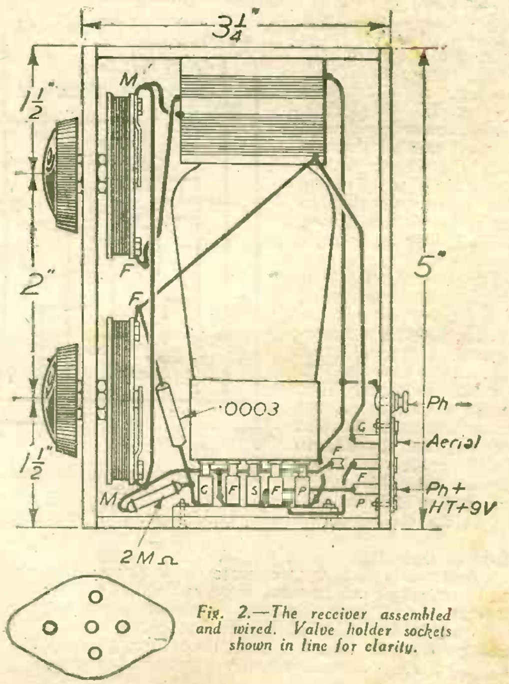


Fig. 2.—The receiver assembled and wired. Valve holder sockets shown in line for clarity.

An Untuned Signal Tracer

A Unit Which Will Prove Most Valuable to the Constructor and Serviceman

FOR the busy serviceman, a signal tracer is just the kind of instrument needed for quickly tracing obscure faults, such as hum, motor-boating, distortion, etc. The following is a description of a convenient type of signal tracer; being untuned it permits stage by stage tests without twisting any dials, as in the more conventional kind of tracer.

Circuit

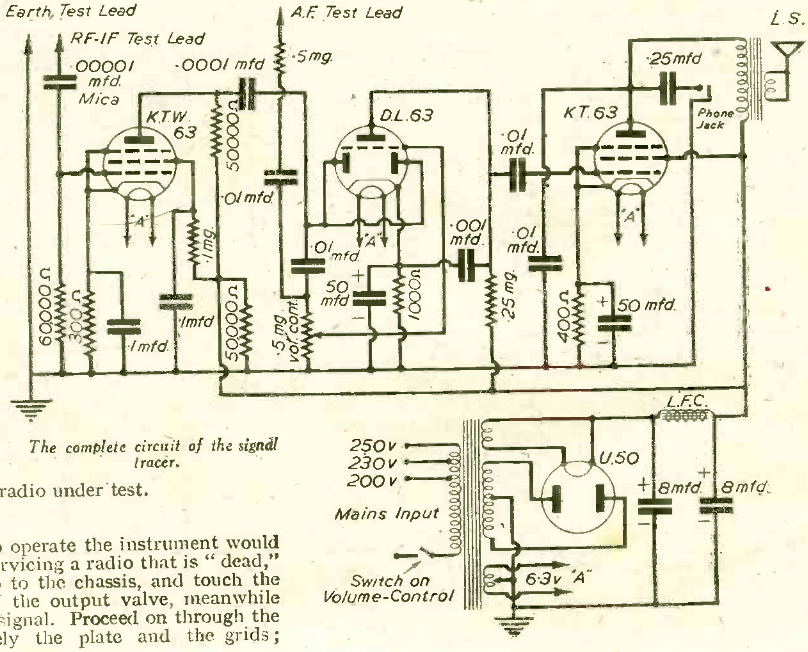
The circuit is not in any way elaborate. A vari-mu pentode is used for the RF-IF stage. I used a KTW63, but as the circuit is not critical it would probably work as well with other types, although I have not tried it. Power or grid-leak detection could have been used, but as simplicity was the keynote, I decided to use a diode detector, as with its method of volume control it makes the simplest circuit, so a DL63 was used with the diodes strapped together. The output stage is a standard one, as is the power supply; a KT63 is used for the ouput and a U50 for the rectifier.

For the RF-IF stage, the signal is fed to the grid of the KTW63 via a .00001 mfd. mica condenser. This condenser is incorporated in the test-prod, and I used one tag of the condenser as the prod, but this is optional. Do not make the RF-IF lead any longer than 2ft., the shorter the better. Low loss cable should be used for the lead, if it is possible to get in these days of shortage, though ordinary heavy covered cable could be employed. CO-AX is, of course, the best, and the lead should be soldered right into the circuit.

The AF lead is also soldered right into the circuit, a .5 megohm resistor is at the prod end of the lead and feeds through a .01 mfd. condenser to one side of the .5 megohm volume control. A .01 mfd. condenser connects the diodes of the DL63 with the AF lead, the grid of the DL63 is fed via the .5 megohm volume control.

A .01 mfd. condenser feeds the grid of the KT63 from the plate of the DL63, thence to a loudspeaker, a permanent magnet in this case, though an energised could be used and so dispense with the choke in the power supply. A phone jack is incorporated in the plate circuit of the KT63 fed by a .25 mfd. condenser.

The power supply is a standard one, consisting of a 350-0-350 v. 100 ma. 5 v. 2 a. 6.3 v. 4 a. transformer, a U50 rectifier, an L.F. choke and an 8 × 8 mfd. condenser. The mains switch is on the volume control, all earths are to the chassis, to which a cable is soldered; this has an alligator clip soldered to it for attaching to the chassis of the radio under test.



The complete circuit of the signal tracer.

Mode of Operation

A few words on how to operate the instrument would not be out of place. In servicing a radio that is "dead," connect the alligator clip to the chassis, and touch the AF lead to the plate of the output valve, meanwhile tuning the receiver for a signal. Proceed on through the stages, testing alternately the plate and the grids; when you reach the detector stage change to the RF-IF lead. This same procedure can be used for tracing hum, distortion, or any other fault that the radio might have wrong with it, and besides simply finding the fault, it can be traced right to its source, but when testing do not confine yourself to merely testing the grid and plate electrodes, but also test the cathode, screen and suppressor grids. In the plate circuit of the KT63, a phone jack is connected; this is very useful when testing on a small signal and also for obscure cases of hum, etc. Using the phones you can operate the set under test at full volume and still hear a signal from any one point in the receiver.—R.L.W.

LIST OF COMPONENTS

One mains transformer, 350-0-350 v. 100 ma. 5 v. 2 a. 6.3 v. 4 a.

One L.F. choke. One chassis.

One permanent magnet loudspeaker

Thirteen condensers: One 8 × 8 mfd. 500 v.w.; four .01 mfd. 350 v.w.; two .1 mfd. 350 v.w.; One .25 mfd. 350 v.w.; one .001 mfd. 350 v.w.; one .0001 mfd. 350 v.w.; one .00001 mfd. mica; two 50 mfd. 25 v.w.

Eleven resistances: one .5 megohm volume control with switch; one 60,000 ohm ½-w.; one 50,000 ohm 2-w.; one .5 megohm ½-w.; one .25 megohm 1-w.; one .1 megohm ½-w.; one 50,000 ohm 1-w.; one 25,000 ohm ½-w.; one 5,000 ohm ½-w.; one 400 ohm ½-w.; one 300 ohm ½-w.

CO-AX cable, sleeving, connecting wire, etc.

Four valves: one KTW63; one DL63; one KT63; one U50. Four octal bases.

F.M. Record Reproducing System

Greater Frequency Response and Absence of Background Noise and Distortion are the High-lights of this Method Which is Reviewed

By D. A. ALDOUS

DURING the past few years an investigation has been conducted at the laboratories of the R.C.A. Manufacturing Company, New Jersey, U.S.A., to determine the prospects of improving materially the overall performance of gramophone record reproducing systems. Part of the investigation was directed toward the possibility of reproducing frequencies up to 10,000 or 12,000 c/s from standard solid-stock records without introducing excessive surface noise.

The two engineers chiefly responsible for this study, Mr. G. L. Beers and Mr. C. M. Sinnett, have recently published, in the Proceedings of the Institute of Radio Engineers, the results of their work, in the course of which the possibilities of producing a frequency-modulated signal were investigated, as this type of play-back system appeared to show promise of satisfying certain requirements considered essential to a really high-grade record reproducing system.

It was found that of the many factors that must be considered in the design of a pick-up to reproduce lateral-cut records, the following six determine the quality of reproduction which will be obtained and also have a direct bearing on the life of the record and playing needle: (1) The vertical force required for satisfactory tracking should be low enough to prevent undue record wear and minimise record surface-noise. Tests reveal that for lacquer-coated discs, i.e., direct play-back records, the vertical force should not exceed 20 grams, and for shellac, i.e., solid-stock pressings, the maximum figure is 30 grams; (2) The vertical and lateral mechanical impedances presented by the pick-up at the needle should be as low as possible, as the work which is performed by the record is a function of these impedances. Low mechanical impedance is likewise desirable to minimise the mechanical noise or chatter radiated directly from the pick-up and record; (3) It is desirable to keep the free resonance of the pick-up at as high a frequency as possible to minimise the effect of ticks and other record groove irregularities; (4) If distortion is to be minimised it is essential that the pick-up and associated circuits provide a linear relationship between audio voltage output and needle displacement, and the necessity for minimising distortion increases as the frequency range of a sound reproducing system is extended; (5) A pick-up suitable for a high-fidelity system should provide a frequency response throughout the useful audio-frequency range which is proportional to either the amplitude or the velocity of the modulation in the record groove; (6) The sensitivity of the pick-up should be such that the amplification required between the pick-up and loudspeaker is not so great as to introduce serious microphonic problems.

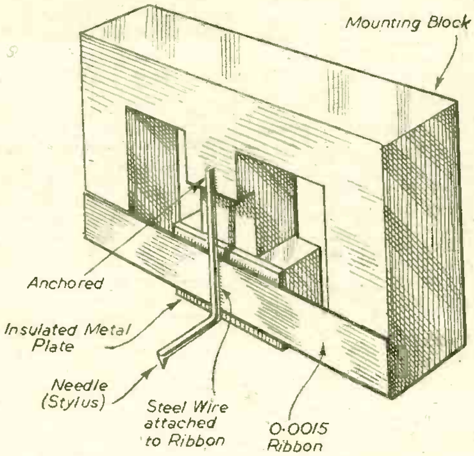


Fig. 1.—General construction of an experimental F.M. pick-up.

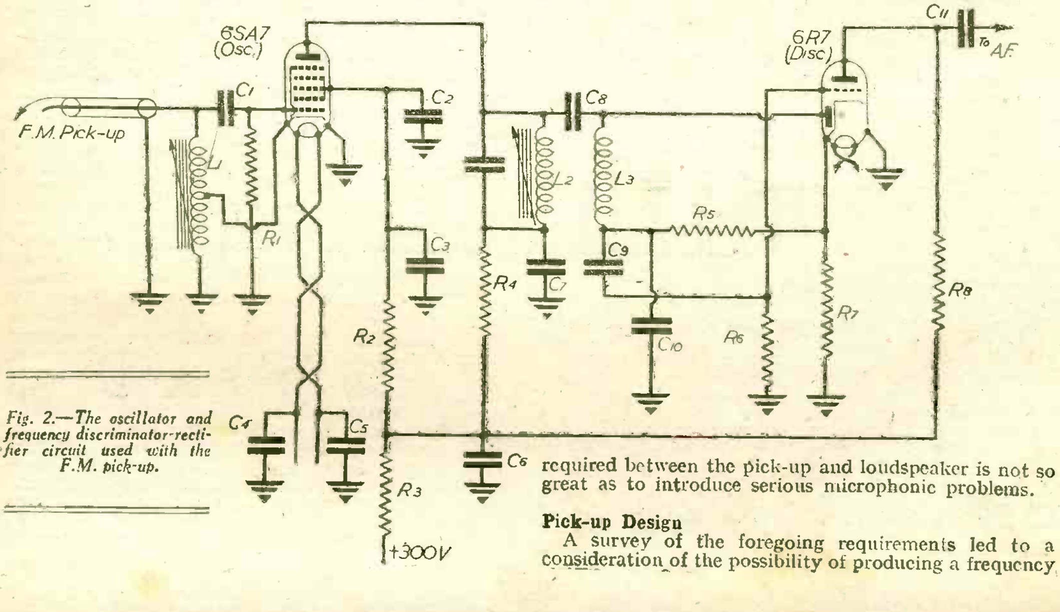


Fig. 2.—The oscillator and frequency discriminator-rectifier circuit used with the F.M. pick-up.

Pick-up Design

A survey of the foregoing requirements led to a consideration of the possibility of producing a frequency modulated signal by means of a special pick-up. It was found that with a simple pick-up a frequency-modulated signal could be produced which had sufficient frequency deviation to provide a relatively high audio-frequency voltage output, when applied to a frequency discriminator and rectifier combination. The inductive or the capacitive reactance of a resonant circuit can be varied to produce a desired frequency shift, but from the standpoint of a gramophone pick-up the control of frequency through a variation in capacity seemed to offer the greater advantage.

The general construction of an experimental FM pick-up is shown in outline in Fig. 1. A metal frame or mounting block is provided as a support for an insulated plate, which is the high-potential side of the pick-up. To this mounting block is also attached a thin metal ribbon, fitted in a plane parallel to the insulated plate and spaced from it by a small air-gap, which is placed under tension to increase the natural resonance frequency of the system. The needle supporting wire is anchored to the mounting block at its upper end. It is attached to the ribbon at approximately the mid-point of its length and its free end is bent in a plane essentially parallel to the record groove. The sapphire used as a needle is attached to the end of the wire. The portion of the wire between the ribbon and the sapphire provides sufficient vertical compliance to minimise mechanical noise and to reduce pinch-effect distortion. From Fig. 1 it is apparent that displacement of the needle laterally results in a change in position of the ribbon with respect to the fixed plate and thus produces a change in capacity. The overall length of the mounting block, shown in the figure, is about 0.5in., and the normal spacing between the fixed plate and ribbon is approximately 0.004in.

Theory indicates that it is necessary in an FM pick-up that the change in capacity with needle displacement must be such as to produce a linear relationship between frequency change and needle motion, or, in other words, the variable capacitor formed by the elements of the pick-up. should be of the straight-line frequency type.

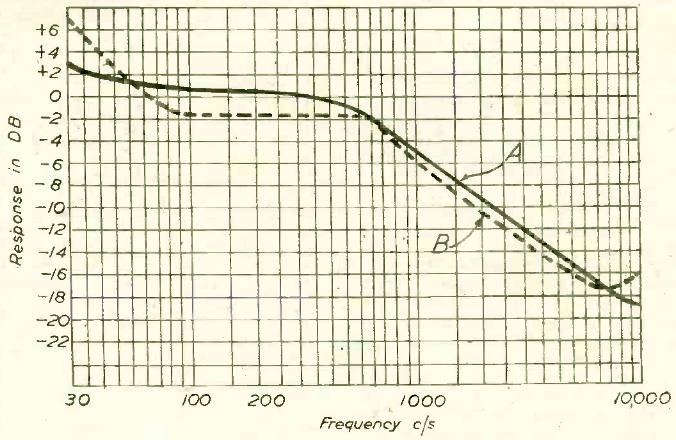


Fig. 3.—Frequency response curves of F.M. pick-up A Measured and B Calculated.

Circuit Considerations

The major circuit considerations involved in the design of an FM record reproducing system may be stated to be : (1) The carrier frequency to be employed ; (2) A suitable oscillator circuit for use with the pick-up ; (3) The type of frequency discriminator-rectifier combination to use. An inquiry into the question of the operating frequency for use in an FM pick-up system led to the conclusion that carrier frequencies as low as those used in the intermediate-frequency amplifiers of radio receivers and as high as those employed for FM broadcasting will give satisfactory results. If the FM pick-up system is to be used in combination with a radio receiver there may be some advantage in using a carrier frequency that permits the use of one or more of the I.F. amplifier circuits as a frequency-discriminating network for converting the frequency-modulated signal into amplitude modulation before demodulation. However, if the FM pick-up system is designed as a separate unit it may be desirable to employ a frequency around 30 megacycles/sec. The signal level provided at the discriminator by the frequency-modulated oscillator can be made fairly high, so there is no likelihood of diathermy machines or other electrical equipment causing interference with the FM pick-up system. (It might be mentioned here that such an FM record reproducing system would radiate, and so adequate screening would be required if its possession and use in Gt. Britain under wartime conditions was not to be regarded by the G.P.O. as infringing the Defence Regulations.)

Fig. 2 shows the oscillator and frequency discriminator-rectifier (demodulator) circuits that have given good results. The circuit problem of the oscillator is to provide an arrangement which will have sufficient frequency stability from the standpoint of line-voltage variations, temperature changes, etc., and at the same time enable the pick-up capacity variations to produce the desired frequency change. From the point of view of obtaining the maximum frequency change for a given capacity variation at the pick-up, it is desirable that the pick-up be connected directly across the oscillator tuned circuit. One way of accomplishing this is by mounting the oscillator valve and associated circuit elements at the pick-up end of the carrying-arm. This arrangement has not been found to be particularly satisfactory, because the carrying-arm is made unduly large and the heat from the oscillator valve causes the end of the carrying-arm, which is handled by the operator, to become uncomfortably hot. The same result, however, can be attained by mounting the oscillator valve on the main instrument chassis and connecting it to the pick-up through a resonant transmission line, which is used as the oscillator tuned circuit. It has been found that by connecting the pick-up previously discussed through a relatively low-capacity line to a conventional oscillator circuit, as depicted in Fig. 2, a sufficient frequency shift is obtained to give the required audio-frequency output. In this case the transmission line is treated as a lumped capacity, and is included as an integral part of the carrying-arm.

Oscillator

It will be noted that the oscillator valve employed is of the 6SA7 type, which permits the use of electronic coupling between the oscillator and discriminator circuits. The oscillator frequency is adjustable by means of an iron core associated with the inductance L_1 shown in the schematic. A simple resonant circuit is utilised as the means for converting the oscillator frequency variations into changes in the amplitude of the signal applied to the diode portion of the 6R7 valve. A powdered-iron core associated with inductance L_2 is used to tune this circuit so that the mean oscillator frequency falls at approximately the 70 per cent. response point on one side of the selectivity characteristic. The rectification (demodulation) of the r.f. signal by the diode develops an audio-frequency potential across the resistor R_5, which is then amplified by the triode section of the 6R7. The output voltage that appears across resistor R_8 in the anode circuit of the 6R7 is applied to a suitable a.f. amplifier and loudspeaker. An experimental pick-up employed in the Fig. 2 circuit has given an r.m.s. potential of 6 to 8 volts across resistor R_8

when reproducing a 400 c/s record cut at a groove amplitude of 0.001in.

In the course of development of the FM pick-up system the authors derived equations, given in detail and graphical form in the original contribution, for calculating the performance characteristics. These characteristics are as follow: (a) Lateral mechanical impedance; (b) Lateral force acting upon needle; (c) Response characteristic of pick-up and carrying-arm; (d) Tracking weight required to overcome vertical force due to lateral velocity; (e) Tracking weights and relative outputs to be obtained with different radius needles, and for purposes of comparison measurements were made on an experimental pick-up to ascertain the last three of these characteristics.

It was found, *inter alia*, that a needle tip radius of 0.003in. was the best compromise from the standpoint of overall performance, that a tip radius of 0.003 to 0.004in. required the least tracking weight, and that a tip radius of 0.003in. was again indicated to maintain high-frequency output with a given tracking weight. (The F.M. pick-up normally operates with a tracking weight of only 18 grams.) Fig 3. curve A, shows the overall response characteristic of the pick-up, carrying-arm, and discriminator as obtained from a frequency record having a 500 c/s crossover point between constant amplitude and constant velocity. The rounded portion of this curve at the cross-over frequency is due to the limitations imposed by the electrical network used to provide the recording characteristic. For comparison the calculated response characteristic is included as curve B.

It is stated that an experimental FM record reproducing system, of the type described, has been in use for some time; and all the evidence indicates that the system is practical and is not adversely affected by temperature changes, humidity or line voltage fluctuations. From the user's viewpoint, this FM pick-up system makes it possible, when playing conventional solid-stock discs, to extend the frequency range of a record reproducing system to 10,000 or 12,000 c/s with marked freedom from surface noise, mechanical noise and distortion. A further reduction in surface noise can be obtained with ordinary records if they are cut with a high-frequency accentuation characteristic comparable with that used in making transcriptions. Test records of this type have been made and the surface noise obtained from these recordings with the new FM playback system was reduced to the point where it was completely unobjectionable.

Permanent Magnets—VII

By L. SANDERSON

(Concluded from page 427, September issue.)

ANOTHER type of fluxmeter depends on the e.m.f. generated in a rotating coil driven by a small motor at known speed. This coil links the magnetic flux to the circuit, and the apparatus has primarily been designed for testing magneto magnets.

Another useful instrument is the magnetic potential meter, somewhat similar in principle to the voltmeter, and employed in order to determine differences of magnetic potential. The instrument comprises a thin ribbon or strip of flexible insulating non-magnetic material, of uniform cross section, with a uniform helix of wire wound upon it. The terminals of the wire are linked up with those of a Grassot fluxmeter or a ballistic galvanometer. The potential difference of magnetic potential is obtained by reading the fluxmeter and the value of an, where a is the number of sq. cms. the helix is wound, and n the number of turns per cm. length. The results obtained are not affected by the curvature of the strip, a point of particular usefulness in the type of measurement for which this instrument is designed.

Magnetisation Curves

In determining magnetisation curves for permanent magnets several methods are available, and the particular one used is largely governed by the form of the magnet or specimen. Broadly, these methods fall into two main groups, those designed for ring-shaped magnets and those for bar-shaped magnets. The ring method most commonly employed and probably the most advantageous is that known as the ballistic method. A ring of exactly known dimensions has an exciting coil uniformly wound over the whole of its surface, and a search coil. It is essential that the number of turns in both these coils should be exactly known. As a rule it is advisable to wind the search coil as close to the ring surface as is feasible, and to divide it into four equi-spaced sections, each of which has about 20-30 turns. Fig. 7 shows the arrangement of the test. The magnetising force is given by the equation $H = \frac{1.26\ w_1}{l}$ I gauss. In this, w_1 is the number of turns in the coil, l is the mean length in cm. of the magnetic circuit in the ring, I is the current amps. in the exciting coil.

It is necessary to ensure that the specimen should be fully demagnetised as a preliminary to the test readings. For every new value of H it is necessary to reverse the exciting current a few times to make certain that the specimen has been brought into a cyclic magnetic state

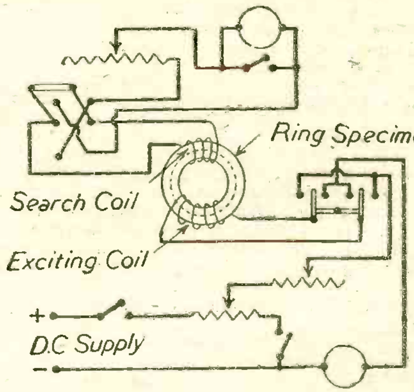


Fig. 7.—Circuit diagram of connections for the test to determine magnetisation curves.

before the final test reading is taken. A rather altered but substantially similar series of connections enables the hysteresis loop to be established.

Low Frequency Amplifier Design—1

A Short Series of Articles Dealing with the Practical Aspects of an Interesting Subject

THERE are many seekers of "quality" reproduction who fail to study the simple type of amplifier fully before rushing to assemble an expensive paraphrase or push-pull outfit. The latter types of amplifiers certainly have their merits, but are not always essential. Moreover, they are generally expensive and call for the use of components that are often difficult to obtain in present conditions. And any attempt at reducing the cost may well result in the amplifier being less satisfactory than one of simpler and more conventional design.

R.C.C. Advantages

There is no doubt that the resistance-capacity-coupled amplifier is simple in construction, and very inexpensive. Perhaps it is partly because of this that it is often regarded as old-fashioned and not very effective. Provided that the valves and components are chosen with care and understanding, this kind of amplifier can be very valuable. For example, by using modern high-mu valves with coupling components of correct values, the overall efficiency may well be little less than that to be obtained by using transformer coupling. In addition, it is easier to provide good reproduction with this type of amplifier than with any other.

The values of components cannot be determined purely by rule-of-thumb, but it is possible to design a first-class unit by combining simple rules with a knowledge of the processes involved and of the probable effects of varying the circuit constants. This matter can perhaps best be explained by making reference to the very simplest type of R.C.C. amplifier, as represented by the circuit in Fig. 1. Indirectly-heated valves are illustrated, but the general principles are precisely the same when using battery valves.

Voltage Amplification

The first valve is a voltage amplifier, the purpose of which is to amplify the audio-frequency voltages applied between its grid and cathode before passing them along to V2. For the valve to give good quality amplification it must be equally effective over the full range of audio frequencies. Since the load in its anode circuit is purely resistive—and therefore offers the same impedance to currents of all frequencies—this would appear to be automatic. But that is not so, for in parallel with the resistor marked R_L there is the anode-cathode impedance of the valve itself, the impedance of the grid condenser C.2 in series with the grid leak marked R_g, and also the grid-cathode impedance of V2.

"Miller Effect" Capacity

It is not always easy to understand that all these impedances are, in fact, in parallel, but it will be seen from Fig. 2 that they are. Even when this is understood it may be remarked that surely the grid-cathode capacity of V2 is so small that it cannot possibly have any effect at the low frequency on which the circuit operates. That is another fallacy. The "real" capacity is certainly small, being in the region of 5 m.mfd. for an average mains triode. Due to an effect known as the "Miller Effect," however, the apparent or effective capacity is equal to the actual grid-cathode capacity, *plus* the grid-anode capacity multiplied by the amplification factor plus one. In simpler terms:

$$C = C_g + C_a(A+1)$$

Where C is the total effective capacity, C_g is the capacity between grid and cathode, C_a is the capacity between grid and anode, and A is the amplification of the valve. The term amplification just referred to must not be confused with the amplification factor of the valve; it is equal to the valve amplification factor (mu) multiplied by $R/R+R_a$, where R is the anode load resistance and R_a is the anode impedance of the valve. Provided that the anode load resistance is correctly chosen, as will be explained later, the term A will be equal to about four-fifths of the valve amplification factor.

An example will help to clarify the explanation. Suppose we consider a triode valve with an amplification factor of 50, and whose grid-cathode capacity is 5 m.mfd., and its anode-grid capacity 6.5 m.mfd. Substituting in the formula given above we have:

$$C = 5.0 + 6.5 \times 41.$$

This gives as answer 271.5 m.mfd., or nearly .0003 mfd. And the reactance of a capacity of .0003 mfd. at 5,000

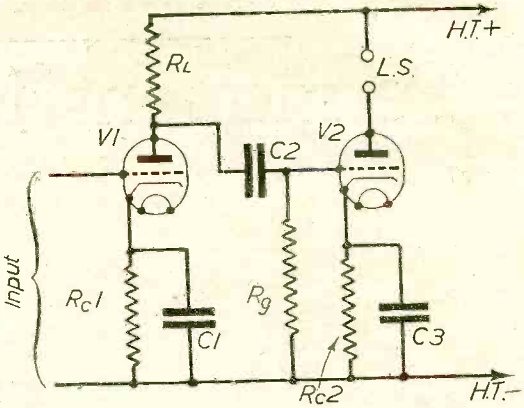


Fig. 1.—A simple and typical R.C.C. voltage amplifier feeding into an output valve. Component values are explained in the text.

cycles is approximately 100,000 ohms. Such a figure is small by comparison with the value of the grid leak, with which it is in parallel. The effective reactance can be reduced, of course, by employing a valve of lower amplification factor, or with a lower inter-electrode capacity.

Anode Load Resistance

Having seen some of the relevant points we can turn again to Fig. 1, and consider the values of the components and the relationships which should hold between the values. A start might well be made with the anode load resistor R_L. This should have a value not less than four times the anode impedance of V1. Thus, if the anode impedance, sometimes called the internal resistance, of V1 were 25,000 ohms, the anode load resistor should be rated at not less than 100,000 ohms. Such a value would naturally cut down the voltage actually applied to the anode for a given H.T. voltage, but within reasonable limits it is better to do this than to use a lower value of load. In practice, the voltage would not be cut down to the extent first anticipated, since reduced anode voltage would cause a reduction in anode current; a reduction in current through R_L would bring about a reduction in the voltage drop across it.

To reduce the value of the load resistor would result in a loss of amplification, which would be most marked on the lower audio frequencies. On the other hand, increasing the resistance would produce only a very slight increase in amplification, and there would be a tendency for higher audio frequencies to suffer. Additionally, a pronounced increase in resistance would reduce the "handling" capacity of the valve by cutting down the anode current.

Bias Component Values

Now let us examine the cathode-biasing circuit, which consists of R_{c1} and C1. The optimum value of the bias resistor is generally given in the valve maker's instructions, and can be calculated with accuracy only when all circuit details are known. A simple method of determination, which at least gives a sufficient degree of accuracy for most triodes of "average" type is to divide the anode load resistance by the amplification factor of the valve. For example, a valve with an internal resistance of 3,000 ohms and amplification factor of 12 would require a bias resistance of 1,000 ohms, assuming that the anode load resistor had a value equal to four times the internal resistance. This is, in fact, the figure given by the makers of one valve having the characteristics quoted.

In passing, it should be noted that this simple method of determination does not hold for special high-mu triodes, and is quite useless where pentodes are concerned. It must therefore be used with discretion.

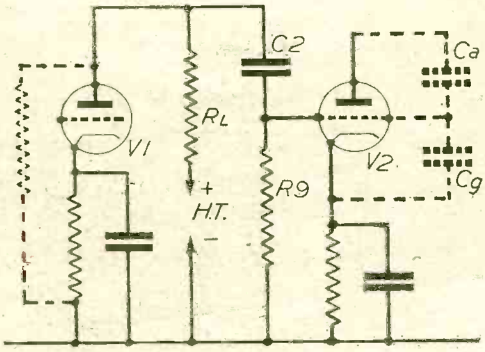


Fig. 2.—This modified form of Fig. 1 shows how many resistances and reactances are in parallel with one another.

Bias By-pass Condenser

In general, the value of the condenser providing an audio-frequency by-pass across the bias resistor should have as high a value as possible. If its reactance at audio-frequencies is to be extremely low, the capacity should be at least 8 mfd.; 25 mfd. is better, having a reactance of only about 6.5 ohms at 1,000 cycles and less than 1.5 ohms at 5,000 cycles per second. Even this capacity has a reactance of about 300 ohms at 50 cycles per second. There is normally a small voltage across the bias resistor, and therefore a condenser of sufficiently high capacity need have only small physical dimensions.

It is scarcely possible to use too high a capacity unless there is a tendency toward hum in the output reproduction. If hum is to be reduced (and low notes are similarly affected, unfortunately), it is worth while to try a lower capacity in this position. The use of too low a capacity or, in the extreme, the absence of this by-pass condenser, will result in a marked loss of amplification. The reason for this is that negative feedback, or degeneration is produced.

Negative Feedback

This is because audio-frequency voltages are developed across the bias resistor. And these are in opposite phase to those applied to the grid, which means that the effective A.F. voltage on the grid is reduced. To understand this explanation fully it is necessary to visualise exactly what happens when, say, the grid is swung positive by the positive half-cycle. We know that an increase in positive potential on the grid causes a rise in anode current. As anode current rises the current through the bias resistor does likewise; and when this happens the voltage drop across the resistor, and hence the applied bias voltage, increases. This increase is in a negative direction, and therefore partially cancels out the original positive potential.

When a bias condenser of low reactance is in parallel with the resistor it "smooths out" the audio-frequency fluctuations, although not affecting the D.C. voltage drop across the condenser. It is then the D.C. voltage only which is applied in the form of bias.

Grid Condenser and Leak

The values of the grid condenser C2 and the grid leak R_g must be considered together for, as we have seen, the two in series are in parallel with the anode load resistor and the internal resistance of V1. In effect, these two components act as a potentiometer feeding the grid of V2, but if the reactance of C2 is very low in relation to the resistance of R_g, the attenuation caused will be very small. This indicates that C2 must have a high value, but to prevent other "shunt" losses the resistance of the leak must then be high. In practice, it is nearly always found that optimum results are to be obtained by making the value of the leak not less than four times that of the anode load resistance. At the same time, if the value is high in relation to the "Miller Effect" capacity between grid and cathode of V2, reproduction of the higher audio-frequencies will result. In general the lower limit may be set at 150,000 ohms, the upper limit being governed entirely by the anode load resistance of V1.

In some respects the choice of grid-condenser capacity is similar to the choice of capacity for grid-bias by-pass. For example, the higher the value, the lower the loss in amplification and the better the reproduction, especially of transients. But where hum is in any way troublesome, it can be reduced by cutting down the capacity. A value of .1 mfd. provides a good starting point, but if a little emphasis of high notes is considered desirable, the value can be reduced to as little as .005 mfd. When the capacity is reduced it is a good plan to increase the resistance of the grid leak in order to retain a good balance in the two halves of the "potentiometer" already referred to. Thus, if the capacity were reduced to, say, .01 mfd., the grid leak resistance should be doubled.

If the general principles outlined in this article are clearly understood it will be easy to follow the articles which are to follow, and which will deal with more advanced amplifier circuits.

(*To be continued*)

PRIZE PROBLEMS

Problem No. 448.

ROBINSON'S receiver, which he had built from spare parts, gave very unsatisfactory reproduction, quality being inferior and volume very poor for a Detector and two L.F. type of receiver. Using a voltmeter he tested H.T., G.B. and L.T. batteries. L.T. was fully up to 2 volts; the Grid battery read 9 volts, and the H.T. also showed the full voltage of 120 volts. The loudspeaker was a balanced armature type with a resistance of 2,000 ohms, joined direct in the anode circuit of the output valve, the anode current of which is 18 milliamps. What was the cause of his trouble?

Three books will be awarded for the first three correct solution, opened. Address your solutions to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 448 in the top left-hand corner, and must be posted to reach this office not later than the first post on Thursday, September 16th, 1943.

Solution to Problem No. 447.

When Thomas selected the components from the junk box, he did not take the precaution of testing the condenser, and in the case in question, he was unlucky as the condenser had a short-circuit which imposed a very heavy drain on the H.T. supply with a consequent serious reduction in voltage.

The three following readers successfully solved Problem No. 446, and books have accordingly been forwarded to them. : A.C.I. McCallum, R.A.F., Shropshire; A. S. Caizley, 346 Sunderland Road, South Shields; George Jackson, 13, Poplar Avenue Blackhall, W. Hartlepool.

YOUR SERVICE WORKSHOP—7

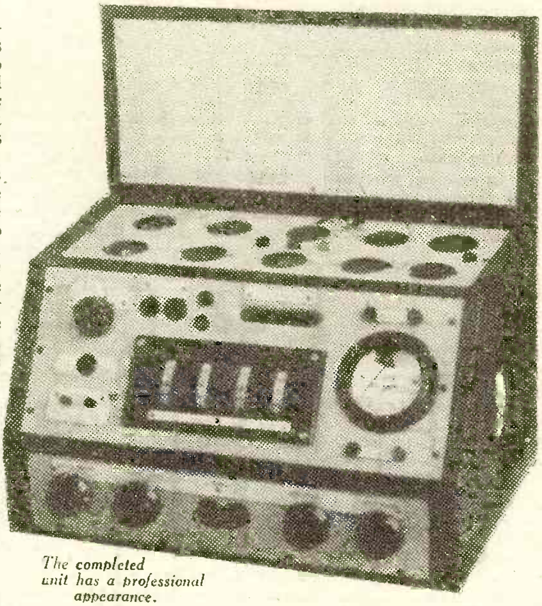
A Valve-testing Unit

Final Constructional Details. By STANLEY BRASIER

(Continued from page 421, September, 1943.)

Operation

ASSUMING now that the instrument is complete, suppose a simple battery triode of the "H.L." type is to be tested. The filament adjustment tap is set to 2 volts. Then by referring to the list of B.V.A. standard valve connections in the *Practical Wireless Service Manual, Radio Engineers' Vest Pocket Book*, etc., it will be seen that pin No. 1 of a 4-pin triode connects to anode, while pin No. 2 connects to grid. Incidentally, the valve data panels appearing in PRACTICAL WIRELESS are extremely useful in this connection. To ensure therefore that the connections in the Valve Tester are correct to receive this valve, it is only necessary to set the discs on the electrode selector switch so that No. 1 shows in the window of the anode switch and No. 2 in the grid. Screen and cathode—which for this valve are not required—are set to 0. Thus, the number shown on the switch panel is 1020, which is the code number for any directly heated triode and is entered for future reference in the column provided on the valve sheet. S.1 is set to "normal" and S.2 to "M.A./V." or "full emission," according to the test required. If the latter, then V.R.1, the anode control, is set about half-way round, and the grid bias potentiometer, V.R.3, to zero. After plugging in the valve the tester is switched on and the H.T. voltage may be adjusted to the desired amount by V.R.1 and a voltmeter connected to H.T. negative and the anode (top cap) socket on the valve panel. The emission of the valve is then shown on the panel meter. (Figs. 5, 6 and 7.)



The completed unit has a professional appearance.

Mutual Conductance

Mutual conductance tests are more or less standardised at 100 volt anode, 100 screen and grid volts 0. If, therefore, this test is required, the switch S2 is turned to that position, the "set zero" control turned clockwise. A milliammeter—preferably the lowest range suited to the valve's anode current—is joined to "Ex. meter"; after switching on, high tension is adjusted to 100 volts and the current backed off to zero by the control. Depression of the M.A./V. button will then cause the current to rise and the reading will be the mu/con. of the valve under test in milliamps per volt. Owing to the large range of anode currents met with in testing all types of valves it is not always possible—when the current is high—to bring the external meter needle right back to zero, so in this case the "set zero" control is turned back until the meter reads some definite figure, say 5 or 10 milliamps. Any increase in the reading (by pressing the M.A./V. button) is then easily calculated, the figure still being M.A. per V.

A 5-pin triode valve of the indirectly heated type, i.e., a mains valve, would need a cathode connection and in this case it would be to pin No. 5, so that the code number would be 1,025, and if it were an L.F. type needing negative bias, this is applied by advancing the control V.R.3, which may, if desired, be calibrated. H.T. control of anode and screen cannot be calibrated owing to the varying currents and must therefore be measured from their respective points on the valve panel. The grid bias control is inoperative in the M.A./V. test and the "set zero" inoperative in the full emission test.

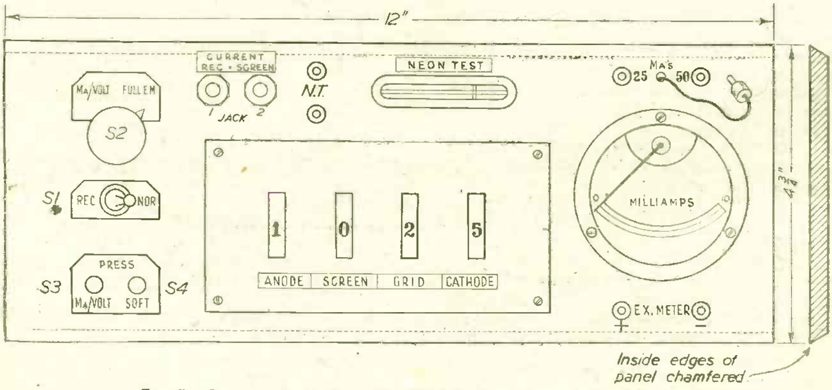


Fig. 5.—Layout of switch panel. Note chamfer on top and bottom edges.

Multi-electrode Valves

Multi-electrode valves are tested in two halves; for instance, take an indirectly heated 7-pin heptode. The amplifier section could be checked first where the code number would be 7,306, the top cap of the valve being joined to the grid socket on the valve panel, consequently the grid selector switch is set to 0. The oscillator section of the valve may then be tested merely by altering the code number to 1,026 and removing the top cap connection. It is convenient to enter the number on the data sheet as TC 7,306/1,026 for the complete valve.

Diodes are tested for emission by applying about 10 volts to the anode and since this low voltage cannot be obtained from the "anode" control, the screen supply is used, because here the voltage may be reduced to zero. It is of the utmost importance, however, that the current drawn from this supply, under any circumstances, should not exceed three, or, at the very most, four milliamps. A diode passing 1 to 4 milliamps with 10 volts on the anode may be considered quite efficient and this may be checked by connecting a milliammeter to jack 2, the code number for a 5-pin mains double-diode being 0105, and for the other diode, 0205.

Rectifiers

Rectifiers are tested by putting S1 to "rec." and under these conditions an A.C. voltage of 250 is applied via the "anode" selector switch. For a 4-pin full-wave rectifier, therefore, the selector switch is set to 1,000 for one anode and 2,000 for the other. A nominal load of 25 milliamps is automatically applied and this current may be measured from jack 1, while the valves D.C. voltage output at this current can be checked from any heater socket on the valve panel and the high-tension negative socket, with, of course, a voltmeter. If the valve is indirectly heated its cathode is connected in circuit by setting the "cathode" selector switch—in the case of a 5-pin base—to 5, making the number 1 or 2,005.

With S1 returned to "normal" the current measured from jack 1 is that of the cathode, which therefore shows the total current of any valve, anode plus screen, etc. Before any valve is plugged into the tester it is wise to test for internal electrode short-circuits. This may be done by plugging a pair of test leads into the "Neon test" sockets. The lamp—which normally serves as a pilot—will then go out, but a dead short across the test leads will cause it to glow to full brilliance. Although no definite degree of insulation is given by the lamp, some idea of this may be gained by its brilliance or otherwise, particularly if it is compared with some

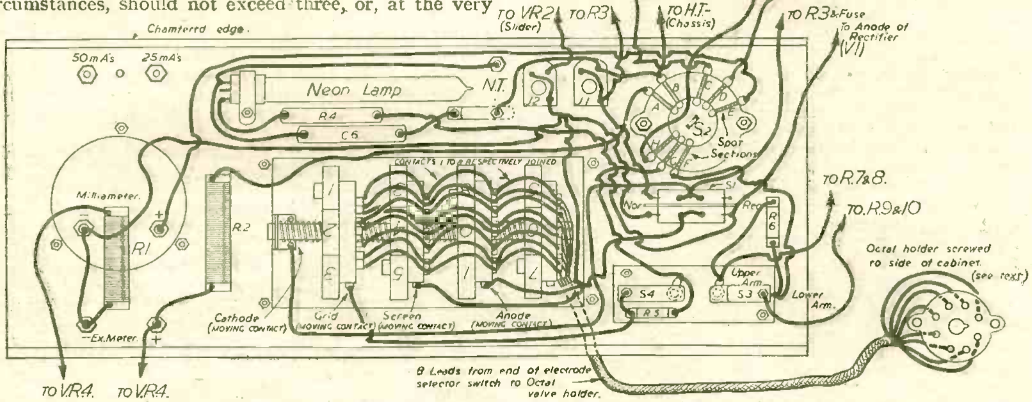


Fig. 6.—Rear of switch panel. Care should be taken with wiring of rotary selector switch.

Standard B.V.A. Valves

TYPE.	BASE.	CODE No.	TYPE.	BASE.	CODE No.	TYPE.	BASE.	CODE No.
Triode ... ... D.H.	4	1020	S.D. Tetrode ... I.H.	7		D.D. Triode ... I.H.	Oct.	
Triode ... ... I.H.	5	1025	Triode-pentode ... D.H.	9		Rectifier, Full-wave I.H.	Oct.	
Triode ... ... I.H.	7		Triode-pentode ... I.H.	9		Rectifier, Full-wave I.H.	Oct.	
Tetrode... ... D.H.	4	TC 0120	Triode-hexode ... D.H.	7		Rectifier, Full-wave I.H.	Oct.	
Tetrode... ... I.H.	5	TC 0125	Triode-hexode ... I.H.	7				
H. F. Pentode D.H.	7		Double-pentode ... D.H.	7				
H.F. Pentode... I.H.	5		Double-pentode ... D.H.	9		SIDE CONTACTS.		
H.F. Pentode... I.H.	7		D.D.-H.F. Pentode I.H.	9		Triode	P	
H.F. Pentode ... I.H.	7	TC 2706	D.D. Output Pentode I.H.	7		H.F. Pentode	P	
Output Pentode D.H.	4		Rectifier, Half-wave D.H.	4	1000	Output Pentode	P	
Output Pentode D.H.	5		Rectifier, Half-wave I.H.	5		Octode	P	
Output Pentode I.H.	5	ST 1025	Rectifier, Full-wave D.H.	4	1000/2000	Double-diode	V	
Output Pentode I.H.	7	7326	Rectifier, Full-wave I.H.	4		Double-diode (alternative)	V	
Heptode ... D.H.	7		Rectifier, Full-wave I.H.	5	1005/2005	Rectifier, Half-wave ...	P	
Heptode ... I.H.	7	TC 7306/1026	Rectifier, Full-wave I.H.	7		Rectifier, Volt. Doubling	P	
Octode ... ... D.H.	7							
Octode ... ... I.H.	7		OCTAL BASES.			AMERICAN U.X.		
Class B Output D.H.	7		Triode ... ... I.H.	Oct		Triode ... ... I.H.	U.X.5	
Double-diode D.H.	4		Triode ... ... I.H.	Oct		H.F. Pentode ... I.H.	U.X.6	
Double-diode I.H.	5	0105/0205	H.F. Pentode ... I.H.	Oct		Output Pentode ... I.H.	U.X.6	
D.D. Triode ... D.H.	5		Output Pentode ... I.H.	Oct		Rectifier (Uni) ... I.H.	U.X.6	
D.D. Triode ... I.H.	7	TC TC 7106/7306	Heptode ... ... I.H.	Oct		Frequency Changes I.H.	U.X.7	
T.D. Triode ... I.H.	9		Double-diode ... I.H.	Oct		D.D. Triode ... I.H.	U.X.6	

high value resistors of known value. It will be noticed that in the case of the 9-pin holder a short flexible lead connected to pin No. 9 is brought through the valve panel and terminates in a plug. This is for connection to the anode, screen or grid sockets—it must be one or the other—and obviated the necessity of providing a ninth contact on all sections of the selector switch just for this one valve.

The valve tester must be switched off before altering the selector switch and the normal/rectifier switch and also when not in use, otherwise there is a constant current drain on the grid bias batteries. The grid bias voltage for the full emission test may be increased to any amount by coupling up 9-volt units, and these are held on the back of the cabinet.

A valve which is suspected of being "soft" may be tested by noting whether the anode current rises unduly when the button of S4 is pressed and is operative on M.A./V. and full emission tests. If the valve is perfect in this respect the current should rise by only a fraction, if at all.

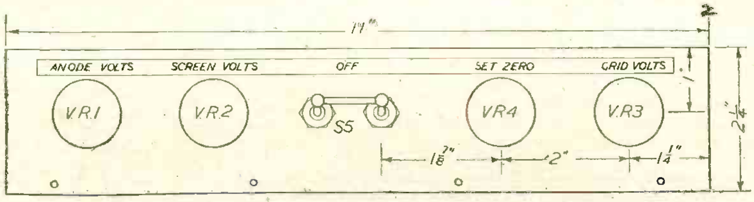
In testing certain types of octal base rectifiers it will be found that the heater is connected to pins different from those provided in the valve tester (which is standard for the rest of the range) and as there is no switching for heater pins, simple adapters may be used for the few types which necessitate them. Similarly, all *Mazda* octals have a different heater connection; therefore, if it is desired to test these types frequently an additional octal holder must be fitted, taking the heater supply to pins Nos. 1 and 8.

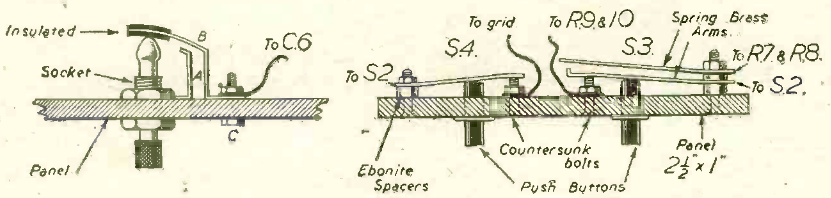
The filament or heater of any valve can be tested for continuity by test leads plugged into the "Neon test" sockets.

Of the possibilities of valve trouble referred to in the last article, only one has not been provided for. This is loose electrodes, but since it would evidence itself in no uncertain manner in normal use in the receiver, by tapping, it is unnecessary to provide any arrangement for checking it in the valve tester.

(To be continued.)

Fig. 7.—Layout of the control panel on the power unit.





The neon switch and S3 and S4 described in the previous article.

Unsuspected Faults

A Service-man Tells of Two Unusual Faults He Encountered

An Earth Lead Astray

A REALLY mysterious incident occurred in a set that worked fairly well through the winter, but with the coming of lighter days the volume fell off more rapidly than would have been expected. There was apparently nothing wrong with the set itself or with the batteries. The aerial seemed perfect, and it was therefore suggested that the earth was faulty. This consisted of a good copper plate, with the wire securely soldered to it. The wire from the set disappeared in a hole in the floorboard behind the set, and passed through an "air brick" under the floor into the garden, and so to the earth plate. There was a thick, insulated wire emerging from the ventilating brick and dipping underground among the flowers. A sharp upward tug convinced me that the soldered joint on the earth plate was intact.

An attempt was then made to pull the wire gently away from the house. Ten feet of wire was pulled out! On going back to the room where the set was installed, however, it was found that the earth wire was still in position. There was nothing for it but to take up a floorboard, and when this was done the mystery was solved, for the wire connected to the earth terminal of the set just led into the empty space under the floor and no farther. It appeared that the aerial and earth had been fitted while the house was being built. The earth plate, with wire already soldered to it, had been buried just outside the wall and the wire fed through the air brick. It had not been possible to manipulate the wire through the hole in the floor, so a stout wire had been pushed down the hole to "fish" for the earth wire, which had eventually been hooked and pulled up through the hole. It will be clear that the hook would have brought up a loop of the earth wire, and the loop had been cut and the wrong end of it used for the earth connection, allowing what had been imagined to be the spare end (but really the end connected to the earth plate) to slip out of sight under the floor.

A Loft-aerial Snag

Here is a word of advice to those who intend to use loft aerials. Pay particular attention to their position with respect to any water pipes which may be installed in the loft. The efficiency of a well fitted loft aerial was reduced to a very low value because it was running immediately above a range of water pipes. The "effective" height of that aerial was certainly less than one metre, and the performance of the set connected to it was very poor until the aerial was taken down and moved to another part of the loft where it was not shielded by well-earthed pipes.

The Manufacture and Testing of Valves—3

Bulbs : Creating the Vacuum : Types of Vacuum Pumps

By LAURENCE ARTHUR

(Continued from page 364, August issue)

THE glass bulbs used for enclosing the electrode assembly are produced in very large numbers by automatic machines, which inject a definite amount of molten glass into an accurately made mould. They are not actually made in valve factories, but in separate works entirely devoted to glass-ware. Very many shapes and sizes are required for different types of valve, but those with a dome top are probably the most popular. The dome provides a secure holding for a suitably shaped mica bridge, which enables the upper part of the assembly to be held rigid. All bulbs, when received from the glass works, have a skirt or cullet which serves a useful purpose when the sealing-in process takes place. A representative shape is shown in Fig. 17. Before use, bulbs are checked for dimensions and examined for flaws. Then, they must be thoroughly cleaned internally, and one method of doing this is to swill them out with a dilute solution of hydrofluoric acid. But as this acid eats into glass, the bulbs are held over powerful jets of water and finally dried in a gas-heated oven.

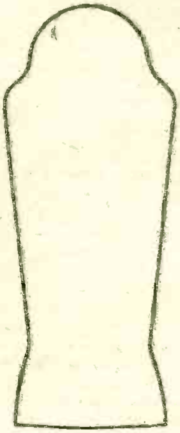


Fig. 17.—Outline of bulb, showing skirt.

Top Cap Connection

Certain types of valve require an external top connection for grid or anode, and before the mounts are inserted, the bulbs are top pipped. This is done on a rotating machine, which gradually heats the top of the bulb against the centre of which is held a short length of narrow glass tube. When the bulb and the tube are almost molten, a jet of hot air is forced through the tube, piercing the bulb, and the two run together.

To prevent the walls of the bulb from becoming electrically charged when bombarded with high velocity electrons, some valves have an internal coating of graphite which is sprayed on with a compressed air spray gun. This coating is frequently trimmed off at the top or bottom of the bulb and small wedge-shaped " brushes " of thick felt or rubber, using alumina powder as an abrasive, are employed for the purpose. Graphited bulbs must be baked before use.

Sealing-in

We now reach the stage when the assembled mount can be sealed into the bulb. The sealing-in machine consists of a series of rotating units, each moving round the circumference of the machine. The stem on the foot of the mount is put into a hole in the unit, and over the mount is placed the bulb, which is held at the correct height by a collar. This is important as the overall length of the finished valve has to be between certain limits. The mount and the bulb rotate while gas jets warm them up at appropriate places. As they move round the machine the glass becomes molten and the weight of the skirt, or cullet, draws the lower part of the bulb down until it is in intimate contact with the edge of the flange. When the flange and bulb run together, the cullet drops clear. Subsequent positions on the machine allow the sealed-in mount to cool down gradually, and when it is taken off it is once again carefully annealed. Fig. 18 shows the general outline of the bottom of a sealed-in mount.

If the valve is one having an external top connection, the borated copper wire previously welded to the anode or grid is threaded through the thin glass tube, already fixed in the top of the bulb, before the sealing-in of the mount. The borated copper is then sealed in the glass tube by the application of a small gas jet. As the tube becomes molten it is pulled up to a point with tweezers and a vacuum tight joint with the wire is obtained. This operation, called top sealing, is shown in Fig. 19.

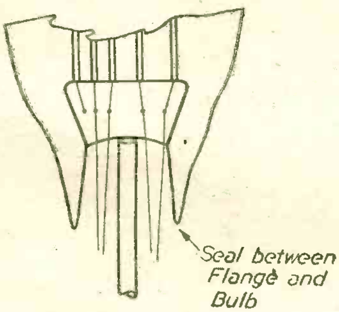


Fig. 18.—The bottom of a sealed-in mount.

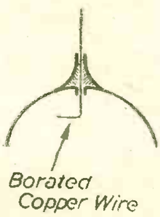


Fig. 19.—Illustrating sealing-in the top cap wire.

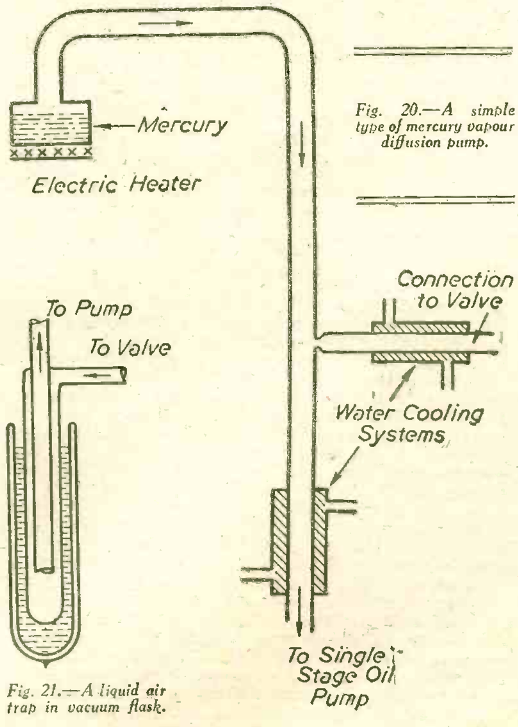
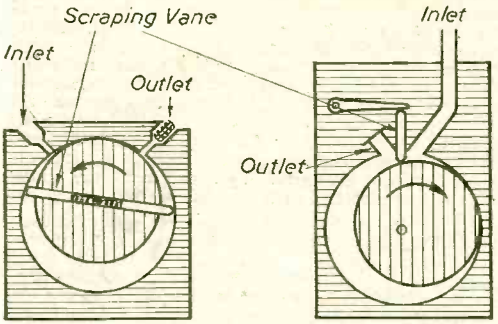


Fig. 20.—A simple type of mercury vapour diffusion pump.

Fig. 21.—A liquid air trap in vacuum flask.

Creating the Vacuum

The valve is now ready for exhausting or evacuating and, although any valve in mass production is produced on rotary machines, it will be simpler to describe the process as if the valves were being handled singly. There are two main types of vacuum pumps in use to-day, one being the mercury vapour diffusion pump and the other the rotary oil pump. An illustration of a simple example of the former is shown in Fig. 20. Mercury is heated in a container by means of an electric heater, and the vapour is drawn down a wide glass tube by suction from a single-stage oil pump. As the vapour passes down the tube it draws with it air from the side arm which is connected to the valve being exhausted. It is essential to prevent the vapour entering the valve and a liquid air trap is used to condense it. Liquid air is intensely cold—lower than *minus* 183 deg. C.—and it rapidly boils away at normal temperatures. In appearance it resembles water and it is stored in



Figs. 22 and 23—(Left) The Gaede and (right) the Hyvac type of rotary oil pump.

vacuum containers, which must have a narrow, unstoppered opening at the top. Liquid air traps are frequently made from vacuum flasks, the vacuum between the two glass walls retarding temperature gain. Fig. 21 shows a liquid air trap.

Rotary Oil Pump

The diffusion type of pump does not lend itself to rotary automatic machines, so that the double-stage oil pump is now very extensively used. Fig. 22 shows the principle of the Gaede type. Inside a cast-iron box filled with oil there is a thick rotating metal disc on a spindle which is eccentric relative to the inside of the box. The disc is driven by an external electric motor. Diametrically across the disc are two spring-loaded scraping vanes, and at the top of the box are two ports, one connected by glass tubing to the valve being pumped, and the other, leading out to the open air, being fitted with a non-return valve. As the disc rotates in the direction shown, air entering the inlet port is trapped by one of the scraping vanes and passed round the chamber, which it leaves at the outlet port. In the meantime the other vane has passed the inlet port and is pushing another lot of air round to the outlet. The top of the disc runs in close contact with the top of the chamber and, in practice, two of these discs are fitted on a common shaft, one unit acting as a backing pump to the other.

Another type of rotary oil pump, called the Hyvac, is also very largely used: it is shown diagrammatically in Fig. 23. This pump, which is also completely filled with oil, has a thick, rotating metal disc mounted eccentrically on a motor-driven shaft in the centre of the chamber. The inlet and outlet ports are close together and between them is a single scraping vane which passes through the outer casing and is held in position by a spring-loaded arm. As the eccentric disc rotates in the direction shown, it revolves around the interior of the chamber. Air drawn in from the valve being pumped, is pushed round until it escapes at the outlet, the vane ensuring that the inlet and outlet ports are isolated. This pump, also, is made as a double unit, with two discs mounted 90 deg. apart on a single common shaft. The outlet port is closed by means of a leather valve or a spring-loaded ball valve. To prevent oil vapour working back to the valve being pumped a liquid air trap is inserted in the glass circuit from the pump.

The pressure to which the majority of valves are evacuated is in the region of .0001 millimetres of mercury. (Normal atmospheric pressure is 30in. or 760 millimetres.)

Testing Vaccum

It is occasionally necessary to test the effectiveness of vacuum pumps and this is generally done with a McLeod gauge, a simple type of which is shown in Fig. 24. The gauge is connected by glass tubing to the valve being pumped and the exact pressure can be read on the calibrated scale when the compression of the air in the side tube is achieved by slowly raising the jar of mercury connected to the rubber tube. Owing to the presence of mercury in the circuit it is necessary to condense the vapour by means of a liquid air trap.

A valve is evacuated by having its stem joined to a length of glass tubing connected to the inlet of the rotary oil pump and starting the driving motor. The average time of pumping for the majority of valves is 25 to 30 minutes, but quite a number of other things must also be done during that time. To obtain a lasting high vacuum in a glass bulb it is necessary during pumping to bake the valve to the highest temperature it will stand without the walls collapsing. This is done in a gas- or electrically-heated oven and the temperature reached is 400 deg. C. After 15 minutes' baking the oven is raised and at this stage a check on the effectiveness of the pumping is made by the application to the outside of the valve of a lead from one side of a Tesla high-frequency coil, the other side being earthed. If the H.F. discharge produces a purple glow inside the valve, there is an air leak somewhere and it must be found and cured before any further pumping takes place. If there is no purple glow the next process is the heating of the metal parts of the valve to a dull red colour by means of eddy currents.

Eddy Current Heating

Eddy currents are induced by bringing close to the side of the valve a small (3in. to 4in.) water-cooled coil of copper tubing, which is fed with a powerful high-frequency current from a giant oscillator. The current

(Continued on page 459)

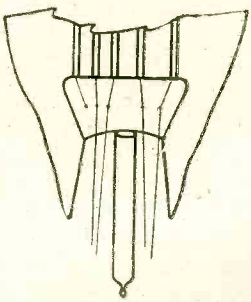


Fig. 25 (above).—A sealed-off stem.

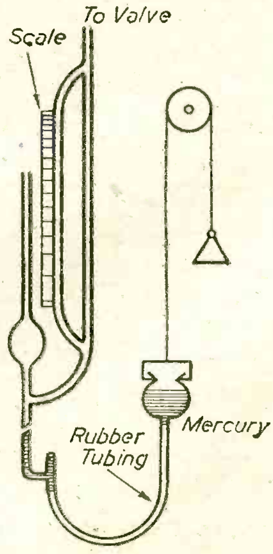


Fig. 24 (right).—Simple type of McLeod gauge.

may vary from 60 to 120 amperes according to the size of the valve being produced. The temperature of the metal at this stage reaches approximately 800 deg. C. The purpose of the baking of the glass bulb and the eddy current heating of the metal is to drive out gases—from the former water vapour and carbon dioxide and from the latter mainly hydrogen and carbon monoxide.

The filament or heater is now connected to a source of supply, generally at double the voltage at which the valve will eventually be rated. This drives off quantities of gas from the coating, some of which settles on the cooler anode and grid so that the next stage is a further application of the eddy current heating, this time to a bright cherry red—approximately 1,000 deg. C. The metal and the glass are now relatively free from gas and the interior of the bulb is roughly exhausted.

Gettering

For the final cleaning up considerable reliance is placed on the use of "getters" which produce the well-known silver or black localised patches on most valves. Various materials are used for gettering, but the principal ones are magnesium ribbon (not much used nowadays); powdered magnesium and barium compressed into a tablet; barium powder inside a copper pellet; and a mixture of powdered barium, magnesium and aluminium in a copper pellet. The tablet and pellets are held in nickel getter cups or pans, covered with a thin disc of nickel or nickel gauze. The gettering material is volatilised by a third application of eddy current heat, the previous applications being accurately positioned to avoid flashing the getter. Magnesium produces a silver patch which remains permanent, but its cleaning-up properties are finished at the time of volatilising. Barium gives a black deposit of a spongy nature which will continue to absorb gases for some considerable time, but the size of the patch shrinks as this process goes on.

The filament or heater is now switched off and the stem of the valve can be sealed off. It is heated by means of a gas blow-pipe until it is molten, when the lower part is pulled down with tweezers until the walls collapse in, securely enclosing the vacuum. Fig. 25 shows an example.

(To be continued.)

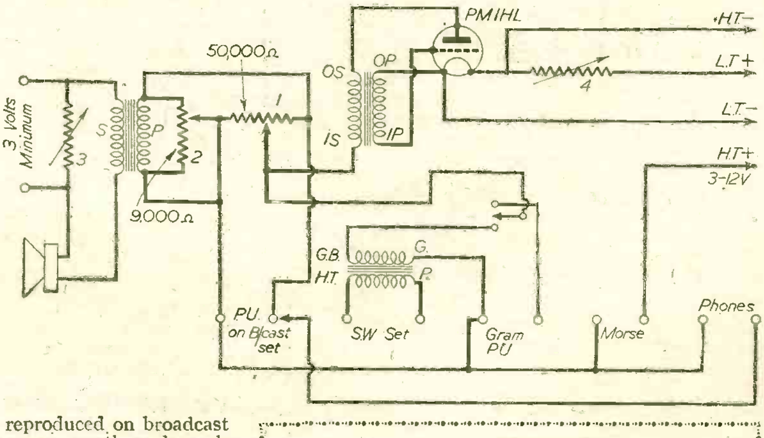
A Simple Mixer-oscillator

A Useful Unit Which can be Constructed from Spare Parts. By L. C.

SHORTLY after building the microphone which was described in the February issue of PRACTICAL WIRELESS, I obtained a gramophone pick-up. Having these two useful instruments to hand, I decided to build a mixer-oscillator of my own design, from components which will be found among the spare parts in most experimenters' dens.

The mixer has four inputs, and is designed to take the following: speech, output from short-wave receiver, gramophone pick-up and morse. After mixing to obtain will operate. No. 3 controls voltage to microphone, and if this is turned down, the microphone will not be on while using other channels. Finally, No. 4 is a rheostat which regulates filament voltage to valve in morse oscillator, and as it has a dead space at the end of the winding, it also acts as a switch. No switch is required in oscillator H.T. lead, as when key is released this breaks the circuit. The wiring should provide no difficulty if diagram is followed carefully.

The theoretical circuit of the mixer and L.F. oscillator. It allows three inputs to be mixed, and the oscillator section will prove most useful to those learning the morse code.



the desired effect, they can be reproduced on broadcast receiver. With one exception, you can use three channels at once; the two-way switch selects pick-up or output from short-wave set, so only one of these circuits can be used at a time. The morse oscillator can be used alone for practice purposes, as two terminals are provided for monitoring 'phones.

The whole unit is mounted on a chassis 9½in. x 5in. x 1¾in. The three transformers are mounted on the top, volume controls 1 and 2 and two-way switch are underneath, but controls 3 and 4 are on panel. Most of the wiring is under the chassis, thus making the assembly neat and tidy. The potentiometer No. 1 controls the pick-up, short-wave input and morse oscillator, while No. 2 controls microphone. The latter must fully be turned up before control No. 1

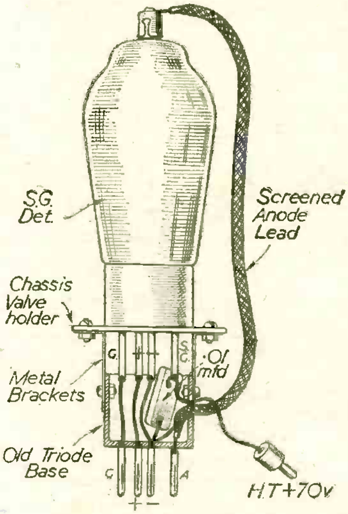
LIST OF COMPONENTS

- One microphone transformer. B.T.H. ETT300.
- One transformer for isolating set. 3—1.
- One morse oscillator 3—1 L.F. transformer. Telsen Radiogrand.
- One valve. Mullard P.M.1L.F.
- One chassis type four-pin valve holder. Clix.
- One 50,000 Ω potentiometer.
- One 10,000 Ω potentiometer.
- One potentiometer below 10,000 Ω.
- One filament rheostat, 10—30 Ω.
- One two-way toggle switch.
- Twelve sockets or terminals.
- One chassis, 9½ins. x 5ins. x 1¾ins.

Practical Hints

A Valve Converter Unit

WHEN experimenting with battery receivers of the straight class, I often wanted to replace a triode demodulator by a S.G. type valve. This, of course, meant disconnecting soldered joints, and fixing anode leads, decoupling condensers, etc., so I devised the following unit whereby a change can be made in a few seconds. With this idea no new joints are necessary, and the original circuit of the set is untouched; also, if the results are not consistent with the S.G. detector being made permanent, the triode can easily be replaced.



A simple valve converter unit.

The two main articles needed in the construction of the unit are an old triode valve base, and a chassis mounting valve holder to take the 4-pin S.G. valve. The construction can be seen from the diagram.

The following connections are first made with short lengths of wire from the old valve base to the holder:

The grid of the base to the grid of the holder; also both the positive L.T. filament legs are joined, as well as the negatives.

A short length of flex is taken from the S.G. pin of the holder, for connection to the H.T. battery. A decoupling condenser (.01 mfd.) is also taken from this socket to the L.T.— leg for earthing purposes; the condenser being mounted on the outside of the base.

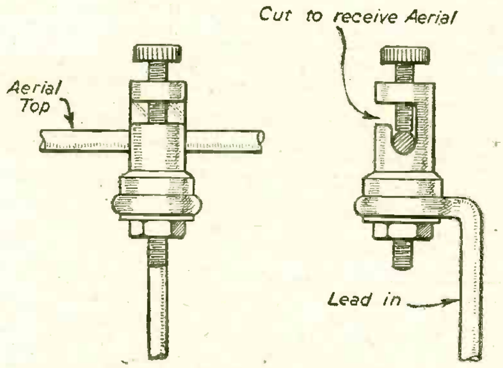
The braided screened anode lead is taken from the anode pin on the old base and through a hole cut in the side. The screening is earthed to the L.T.— pin. After the above connections have been made the holder is supported on top of the old base by means of two metal brackets (as shown), and the S.G. valve is placed in the holder and the anode lead connected.

The unit is then ready for use, and a conversion is simply made as follows:

The triode detector is removed from set (current off) and the unit placed in the holder. The only connection remaining to be made is the S.G. voltage, which is done simply by plugging the lead into the H.T. battery at approx. 70 volts.—G. T. EDWARDS (Halifax).

Improved Aerial Clip

I HAVE recently been experimenting with short-wave aerials, and as this required frequent readjustments of the lead-in tap, soldering was not a practical proposition. I therefore devised the clip, shown in the sketch, from a 'phone terminal of the usual type. A slot was cut in the side of the terminal and the clip was then slipped over the aerial and secured by the clamping screw. I secured the lead-in to the clip by the fixing nut, but this could be soldered if desired. With this clip the lead-in may be removed or replaced in a few seconds.—L. R. HOPKINS (Loughborough).



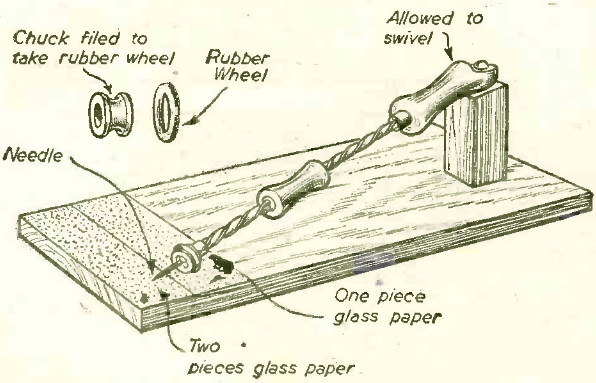
Adapting a terminal as an aerial clip.

Fibre Needle Sharpener

IN view of the high price of fibre needle sharpeners, I devised the following sharpener. The sketch is self-explanatory, the whole thing being made out of an archimedean drill. The drill is mounted, as shown, after fitting a rubber wheel from a child's toy, and gluing grade-O glasspaper on the base.

When the device is in operation the handle on the drill stock is moved sideways, and up and down the twisted stock at the same time.

The needle moves over the glasspaper whilst rotating, ensuring uniform sharpening. When complete, the sharpener costs under a quarter of the price of its commercial equivalent.—G. MAUND (Minehead).



A novel device for sharpening fibre needles.

ON YOUR WAVELENGTH

By THERMION

Statistic

NEARLY nine out of every ten people in this country own wireless sets. The remainder, of course, merely open their windows!

Pre-war Position of Radio

IN pre-war days the annual turnover of the British radio industry was about £25,000,000. About 80 specialist firms were engaged, most of whom were producers of radio broadcasting receivers—the output of which was about 1,250,000 sets a year—and about 80 per cent. of the industry was devoted to this class of work. The remaining 20 per cent., mainly centred in a few firms, was devoted principally to the production of broadcasting transmitters, and communications equipment for marine use and for long-distance commercial radio services. In general, it can be said that nearly the whole of the effort was directed towards meeting civilian needs. There were some signs that the output of broadcasting receivers had approached, or had even passed, its peak (practically every home—actually 8,800,000—had a receiver and new models were therefore only required for replacements, or to provide additional refinements). A television service had been opened in London and there were signs of growing developments in this field, but the application of this service was still in its infancy.

The ratio of skilled to unskilled labour in firms producing radio broadcasting sets was of the order of 1 to 30, and the firms producing communications equipment was about 1 to 10. Radio production was almost entirely in the hands of private enterprise and Government control was confined to such matters as the allocation of wavelengths and the general rules governing the use of the ether.

Libel Case Result

I PUBLISH the following without comment:

The appeal of the *Daily Telegraph* against the judgment in the libel action brought by Ben Lyon and his wife, Bebe Daniels, who were awarded damages £5 and costs, came before the Appeal Court recently. It was heard by Lord Justices Scott, Goddard and MacKinnon. After hearing the arguments of counsel, their Lordships reserved judgment.

Serjeant Sullivan, for the appellants, stated that the libel appeared in a letter published in the *Daily Telegraph*, under the heading "Flabby Amusement," which criticised the radio broadcast "Hi-Gang," in which the plaintiffs take principal parts.

The letter read:

"Every Sunday evening at church time there is put on the air a costly production which is an insult to the British intelligence. The type of comment consists of a libellous exchange of abuse, one comedian alludes to the other as a 'louse,' and his contribution is to say: 'I'm laughing me blooming head off.' The woman artist sings a good song, but for the most part she indulges in vulgar wisecracks. We must be a nation of lunatics to permit such a waste of money for such a very sordid show."

The letter was signed: "A. Winslow, 'The Vicarage,' Wallington Road, Winchester."

Lord Justice MacKinnon: "In my papers I have four copies of what I presume is called script. Do you mean to tell me that the B.B.C. insults their public with that sort of stuff? I have no wireless set."

Serjeant Sullivan: "Your Lordship speaks on a privileged occasion."

When counsel began to refer to the script, Lord Justice MacKinnon remarked: "God forbid that we should have to read much of it. I have glanced at it, and you can use any epithet about it that you wish."

Serjeant Sullivan pointed out that at one stage Mr. Justice Hilbery said there was a mis-statement of fact, because the letter described the entertainment as costly

Lord Justice Goddard: "That is not a libellous statement."

Mr. G. O. Slade, K.C., said that the letter was anonymous, and privilege was claimed against its production.

Lord Justice Scott: "I suggest that if the comment is fair there is no defamation."

Mr. Slade remarked that throughout the *Daily Telegraph* had behaved with perfect propriety.

Lord Justice Scott: "You are bound to admit that the *Daily Telegraph* acted fairly in publishing this letter."

Serjeant Sullivan ended, submitting that there was not an atom of evidence of malice on the part of anybody, so that nobody went outside the limits of fair criticism so as to raise any presentiment for evidence of malice.

Radio Rejects for A.T.C. Training

SQUADRON-LEADER A. F. BULGIN has issued an appeal for old radio apparatus not wanted for salvage for the use of members of the A.T.C. Parts rejected by manufacturers are particularly welcome. He not only welcomes gifts of apparatus that the trade may care to make, but offers of assistance from retailers and others. Gifts may be sent to Squadron-Leader Bulgin at By-Pass Road, Barking. Those offering personal assistance should, of course, have a good knowledge of radio.

More B.B.C. "REFANEMENT"

[*Press Item.—There is no end to the stupidity of the B.B.C. It has now decided that the Christian name of R-A-L-P-H is to be pronounced as R-A-I-F.*]

The vulgar herd still calls it Ralph,
Pronounced as if it rhymes with Balfe.
The B.B.C. with culture naif,
And more "refaned," insists on Raif.
Oh! how they work this "culshaw" stunt,
Which gives the low-brow such affront
And makes him constantly deride
The way announcers put on side.
The low-brow listener is no ass
And simply loathes this "bettah class"
Pronunciation they invent,
Knowing that's how his money's spent
On "culshaw" which gives him affright,
Instead of programmes which delight.
This weird "New English" of their own
Suggests they run a "Ladies' Home,"
Where good sound English is well minced.
But leaves some people unconvinced.
So R-A-L-P-H it was and R-A-L-P-H shall be,
Defying high-brow B.B.C.

"TORCH."

Our Roll of Merit

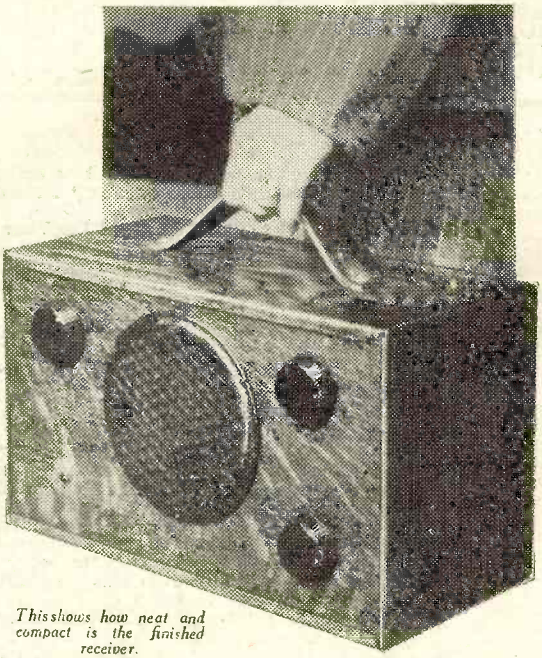
Readers on Active Service—Thirty-fourth List

G. Clouston (A.C.1, R.A.F.).
J. Brown (R.N.).
D. A. Udy (Sgn., R. Signals).
E. S. Walton (A.C.1, R.A.F.).
N. Bouchier (A.C.1, Flight Signals, R.A.F.).
W. R. Wilshire (R.N.).
E. Palmer (A.C.1, R.A.F.).
B. E. Kirby (R.N.).
A. W. Benson (Bdr., R.A.F.).

The "Odd-mo

Constructional Details of a

By A. W. LI



This shows how neat and compact is the finished receiver.

THE "Odd-Moment" Portable has been designed to meet the present need for a small set to take to camp or on holiday. The following points were considered in the design: (1) The components must be fairly easy to obtain, or home-made. (2) Easy construction and flexible design, i.e., capable of a certain amount of alteration in small details without greatly affecting results. (3) Compactness and balance. A set that feels lopsided, as many portables do, is very unpleasant to carry about. (4) Expense. This should not greatly exceed £5 10s., including everything. After experimenting with various circuits, it was finally decided to use a straight T.R.F., and to cover only the waveband from 200 metres (1,500 kcs.) to 550 metres (545 kcs.) as being sufficient for the purposes for which the set was intended. The high tension current is supplied from two 45-volt units, and grid bias is provided for in the design, that for the output pentode from the high tension supply and that for the H.F. pentode (2 volts) by the order in which the low tension current is supplied to the valve filaments. This low tension is normally supplied by three unit cells, which will suffice to run the set for from seven to ten days on a light load, i.e., short intermittent periods of listening. Two terminals can be included on the side of the low tension battery box, however, and when the set is required to be used for longer periods the internal batteries can be removed and wires connected from the terminals to three large cells of the bell type, which should last for some two months' heavy use, or to two 2-volt accumulators in series. Two small type accumulators should give 14 to 28 days' heavy use. The low tension consumption of the set is about .2 amperes at 4 volts, and the high tension current should approximate 6½ to 7 milliamperes at 90 volts *provided the low tension supply is connected the correct way round.*

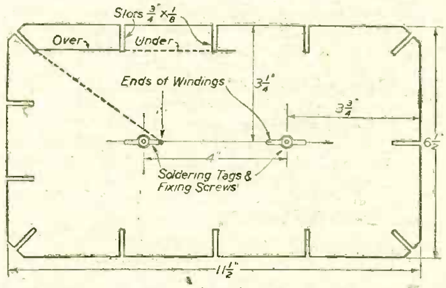


Fig. 2.—The construction and winding diagram of the frame aerial.

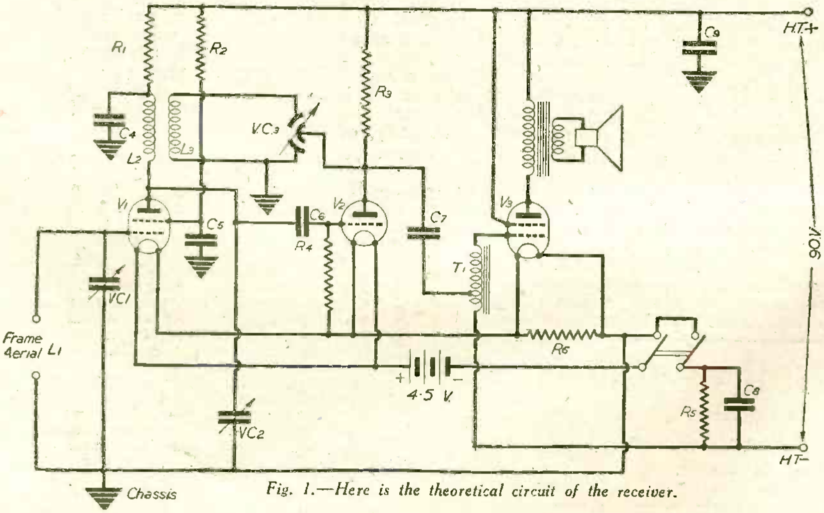


Fig. 1.—Here is the theoretical circuit of the receiver.

The Circuit

Referring to the circuit diagram, Fig. 1, it will be seen that the (R.F.) circuit consists of a frame aerial (L1) tuned by VC1 across the grid/cathode of V1. In the plate circuit of V1 is a coil (L2) tuned by VC2, and feeding V2, a leaky grid detector of standard type. R3 is the plate

ment" Portable

Useful and Compact Receiver.

ES, A.M.(Brit.)I.R.E.

oad of V2, and the radio frequency component a this plate is fed through VC3 and L3 to obtain reaction, the amount of reaction being controlled by VC3, while the low frequency component passes via C7 to an auto-transformer (tapped L.F. choke), by which it is stepped up and fed to the grid of V3. Grid bias for V3 is derived from the volts dropped across R5 in the high tension minus lead, the minus side of R5 being connected to the lower end of the auto-transformer. C8 is to prevent the development of audio frequency voltages across R5. The output from V3 is supplied to a 5in. P.M. speaker, and the reproduction, while not as good as a larger set, should be fully up to that of the average portable. The volume, on a strong signal, should be sufficient for a small room without use of reaction when the batteries are in good order.

With regard to construction, many of the component parts can be varied somewhat in value without greatly affecting results, and in view of present difficulties,

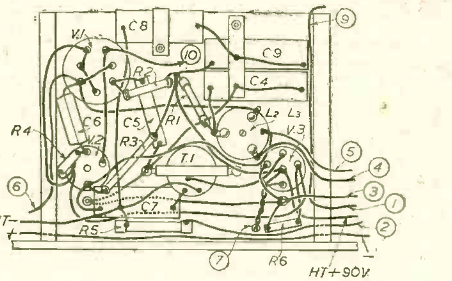


Fig. 7.—Plan view of underside of chassis, showing wiring.

and also to enable constructors to use up any suitable components they may have in stock, the somewhat unusual course is being taken of stating against each component (see list) the tolerances, that is to say, the limits within which that particular component might be varied, but do not conclude that *all* can safely be varied to the extreme limits given. As far as possible adhere to the values first given, or to very approximate ones.

The frame aerial, Fig. 2, is wound basket fashion on a piece of stout cardboard round the edge of which slots have been cut, one at each corner, three in each longer side, two one end and one the other end (13 slots in all). Nineteen turns of enamelled or cotton-covered wire, 26 gauge, should be wound in the slots, and the ends are taken to two bolts, centrally placed, which bolt the aerial to the back of the cabinet. On each bolt is fixed a soldering tag, to which is connected one end of the frame aerial. These tags are used for connecting the frame to the set by means of flexible wire, which should be long enough to allow the back of the cabinet and frame aerial to lie on the top of the set, out of the way, when changing batteries.

The coil in the plate circuit of V1 (L2) and the reaction coil (L3) are wound side by side on a piece of dry wood, ½in. diameter by 1in. long (Fig. 3). To one end is screwed a round piece of paxolin or waxed card-

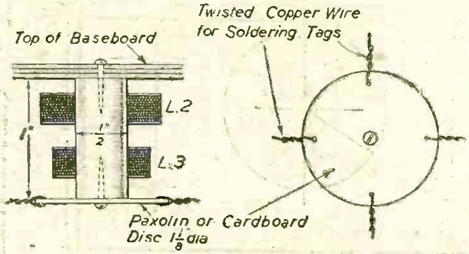


Fig. 3.—This is how the coils L2 and L3 are constructed.

board, 1⅛in. diameter, in the edge of which four equally spaced holes have been drilled. Through each hole is passed a short piece of tinned copper wire, about 20 gauge, doubled over and the ends twisted together to form soldering tags. For the coils use D.C.C. or D.S.C. wire of approximately 36 gauge, winding on 100 turns for L2 and 40 for L3. It may here be mentioned that C4 serves the important purpose of "earthing" one end of the coil in the plate circuit of V1 (L2). It *must* be in good order, otherwise L2 will not tune properly, and the set will give practically no results.

Chassis

The next part to construct is the chassis, which consists of a three-ply panel, to which is fixed a small baseboard of the same material, supported on two side pieces, 1½in. deep, raising the baseboard that distance from the bottom of the set. The various dimensions can be gathered from Figs. 4 and 5. Cut all holes in panel and baseboard before assembling. The panel brackets should be made from small pieces of sheet metal—stout tin would serve if nothing else is available—in fact, if the side supports are of good hard wood, the brackets might be dispensed with altogether. A simple method of constructing the box (Fig. 6) for the three unit cells is as

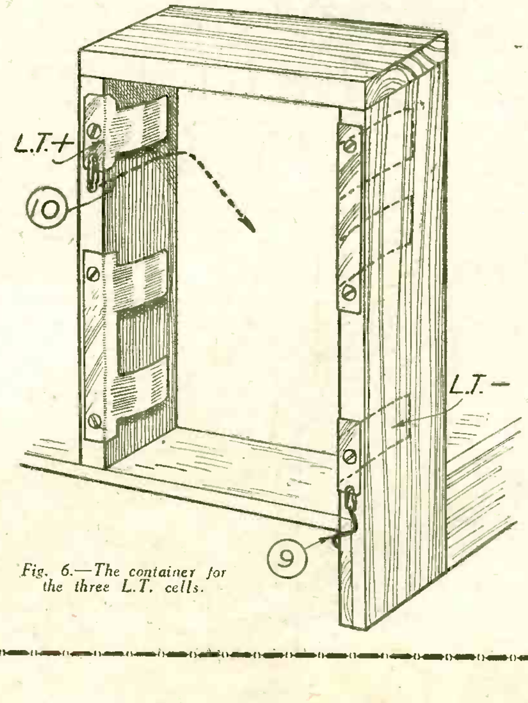


Fig. 6.—The container for the three L.T. cells.

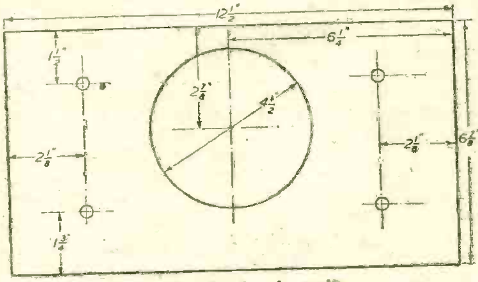


Fig. 5.—Details of panel.

follows: First make a shallow wooden box, the sides and ends of wood at least ⅜in. thick, and the bottom of three-ply, the *inside* measurements being 4[1]/16in. long, 2⅛in. wide, and 1¼in. deep, and cut and fit in place the brass strips which connect the cells in series. The box completed, screw it to the baseboard in the correct position by two screws from underneath the chassis, into one end. Mark a plus sign on the strip at the plus end of the box (the end connected in the wiring to one side of the filaments of V1 and V2), *as it is important that the low tension batteries should always be inserted or connected the right way round.* The negative low tension wire runs from the strip at the other end of the box to one point of the three-point switch. A three-point switch is essential, because, with a two-point switch it would not be possible entirely to isolate the high-tension batteries from the electrolytic condensers. Those who wish also to use external batteries will mount two terminals for these on the battery box, connected to the appropriate brass strips. Do not connect more than three Leclanche cells (4.2 volts) or two accumulators (4 volts) in series to the terminals.

(To be continued)

LIST OF COMPONENTS

Three Mullard Valves: V1 VP2B (equivalents, Ever Ready K50N); V2 PM1HL (equivalents, Ever Ready K30C, Cossor 210 HL, Marconi HL2, Mazda H 210); V3 PM22A, or *can* use KT2 Marconi or 220 H PT Cossor (if using either of these omit the 40 ohm resistor).

Six Resistances: R1 Anode V1 2,800 ohms (2,000 to 5,000 ohms); R2 Screen V1 20,000 ohms (15,000 to 30,000 ohms); R3 Anode V2 56,000 ohms (35,000 to 65,000 ohms); R4 Gridleak V2 2 megohms (1 to 3 megohms); R5 Grid bias V3 400 ohms (390 to 410 ohms); R6 Filament bypass V3 40 ohms (40 ohms only).

Condensers: C1, C2, solid dielectric tuning condensers, .0005 mfd. only; C3, solid dielectric differential type reaction condenser, .0003 mfd. only; C4, C9, electrolytic condensers 4 mfd. (2 mfd. to 8 mfd.) (at least 150 volts working); C5, Screen V1, .01 mfd. (.005 to .1 mfd.); C6, Grid V2, .0001 mfd. (.00005 to .0003 mfd.) C7, Grid V3 (Autofeed) .25 mfd. (.25 to 1 mfd.)); C8, Bypass grid bias resistor, .01 mfd.(.01 to .5 mfd.).

Other Components: Three knobs, one 3-point on-off switch, two 5-pin valveholders, one 7-pin valveholder, screws, brass strip, bolts and nuts, wire, etc., one 5in. Permanent Magnet speaker, one Franklin intervalve auto-transformer, three unit cells (Ever Ready U2, etc.), two 45 volt high tension units (Ever Ready Alldry No. 2, etc.).

Cabinet, chassis, frame aerial, and coils—home-made, see text.

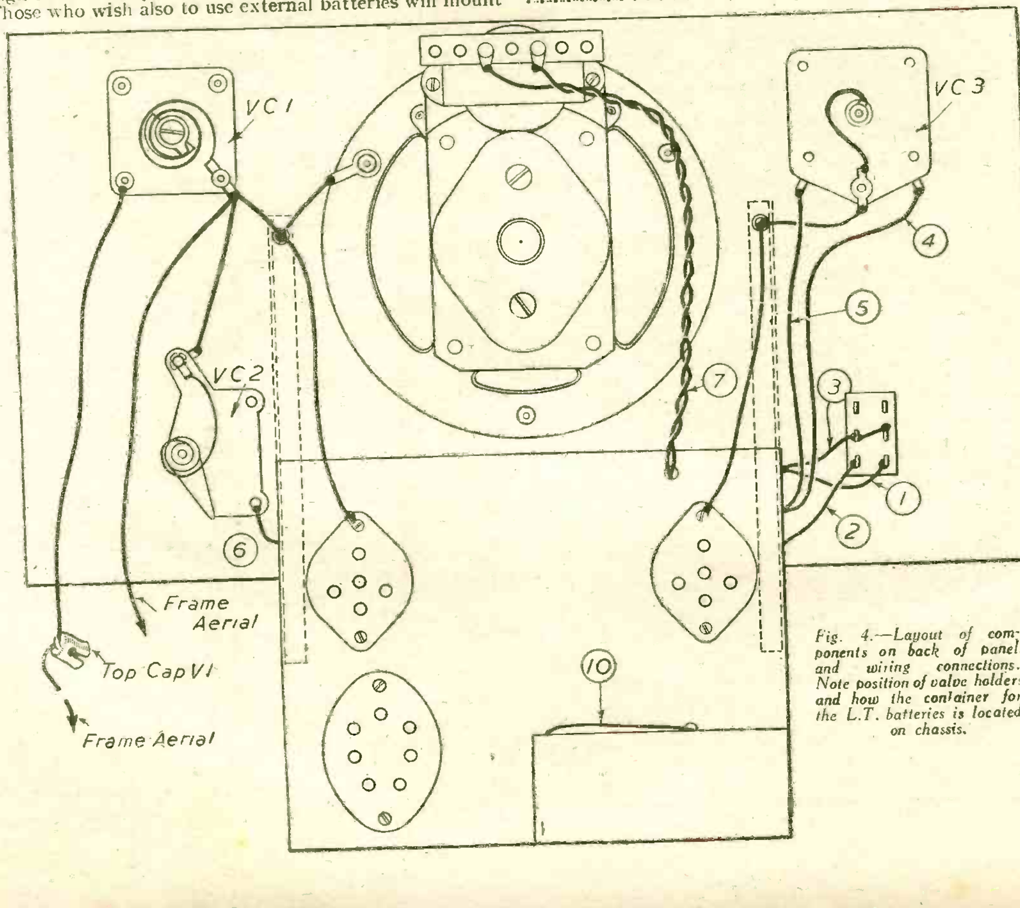


Fig. 4.—Layout of components on back of panel, and wiring connections. Note position of valve holders and how the container for the L.T. batteries is located on chassis.

Secondary Batteries—2

Testing Electrolyte : Capacity : Quantity Efficiency and Plates

By G. A. T. BURDETT

(Continued from page 367, August issue)

THE efficient maintenance and servicing of batteries, particularly those of the lead acid type, is essential for prolonging their useful life. Batteries should be charged at regular intervals, and where they are in normal use, the length of the period between each charge will depend upon their rate of discharge. All batteries should, however, be given a refresher charge at least once every three weeks, whether in use or not, to prevent sulphation of the plates.

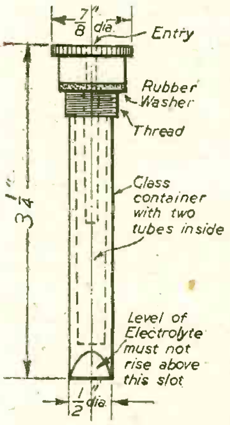


Fig. 1.—Vent cap of the unspillable type.

Testing Electrolyte (Lead Acid Type)

The two chief tests which should be periodically carried out are measuring the S.G. of the electrolyte and its height above the plates of the cell. For this purpose the syringe type of hydrometer, as described last month, should be utilised. Some batteries incorporate in their manufacture a number of coloured balls immersed in the liquid and enclosed in a small grid-like compartment. These balls float at different heights according to the specific gravity of the liquid, and are an indication of the state of the cell. As the success of this method depends upon whether electrolyte of the correct S.G. has been used in the cell, its performance is not always reliable, and the hydrometer should in any case be used for checking. When receiving a battery for charge the S.G. of each cell should be measured, and should there be any appreciable variation obviously something is radically wrong with the cell where the deviation is shown. If a low reading, it is obvious that either the cell is shorted or the electrolyte has been spilled and subsequently topped up with distilled water. An abnormally high reading will indicate that the cell has been topped up with acid upon evaporation of the water. Immediate action is advisable.

Frequent tests of the electrolyte of alkaline batteries are not necessary. About one every two months will give the rate of decrease of the S.G. The rate of decrease should be constant over a period of 12 months. Should the minimum figure of 1.600 be reached before the 12 months is expired, or should a sudden drop be shown, the electrolyte should be changed and the cell inspected for faults. In normal circumstances there should be no sudden drop, and certainly no rise in the S.G. of alkaline electrolyte. Cases sometimes occur, however, where inexperienced staff at a service station have upset the alkaline batteries during charge, spilled the electrolyte and have topped them up with distilled water or with strong electrolyte. Where possible a charging log of all batteries received for charge should be made, of which Table I is a typical example. From this the history of an accumulator may be compiled, and greatly assists in diagnosing subsequent faults.

TABLE I.
Typical Entry in Battery Charging Log Book.

No. and type	Date Rec.	Before Charge		Date completed charge	End of Charge		Remarks. Particulars of any faulty cells
		Spec. G.	Voltage		Spec. G.	Voltage	
From Vehicle ABC 123 12v. 48 amp. H Lead Acid	1.7.43	1.170	10.2	3.7.43	1.275	15.0	All cells serviceable

Measuring Level of Electrolyte

The electrolyte should be periodically measured to ensure that it covers the plates, otherwise the plates will be damaged, and the efficiency and capacity of the cell decreases. Not only is that part of the plate exposed to the air damaged, but extra strain is placed on the immersed portion of the plates, which expedites their buckling and disintegration. Normally the electrolyte level should be $^3/_{16}$in. to $\frac{1}{4}$in. above the top of the plates, although, with the larger M.T. type of battery, this level is sometimes increased provided it is clear of the ends of the vent stoppers. Great care must be taken of the height of the acid in batteries having unspillable vent caps, of which Fig. 1 is a typical example. Should the level of the electrolyte be above the slots, siphoning of electrolyte will take place and probably will cause some damage. The level of the electrolyte in glass and

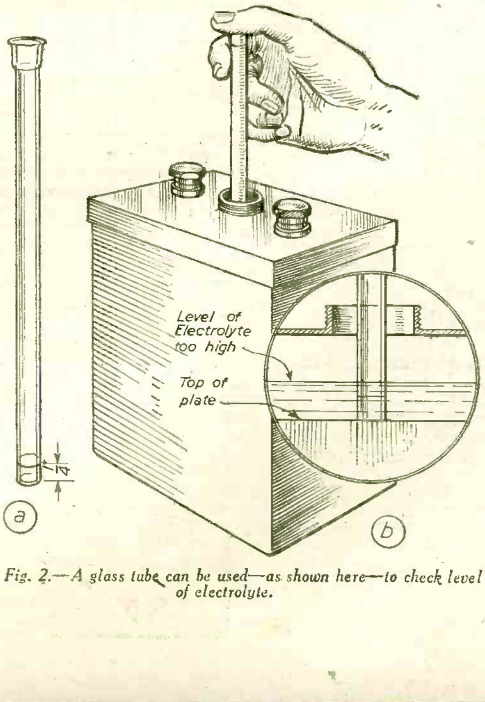


Fig. 2.—A glass tube can be used—as shown here—to check level of electrolyte.

celluloid cells is easily checked, but with non-transparent containers it can only be carried out effectively by inserting in the vent of the cell a glass tube having a bore of approximately ¼in., see Fig. 2(a). To measure the height push this firmly on to the plates, place the thumb over the top and withdraw the tube, Fig. 2(b). The level of the electrolyte in the cell under test will correspond with the height of the electrolyte in the tube. The electrolyte will then return to the cell by releasing the thumb, and the next cell is tested in a similar manner. These glass tubes for testing the level of the electrolyte are contained in most hydrometer sets, or they may be purchased separately. They are flanged at the top to facilitate holding, while the lower end is graduated with one or more levels, enabling a very accurate measurement to be obtained.

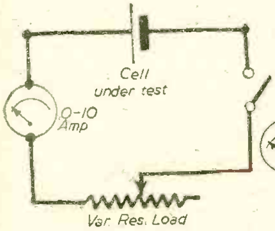


Fig. 3.—Typical cell capacity test circuit.

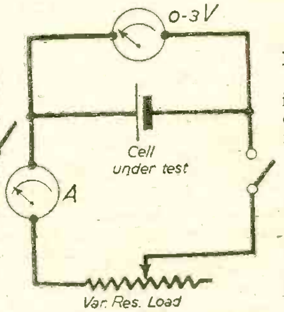


Fig. 4.—The connections for the energy efficiency test.

Practical Tests of Batteries

Capacity Test.—The initial capacity in amp-hours of a battery is usually stated on the label supplied by the manufacturers. The initial capacity of the cell depends upon the quality of the active material in the plates, and the number of plates. The theoretical capacity may be determined from the formula, but these figures will vary between different makes of battery. The capacity in amp-hours also varies according to the rate of discharge. For instance, a battery discharged over a period of 20 hours, termed the 20-hour rate, will give a higher effective capacity than one discharged in two hours, while the intermittent capacity of the battery is a very high one. It is the former, viz., the actual capacity, and not the intermittent one, with which we are concerned here, as the higher figure applies only when the battery is used on work of an intermittent nature demanding a low rate of discharge, e.g., morse signalling, coil ignition, etc. This figure cannot be measured and is usually calculated from the actual capacity. The maker's figures apply only when the battery is in perfect condition and subsequent tests are necessary for determining the capacity at the time of the test. When carrying out this test, batteries should be charged and discharged a number of times at constant current, the rates of which should be as specified by the manufacturers. Such tests are usually made at the 10-hour rate. For example, we will take a standard 90 amp-hour (actual) two-volt coil. At the 10-hour rate the discharge current will be 9 amps. The cell should first be fully charged until it gases freely. The voltage should be taken just prior to removal from charge. A suitable resistance, viz., load, should then be placed across the cells with an ammeter in series (see Fig. 3). Taking the average voltage of the cell at 2 volts, to obtain a discharge rate of 9 amps., applying Ohm's Law and ignoring the internal resistance of the battery, the resistance of the load will be 0.22 ohms. A variable resistance of 0.5 ohms to zero is most suitable, so that at the commencement of the test the resistance may be set to give a discharge of exactly 9 amps. The time the test is started should then be regarded and subsequent half-hourly readings taken (see Table II). An efficient cell should give a constant discharge of six hours (60 per cent. of the time) at a 10-hour discharge rate. In the example (viz., Table II) the average discharge throughout the test of 10 hours is 8.24 amps. The capacity is therefore $8.24 \times 10 = 82.4$ amp-hours. This procedure should be repeated a number of times, when the voltage of the cell at the commencement and the end of the charge should carefully be noted. The final calculation should be taken from the figures where the voltage was identical in the majority of cases; this to avoid errors from tests made through the cell not being fully charged.

Quantity Efficiency

This is equivalent to the ratio of the output to the input, and in practice this efficiency should be as high as 95 per cent. In the above example the quantity efficiency is

$$\frac{\text{Amp-hours discharged}}{\text{Amp-hours charged}} = \frac{82.4}{90} \times \frac{100}{1} = 91.5 \text{ per cent.}$$

Energy Efficiency Test.

This is taken in watt-hours, e.g., the ratio of the input in watts during the period of charge and the output in watts during the period of discharge, which is equal to

$$\frac{\text{Watt-hours discharged}}{\text{Watt-hours charged}} \times \frac{100}{1}.$$

In practice the value is approximately 75 per cent. The reason for this lower value compared with the capacity figures is due to the waste of energy during the gassing period, which may be in the order of three hours. To carry out the test a discharged battery is first put on charge, the charge being maintained until the cell gases freely, and there are no further rises in its voltage and in the S.G. of the electrolyte. The times of the commencement and of the completion of the charge are noted. The ammeter must be placed in the charging circuit to ensure that the charging rate is constant for the duration of the charge. Frequent readings of the potential difference (P.D.) of the cell are taken and are recorded and tabulated as in the table. For the discharged part of the test, a load is connected to the battery, preferably consisting of a variable resistance (see Fig. 4), in order that a constant discharge current may be maintained, otherwise the average current cannot be calculated as in the capacity test. For example, the 20 amp-hour (actual) 2-volt cell is selected, and charged and discharged at the 10-hour rate, viz., the 2 amps. Before putting on charge it is assumed to be fully discharged. After about 13 hours all plates should be well gassing and

TABLE II.
Tabulated Readings for Capacity Test of 90 amp./hr. 2.0 Volt Cell at 10-hour Discharge Rate.

Time of Reading	Discharge Current (amps.)	Remarks
12.0	9.0	Commencement of test
12.30	9.0	
1.0	9.0	
1.30	9.0	
2.0	9.0	
2.30	9.0	
3.0	9.0	
3.30	9.0	
4.0	9.0	
4.30	9.0	
5.0	9.0	
5.30	9.0	
6.0	9.0	
6.30	8.8	Rate of discharge decreasing
7.0	8.5	
7.30	8.3	,, ,,
8.0	8.0	,, ,,
8.30	7.2	,, ,,
9.0	6.5	,, ,,
9.30	5.0	,, ,,
10.0	4.5	,, ,,
	8.24 =	Average value of current

the P.D. and S.G. of the cell both constant. The amp-hours of charge is equivalent to $13 \times 2 = 26$ amp-hours. Ten hours for the theoretic charge plus three hours for gassing. From the figures in Table III we get energy efficiency in watt-hours=

$$\frac{\text{Amp-hours of discharge}}{\text{Amp-hours on charge}} \times \frac{\text{Average volts on discharge}}{\text{Average volts on charge}} \times 100 = \frac{19}{26} \times \frac{2.09}{2.23} \times \frac{100}{1} = 78 \text{ per cent.}$$

Testing Condition of Plates

For this purpose the cadmium test is applied. Both positive and negative plates may be tested, but for the ordinary type of cell having small vents the test is restricted to one positive and one negative plate, so that the true condition of the complete cell cannot be ascertained. The tester consists of a stick of cadmium (Fig. 5) connected to the negative and positive terminals of a moving-coil voltmeter, when testing a cell during charge or discharge respectively. The cadmium stick is then placed in the electrolyte in the centre of the cell between the plates. The positive lead of the voltmeter is connected alternately to the positive and negative terminals of the cell during a charge test. During the discharge test the negative lead from the voltmeter is alternately connected to the positive and the negative of the cell under test.

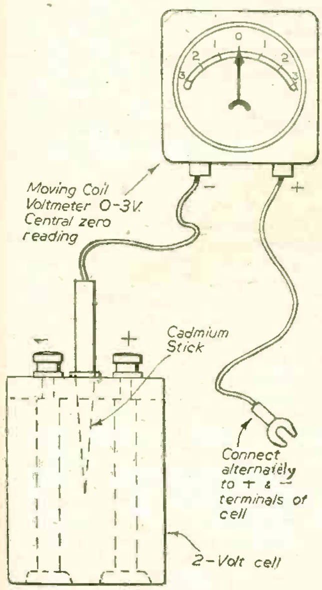


Fig. 5.—Cadmium test charge. Reverse connection of cadmium stick for test on discharge.

Results of Tests

(*a*) *During charge.*—When fully charged, the cadmium to the positive of the cell should read 2.45 volts, while the cadmium to the negative 0.25 volts. The voltage of the cell is obtained in this case by adding the readings, i.e., $2.45 + 0.25 = 2.70$ volts. If the former reading is lower than 2.45 the positive plate is not fully charged, while if the latter reading is less than 0.25 volts or in the reverse direction the plate is not fully charged.

(*b*) *During Discharge.*—When fully discharged, the cadmium to the negative plate should not give a deflection on the voltmeter of more than 0.2 volts, while for the cadmium to the positive of the cell, not less than 1.95 volts, or the plates are practically exhausted. Both readings should be on the same side of the zero reading of the voltmeter. The voltage of such a cell is obtained by subtracting the negative reading from the positive reading. For example, if the positive and negative readings are 1.95 and 0.2 respectively, the cell voltage is $1.95 - 0.2 = 1.75$ volts.

(*To be continued*)

TABLE III.

Tabulated Readings for Energy Efficiency Test of 20 amp./hr. 2-volt Cell at 10-hour Discharge Rate.

During Charge		During Discharge		
Readings Taken Hourly	P.D. (E) of Cell	Readings Taken Hourly	P.D. (E) of Cell	Discharged Current (I)
Time		Time		
12.0	1.85	1.0	2.6	2.0
1.0	1.85	2.0	2.2	2.0
2.0	1.9	3.0	2.2	2.0
3.0	1.95	4.0	2.2	2.0
4.0	2.0	5.0	2.2	2.0
5.0	2.0	6.0	2.1	2.0
6.0	2.1	7.0	2.0	1.9
7.0	2.2	8.0	1.9	1.8
8.0	2.3	9.0	1.9	1.7
9.0	2.4	10.0	1.8	1.2
10.0	2.5	11.0	1.8	0.4*
11.0	2.6			
12.0	2.6			
1.0	2.6			

* Cell practically discharged—further discharge not advisable.

Practical Pars

Using Old Coils

COILS designed over five years ago are seldom suitable for use in modern receivers, except in the very simplest types of set. This is especially true of superhet coils. The old type coil was designed for use in conjunction with a separate oscillator valve and cannot be relied upon to work satisfactorily with a pentagrid or triode-hexode frequency changer. Even if the receiver is of the straight type having one or two H.F. stages, the high efficiency of modern H.F. pentode valves would cause instability. With this type of valve very effective screening of the H.F. components is essential if optimum results are to be obtained. In the old type S.G. receivers the coils were often of the unscreened type, screening being effected by inserting a metal sheet between the aerial and H.F. coils. This method of screening is not always satisfactory with modern H.F. valves, therefore, unless the screening is made really effective, new coils of modern design should be incorporated.

* * * *

Extension Speakers

WE receive numerous inquiries from readers concerning the addition of extension speakers to mains-operated receivers. Many of these querists are under the impression that if the receiver is mains-operated the extension speaker should also be of the mains energised type. This is quite incorrect, however—a permanent magnet model is more suitable than the mains energised type for extension purposes. If an energised type is used it must be separately energised from the mains, and if the mains are A.C., rectifying equipment must be added, of course. When a permanent magnet model is used it is only necessary to ascertain that it has the correct impedance for matching the receiver output valve. In some cases the extension sockets are joined to the speech coil on the set speaker, and therefore the extension speaker should be of the low impedance type—approximately 2 ohms.

* * * *

Terminals

ALL terminal shanks *should be inspected* to see whether they are *perfectly secure* in their component before bolting it down, otherwise, when tightening up the terminal head there will be the possibility of the shank rotating, with the result that an *imperfect* connection will be formed and, when a metal chassis is used, the shank being unscrewed sufficiently to cause it to touch the chassis and produce a *short-circuit* to earth.

Remember that all terminals used for radio work have a *right-hand* thread, so see that the wire loop forming the connection is placed under the head in the manner which will cause the head, on being screwed down, to *close* the loop and not open it and tend to force the wire off the terminal collar.

Mains Transformer Design

An Interesting Paper Dealing with the Construction and Winding of Transformers

By P. G. HEATH

THE design of mains transformers of the type used for supplying power to commercial forms of radio receivers can be simply outlined by reference to a somewhat standard or average one operating from an A.C. mains supply of 230 volts, at a frequency of 50 c/s, with a H.T. secondary winding, for full-wave rectification, 350 volts centre-tapped 350 volts and a current load not exceeding 80 milliamperes. For heating the rectifying filament of the valve the usual 5-volt, 2-ampere winding is included; and for the heaters of the operating valves a 6.3-volt winding of 1.6 amperes is to be used.

Output or Load Extent

The initial consideration is the extent of the output load, a factor influencing the transformer size, for if voltage and amperage are high, the use of heavy gauge wire and the number of winding turns add to overall dimensions. Watts, as the product of volts and amperes, must be first derived for all windings, then an allowance made for efficiency, which, though often quoted as 80 per cent. for this type of transformer, is, for this form of design, best placed at 75 per cent., necessitating a 25 per cent. compensation, a factor to be considered when selecting core sizes—and performance. The entire energy circulating (except that dissipated as resistance loss in the primary) must be transformed from primary winding electrical energy to magnetic core energy, and then reconverted to secondary electrical energy, so that the amount of the core material utilised must determine the amount of power the design can safely take. Hence under these conditions, and by the aid of the simplest of arithmetic, to connect the agencies, the wattage can be first derived from: 350V × 80mA + 5V × 2A + 6.3 V × 1.6A = 28W + 10W + 10.1W = 48.1W + 25% (12.25W) = 60.35W or 60.5 watts for the purpose of computation.

Core Stampings

The output factor derived, it is to be regarded as a contributing one to size and to the amount of wire used for the windings. *Window-space area* of the assembled laminations of suitable dimensions to contain the windings is conveniently found from published tables, extracts from one being appended, that of standard *Stalloy* stampings, suitable for 50-cycle electrical mains.

Output in Watts Wanted	Stamping No. (Stalloy)	Length	Width (Core cross-sec. ins.)	Area	Stampings (No. Pairs)	Window Area (Sq. ins.)
10	100	0.5	5/8	0.3	35	0.54
20	100	.8	5/8	0.5	57	0.54
25	95	0.8	13/16	0.6	57	1.00
50	4	13/16	15/16	1.0	67	2.00
75	4	1.25	15/16	1.2	89	2.00
100	28	1.23	1.22	1.5	88	3.00

Stamping No. 4, suitable for a 75-watt output transformer, is thus selected, 89 pairs being required. Should the design wattage not be quoted in tables, use the next highest value listed.

Turns-per-volt

This factor, abbreviated to TPV, is dependent upon the magnetisation extent of the core material expressed in lines of force per square centimetre of cross-sectional core area. The flux density of Stalloy is fixed at 10,000 lines per sq. cm. of core or at 65,000 lines per sq. in. From this, giving some precision to the statement, has been derived the following equation:

$$\frac{\text{Mains Volts}}{\text{Turns}} = \text{Cross-sec. area of core in sq. in.} \times \frac{10{,}000 \times f \text{ (mains)}}{3.5 \times 10^6}$$

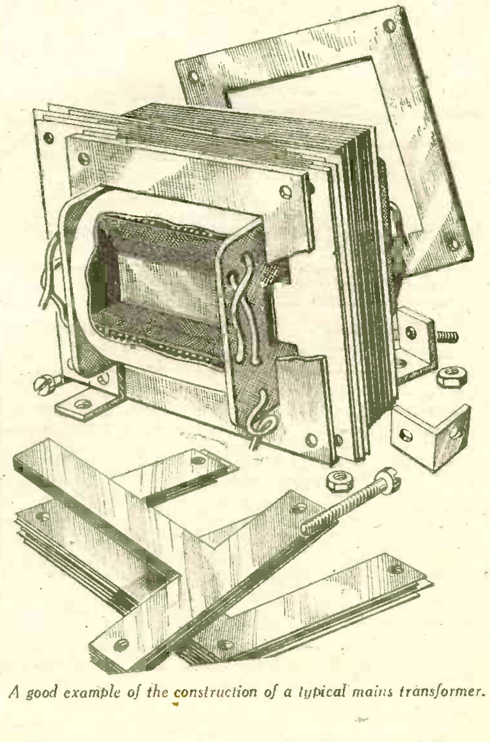
The cross-sectional area is then got from the table and, in this instance, seen to be 1.2in. (column 5), permitting the resolving to show as:

$$\frac{\text{Mains Volts}}{\text{Turns}} = \frac{1.2 \times 10{,}000 \times 50}{3.5 \times 1{,}000{,}000} = \frac{1.2}{7.0} = 5.83 \text{ TPV or } 5.9 + 1 = 6.9 \text{ TPV.}$$

The "+ 1" or extra TPV is added as a safety factor—this being customary. Progressing: the TPV must be now multiplied by the supply A.C. voltage in order to learn the number of primary turns required; the design calling for 230 volts, it is obvious that 6.9 × 230 = 1,587 primary turns. The current drawn as W/E = 64.5/230 = 0.28 amp., a factor determining what gauge of wire to use for the winding.

Gauge Constants of Suitable Wire

Copper wire of 1 sq. in. sec. area is rated to carry with safety 1,200 amperes of current, enabling this figure, as a constant, to be divided into the 0.28 amp. for the purpose of finding the cross-sectional area of a suitable gauge of wire to use. This resolves as 0.28/1,200 = 0.00023 sq. in. But again reference to a table is necessary, this time one of S.W.G. wires, excerpts following:



A good example of the construction of a typical mains transformer.

S.W.G.	Dia.	Sec.-area	Wgt. Per 1,000 yds.	Resistance in Ohms		Turns	Current 1,200 sq. in.
No.	Sq. in.	Sq. in.	in lbs.	Per 1,000 yds.	Per lb.	Per in.	amps.
18	0.048	0.00181	20.93	13.747	0.634	19.8	2.25
26	0.018	0.0002545	2.943	94.35	32.06	50.6	0.32
34	0.0092	0.000066	0.77	361.00	471.0	98.0	0.08

The nearest figures approaching the 0.00023 sq. in. are seen in column 3 and opposite No. 26 S.W.G., a gauge to be used without the risk of over-heating the winding.

Length and Weight of Wire

The length of wire required for the winding may be found from the expression: turn numbers multiplied by mean circumference, which for the No. 4 stampings (in square section equalling circumference) is 2 × (1.25 + 0.935) = 4.37in. The maximum circumference equals 2 × (2.7 + 3) = 11.4in. So that 4.37 + 11.4 ÷ 2 = 7.9in. per turn, 1,587 of which are wanted. So that 1,587 × 7.9 gives the total length in inches which divided by 36 totals the length in yards, or (1,587 × 7.9)/36 = log 3.20059 + 0.89763 − 1.55630 = log 2.54189, antilog = 348yds. of wire. Reference to the wire tables now permits the computing of the weight, this equalling (348 × 2.843)/1,000 = log 2.54158 + 0.46879 = log 0.01037 = antilog 1.0241lb. of wire.

Resistance Considerations

If the output voltage is to meet requirements a small percentage of turns must be added to the secondary windings so as to overcome the resistance of the relatively small gauge wire used, this to compensate for the voltage drop. Again referring to the wire table, the resistance, R, can equal (348 × 94.35)/1,000 = log 2.54158 + 1.97474 − 3.0 = log 1.51632 = antilog 32.9 ohms, and as the current is 0.28 amp. the voltage drop value in the primary winding can be shown as equalling 0.28 × 32.9 = 9.2 volts.

It is also necessary to understand that allowance has to be made to compensate for secondary winding resistance as well, the voltage drop being computed from the expression: Primary VD × Secondary voltage ÷ Mains voltage. That is, the secondary VD is found and both values added for multiplication by the TPV ratio in order to learn what number of turns must be added to the secondary windings to compensate for the resistance present in the two windings.

Secondary Characteristics

As can be noted, the arithmetic for this type of calculation is quite simple and made more so by recourse to logarithmic tables. Therefore the designs of the secondary and other windings can be, if the foregoing is studied, reviewed without comment:

Number of H.T. secondary turns = 700V × 6.9 = 2,415 c.t. 2,415 plus compensating turns.

The gauge of wire required = 0.08/1,200 = 0.000066 sq. in. = No. 34 S.W.G.

The length of wire = (4,830 × 7.9)/36 = log. 3.68395 + 0.89763 − 1.55630 = log 3.02528 = antilog = 1,060yds.

The resistance = (1,060 × 361.7)/1,000 = log 3.02528 + 2.55834 − 3 = log 2.58362 = antilog = 383.36 ohms.

The voltage drop in the secondary winding = 383.36 × 0.08 = 30.67 volts; that of the primary winding = (9.2 × 700)/230 = log 0.96379 + 2.84510 − 2.36173 = log 1.44716 = antilog = 28 volts. 30.67V + 28V = 58.67 total voltage drop.

Compensating turns = 58.67 × 6.9 = 405. Therefore the total H.T. secondary turns = 4,830 + 405 = 5,235 or 2,617 c.t. 2,617.

The wire weight required is (1,060 × 0.7686)/1,000 = log 3.02528 + $\bar{1}$.88570 − 3.0 = $\bar{1}$.91092 = antilog = 0.81468 lb.

Rectifier Winding

Repeating the reasoning for the design of the rectifier heater winding: The number of turns = 5V × 6.9 = 34.5 plus compensating turns.

The gauge of wire required equals 2/1,200 = 0.0016 sq. in. = No. 18 SWG.

The length of wire = (34.5 × 7.9)/36 = log 1.53782 + 0.89763 − 1.55630 = log 0.87915 = antilog = 7.57 yards.

The resistance = (7.57 × 13.747)/1,000 = 0.8715 + 1.13820 − 3.0 = $\bar{1}$.01735 = antilog = 0.128 ohms.

The voltage drop is 0.128 × 2 = 0.256 volts. That of the primary is (9.2 × 5)/230 = 46/230 = 0.2; so that the total voltage drop is 0.256 + 0.2 = 0.456.

Compensating turns = 0.456 × 6.9 = 3. Therefore, the total of the heater winding turns is 34.5 + 3 = 37.5.

The wire weight required = (7.57 × 20.93)/1,000 = log 0.87915 + 1.32079 − 3 = log $\bar{1}$.0994 = antilog = 0.15845 lb.

The Winding for the Valve Heaters

Computing for the heater winding to apply to the operational valves may be similarly undertaken as:

The number of turns = 6.3 × 6.9 = 43.5 plus compensating turns.

The gauge of wire required = 1.6/1,200 = 0.0013 sq. in. = No. 18 S.W.G.

The length of wire = (43.5 × 7.9)/36 = log 1.63849 + 0.89763 − 1.55630 = log 0.97982 = antilog = 9.55 yards.

The resistance = (9.55 × 13.747)/1,000 = 0.97982 + 1.13820 − 3.0 = log $\bar{1}$.11802 = antilog = 0.13 ohms.

The voltage drop is 0.13 × 1.6 = 0.2. That of the primary = (9.2 × 6.3)/230 = 58/230 = 0.25 volts. Therefore, 0.2 + 0.25 = 0.45 volts total VD.

Total turns = 0.45 × 6.9 = 0.3 + 43.5.

Weight = (9.55 × 20.93)/1,000 = log 0.97982 + 1.32079 − 3.0 = log $\bar{1}$.30061 = antilog = 0.19986 lb. of wire.

Turns Per Layer and Spacing

Considerations of spacing and turns per layer lend themselves to similar easy computing, figures relative to the design in hand being virtually self-explanatory.

The space for the primary winding equals the diameter of the No. 26 S.W.G. = 0.018in., so that the number of turns per layer will be 2.06/0.018 = 114 per layer. The number of layers will be thus 1,587/114 = 13.8 + 0.002, the 0.002 being an allowance for insulation on the wire, the total equalling 13.802 layers.

The space for the H.T. secondary equals the diameter of the No. 34 S.W.G. = 0.0092in. The number of turns per layer being 2.06/0.0092 = 223. The number of layers equal 5,235 ÷ 223 = log 3.71892 − 2.34830 = 1.37062 = antilog = 23.476 which with the insulation allowance of 0.002 approximates 23.5 layers.

The rectifier heater winding space = 18S.W.G. diameter = 0.048in. The turns per layer = 2.06/0.048 = 42, the number of layers being 37.5/42 = 0.89, which, with the insulation allowance is near enough to 1 layer of wire.

The receiver valve heaters winding = 18 S.W.G. diameter = 0.048in. The turns per layer = 2.06/0.048 = 42, the number of layers being 46.5/42 = 1.1 layer, but as the diameter of the wire is larger two layers should be allowed for.

The number of turns per layer as given, leaves a space of ⅛ in. at either end, and allowances are made for width of coil former, insulation between windings, and for outside cover insulation.

With transformers of this type the primary is usually wound first on the coil former, over which is placed an electrostatic screen to prevent capacitative coupling of the secondary with the electrical mains and thus lessen modulation hum.

(By courtesy of The Institute of Practical Radio Engineers.)

(To be continued)

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

THE second movement from Bach's Suite No. 3 in D Major is now generally known as "Air on the G String," but it is perhaps not so widely known that it was not Bach's idea that the air should be played on that string of a solo violin. The noted violinist and arranger Wilhelmj was responsible for the arrangement, which has become exceedingly popular, but Yehudi Menuhin, in his recording of "Air" (from Suite No. 3 in D Major), on *H.M.V. DB*6156, ignores the latter arrangement and keeps to Bach's original melodic line.

On the other side of *DB*6156 Menuhin records "Præludium" (from Violin Sonata No. 6 in C Major, Bach), thus providing us with some of the finest Bach music, enhanced by the unblemished technique and playing of Yehudi Menuhin.

On *H.M.V. C*3347 the Indianapolis Symphony Orchestra—conducted by Fabien Sevitzky—have recorded two outstanding performances of works by Glinka and Rimsky-Korsakov, namely, "Overtur Russlan and Ludmilla" and "Dubinushka."

The "Spitfire Prelude" and the "Spitfire Fugue," in original form, formed part of the incidental music—composed by William Walton—for Leslie Howard's film "First of the Few." On *H.M.V. C*3359 the Hallé Orchestra—conducted by the composer himself—has made a wonderful recording of these brilliantly orchestrated works.

Gwen Catley, the charming possessor of a superb soprano voice, has recorded—with the Hallé Orchestra under the baton of Warwick Braithwaite—"What Folly" (Follie Follie) and Recit.; "'Tis Wondrous" (E Strano) and Aria, "Ah, Was It He?" (Ah Fors E Lui), from "La Traviata."

Two fine compositions by Johann Strauss, "Indigo March, Op. 349," and "March from 'The Gypsy Baron'" have been recorded on *H.M.V. B*9335 by the Boston Promenade Orchestra, conducted by Arthur Fielder.

Noel Coward has selected two numbers featured in the films "You Were Never Lovelier" and "Something to Shout About" for his recordings on *H.M.V. B*9337. The songs are "I'm Old Fashioned" and "You'd Be So Nice To Come Home To," and he sings them in his own inimitable style.

Reginald Foort has made a fine record of "Dreaming" and "Vision of Salome"—both waltzes of the good old style. These are melodious tunes and Reg makes the most of them on his Giant Moller Organ. The record is *H.M.V. BD*1050; make a note of it.

Joe Loss and his Orchestra give us two good tunes on *H.M.V. BD*5809. They are "I'm Thinking Tonight of My Blue Eyes" and "Silver Wings in the Moonlight" both slow foxtrots.

Glenn Miller and his Orchestra have selected "At Last" and "That Old Black Magic"—foxtrots—for their recording on *H.M.V. BD*5811, and a very fine recording they make.

Columbia

IGNAZ LEUTGEB, the hornist of the Salzburg Orchestra, was a great friend of Mozart; between 1782 and 1786 Mozart wrote four horn concertos for him, one in D and three in E flat, and it is No. 4 in E Flat which Dennis Brain (Horn), with the Hallé Orchestra, has recorded for us on *Columbia DX*1123-24. This young artist of outstanding ability is the son of Aubrey Brain, the first horn in the B.B.C. Symphony Orchestra, and it is very evident that he has inherited his father's technique and skill.

The Albert Sandler Trio always provides good entertainment, and I have every confidence in recommending their latest recording, which is outstanding in many respects. The record is *Columbia DB*2116, and the composition is "The Vagabond King—Selection," two parts, which introduces "Valse Huguette"; "Song of the Vagabonds"; "Some Day" and "Only a Rose."

"Phyllis Has Such Charming Graces" and "Is She Not Passing Fair?" are the two ballads recorded by David Lloyd, with Gerald Moore at the piano, on *Columbia DB*2117. David Lloyd has a tenor voice of exceptional quality, and he makes a perfect recording of two pleasing ballads.

Victor Silvester and his Ballroom Orchestra give us—in strict dance tempo—"Just A While," waltz, and "A Fool With a Dream," slow foxtrot, on *Columbia FB*2948. Recommended for dancing enthusiasts. "Hawaiian Love," linked with "Mui Waltz"—the latter an original Hawaiian air—are the names of the two numbers which Felix Mendelssohn and his Hawaiian Serenaders have recorded on *Columbia FB*2942.

Turner Layton sings, in that pleasing easy manner, "The Old Curiosity Shop" and "I'd Like to Set You to Music," on *Columbia FB*2941.

Carroll Gibbons and the Savoy Hotel Orpheans have made a fine record out of "Better Not Roll Those Blue Blue Eyes," foxtrot, and "Silver Wings in the Moonlight," also a foxtrot. The record is *Columbia FB*2945.

Parlophone

THE Organ, The Dance Band and Me are with us again on *Parlophone F*1984, on which they have recorded "Seven Days of Heaven"—a fine waltz—and, on the other side of the disc, "Four Buddies," which tempts one to foxtrot. Good tunes well presented.

Geraldo and his Orchestra put up a good performance on *Parlophone F*1985 when they play "You'll Never Know," foxtrot, and "Don't Get Around Much Any More," a slow foxtrot.

For the super rhythm enthusiasts I recommend *Parlophone R*2879 On this record Harry Parry and his Radio Sextet have recorded "Body and Soul" and "St. Louis Blues."

Valve Data Sheets

COSSOR

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RECTIFIERS

Type	Description	Base	Heater or Filament Volts	Heater or Filament Amps.	Maximum Volts Per Anode	Maximum Rectified Curr. mA.	Base Index No.
225 D.U.	Voltage Doubler	7-pin	2†	.5†	750	20	25
506 B.U.	Full Wave	4-pin	4	1.0	250	60	1
442 B.U.	Full Wave	4-pin	4	2.5	350	120	1
460 B.U.	Full Wave	4-pin	4	2.5	500	120	1
43 I.U.*	Full Wave	4-pin	4	2.5	350	120	2
44 I.U.*	Full Wave	4-pin	4	2.5	500	120	2
80	Full Wave	4-pin UX	5	2.0	350	120	71
5Y4G	Full Wave	Octal	5	2.0	350	120	50
5X4G	Full Wave	Octal	5	3.0	500	250	50
5Z3	Full Wave	4-pin UX	5	3.0	500	250	71
6ZY5G*	Full Wave	Octal	6.3	.3	350	35	51
84*	Full Wave	5-pin UX	6.3	.5	350	60	79
25RE*	Multiple	6-pin UX	25	.3	250	80	87
25Z5*	Multiple	6-pin UX	25	.3	250	80	87
OM1*	Half Wave	Octal	30	.2	250	120	68
35RE*	Multiple	6-pin UX	35	.3	250	120	87
40 S.U.A.*	Half Wave	5-pin	40	.2	250	75	11
SPECIAL RECTIFIERS							
405 B.U.	Full Wave	4-pin	4	.5	1,500	20	1
4/100 B.U.	Full Wave	4-pin	4	2.5	500	200	1
45 I.U.*	Full Wave	4-pin	4	3.5	500	250	2
S.U. 2130	Half Wave	4-pin	2	1.0	4,000	2	—
S.U. 2150*	Half Wave	4-pin	2	1.0	8,000	2	—

* Indirectly heated. † Each filament.

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CATHODE RAY OSCILLOGRAPH TUBES

Cat. No.	Size Ins.	Class	Focus	Deflection	Type	Heater Volts	Heater Amps.	Base Type
3237	4½	Gas	Ionic	Electrostatic	Non Origin Distortion	0.6	1.2	a.
3232	5½	Gas	Ionic	Electrostatic	Standard	0.6	1.2	b.
3236	5½	Gas	Ionic	Electrostatic	Non Origin Distortion	0.6	1.2	b.
3226	4½	High Vacuum	Electrostatic	Electrostatic	Single Beam Non Trapezium	4.0	1.0	d.
3209	4½	High Vacuum	Electrostatic	Electrostatic	Double Beam Non Trapezium	4.0	1.0	d.
3222	5½	High Vacuum	Electrostatic	Electrostatic	Single Beam High Voltage	4.0	1.0	g.
3239	6½	High Vacuum	Electrostatic	Electrostatic	Double Beam Non Trapezium	4.0	1.0	e.
3279	9	High Vacuum	Electrostatic	Electrostatic	Single Beam	4.0	1.0	f.
3259	9	High Vacuum	Electrostatic	Electrostatic	Double Beam	4.0	1.0	f.

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CATHODE RAY OSCILLOGRAPH TUBES—*Continued*

Cat. No.	Final Anode Volts Max.	Negative Grid Volts Normal	Sensitivity Y Axis MM./V.	Overall Dimensions: Bulb Dia. mm.	Overall Dimensions: Tube Length mm.	Overall Dimensions: Tube Neck Dia. mm	Fluorescence	Base Type
3237	1,500	V/10	300/V	114	345	41	Blue or Afterglow	a.
3232	1,500	V/10	375/V	135	409	41	Blue	b.
3236	1,500	V/10	375/V	135	409	41	Blue or Afterglow	b.
3226	2,000	V/80	390/V	114	375	41	Green	d.
3209	2,000	V/80	400/V	114	375	41	Green	d.
3222	10,000	V/360	750/V	135	490	52	Blue	g.
3239	5,000	V/360	650/V	160	455	60	Blue	e.
3279	5,000	V/360	600/V	228	525	70	Blue or Afterglow	f.
3259	5,000	V/360	650/V	228	525	70	Blue or Afterglow	f.

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TELEVISION TUBES

Cat. No.	Size Ins.	Class	Focus	Deflection	Type	Heater Volts	Heater Amps.	Base Type
3244	6½	High Vacuum	Electrostatic	Electrostatic	Non Trapezium	4.0	1.0	e.
3241	11	High Vacuum	Electrostatic	Electrostatic	Standard	4.0	1.0	f.
3265	15	High Vacuum	Magnetic	Magnetic	*Long	4.0	1.0	c.

Cat. No.	Final Anode Volts Max.	Negative Grid Volts Normal	Sensitivity Y Axis MM./V.	Overall Dimensions: Bulb Dia. mm.	Overall Dimensions: Tube Length mm.	Overall Dimensions: Tube Neck Dia. mm.	Fluorescence	Base Type
3244	5,000	V/360	980/V	160	507	60	White	e.
3241	5,000	V/360	600/V	295	580	64	White	f.
3265	6,000	V/280	—	382	705	35	White	c.

*Scanning Angle tan = 0.76.

Valve Data Sheets

COSSOR

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SPECIAL TYPES (TELEVISION, TIME BASES, etc.)

TYPE	DESCRIPTION	BASE	BULB	NOMINAL RATING Fil. or Heater Volts	NOMINAL RATING Fil. or Heater Amps.	BASE INDEX No.
4 T.P.B.	Screened HF Pentode	7-pin	Cl./Met.	4	1.0	34
4 T.S.P.	Screened HF Pentode	7-pin	Cl./Met.	4	1.0	33
41 M.P.T.	Screened HF Pentode	7-pin	Clear	4	1.0	33
42 M.P.T.	Screened HF Pentode	7-pin	Clear	4	2.0	33
42 P.T.B.	Screened HF Pentode	7-pin	Clear	4	2.0	34
4 T.P.	Triode Pentode	7-pin	Clear	4	1.4	46
D.D.L.4	Low Imped. Double Diode	5-pin	Clear	4	.75	12
41 M.T.S.	Split Anode Pentode	7-pin	Clear	4	1.0	44
4 T.S.A.	Split Anode Pentode	7-pin	Met.	4	1.0	45
41 M.T.B.	Triode	5-pin	Clear	4	1.0	13
41 M.T.L.	Triode	5-pin	Met.	4	1.0	13
42 S.P.T.	Screened Pentode	7-pin	Clear	4	2.0	33
41 M.T.A.	Trio Discharger	5-pin	Clear	4	1.0	13
G.D.T.4B	Gas Discharge Triode	5-pin	Clear	4	1.75	‡13
G.D.T. 4	Gas Discharge Triode	5-pin	Clear	4	1.5	‡13
206 P.T.*	Deaf-Aid Pentode	†	Clear	2	.06	—
S.130	Voltage Stabilizer	4-pin	Clear	—	—	7
7	Barretter	4-pin UX	Clear	—	.3	75
41 ME	Magic Eye Tuning Indicator	8-side contacts	Clear	4	.3	105

*Directly heated. †Wire end connections. ‡Anode to top cap, pin 1 blank.

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SPECIAL TYPES (TELEVISION, TIME BASES, etc.) —*Contd.*

TYPE	NOMINAL RATING Max. Anode Volts	NOMINAL RATING Max. Screen Volts	TYPICAL OPERATING CONDITIONS Anode Volts	Screen Volts	Grid Bias Volts	Anode Current mA	Mutual Conduct-ance mA/V.	BASE INDEX No.
4 T.P.B.	250	250	200	150	3	12.0	8.0	34
4 T.S.P.	250	250	200	150	3	12.0	8.0	33
41 M.P.T.	250	200	250	100	1.5	12.0	4.8	33
42 M.P.T.	250	250	200	200	3	34.0	8.5	33
42 P.T.B.	250	250	200	200	3	34.0	8.5	34
4 T.P.	200	200	150	150	5	°16.0	4.5	46
D.D.L.4	—	—	—	—	—	—	—	12
41 M.T.S.	250	100	—	—	—	—	—	44
4 T.S.A.	250	100	—	—	—	—	—	45
41 M.T.B.	250	—	200	—	1	3.4	2.6	13
41 M.T.L.	250	—	200	—	3	4.0	3.0	13
42 S.P.T.	500	250	250	250	15	27.0	11.0	33
41 M.T.A.	200	—	—	—	—	—	—	13
G.D.T.4B	§350	—	—	—	—	**100.0	—	‡13
G.D.T.4	500	—	—	—	—	‡20.0	—	‡13
206 P.T.*	120	35	35	35	0	3.35	0.8	—
S.130	‖180	—	—	—	—	¶75.0	—	7
7	Voltage drop 176 volts.							75
41 M.E.	250	—	—	—	0-5	—	—	105

* Directly heated. ‖ Max. striking voltage. ¶ Max. current through tube. ° Pentode section.
‡ Max. continuous anode current. ** Averaged over 15 second period. § Peak volts between electrodes. ‡ Anode to top cap, pin 1 blank.

Valve-base connections, as seen from underside of base

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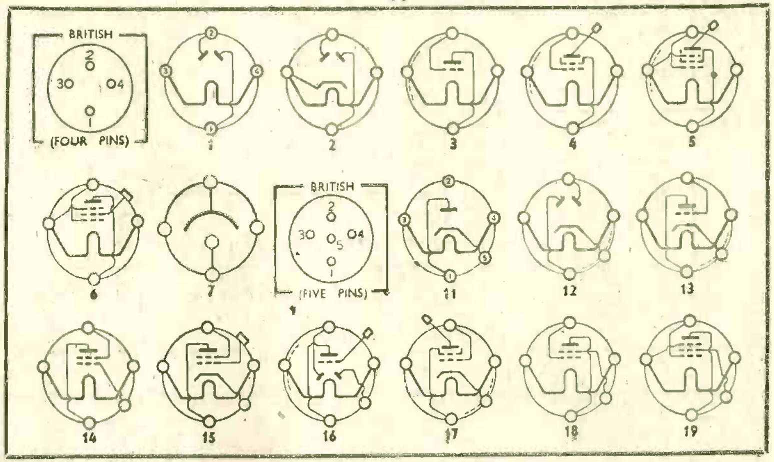

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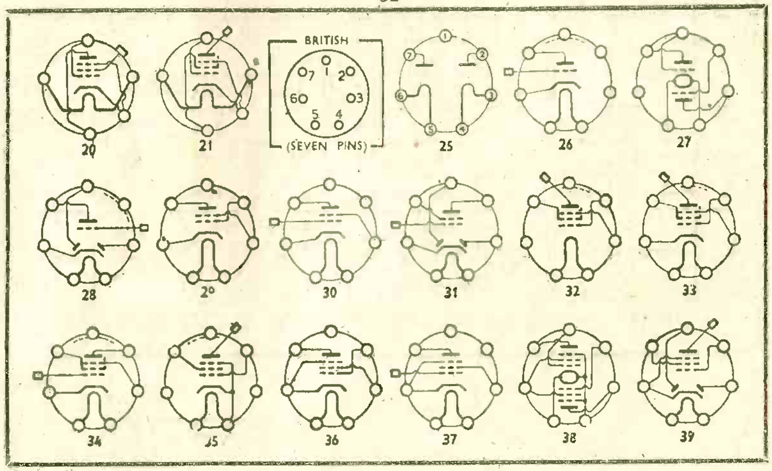


Radio Examination Papers—23

Colour Codes, Units of Sound Measurement, Cross Modulation, Static, Variation in Range of S.W. Transmissions and the Choice of Line-cord Resistance Form the Subjects of this Month's Questions, to which Answers are Given by THE EXPERIMENTERS

QUESTIONS

1. *Briefly explain the R.M.A. colour-code system as applied to fixed resistors and fixed condensers. What would be the value of (a) a resistor having a brown body, black tip and blue spot, and (b) a condenser with red, green and orange spots, in that order?*
2. *Explain simply the difference in meaning between the decibel and the phon.*
3. *What do you understand by the term "cross-modulation," and how can this form of interference be prevented?*
4. *How can the effect of atmospherics be distinguished from so-called man-made static?*
5. *If you were using a receiver covering the wavelength range of 13 to 50 metres, at what times of the day, or in what other conditions, would you expect to obtain best reception on the different wavelength bands?*
6. *Calculate the resistance required in a line cord for use with a three-valve-plus-rectifier A.C./D.C. receiver fitted with American .15A valves, the heaters of which are rated at 12, 12, 50 and 35 volts respectively. It may be assumed that the rectifier requires an input of 120 volts at 60 mA, and that the supply voltage is 230.*

1. Colour-coding

THE object of colour-coding is to simplify the indication and recognition of component values and connections. Although used with a large number of components, the system is of chief value in connection with resistors and condensers whose physical dimensions in many cases make other means of marking virtually impossible. Colour-coding was first introduced by the Radio Manufacturers' Association, and is now universally employed.

Colour-code charts are available, but with a little practise the code can easily be memorised if its general form is understood. The underlying principle is that colours are used to indicate the digits from 0 to 9, and also a number of noughts from none to nine. The colours used are as follow:

Black = zero.
Brown = 1 or a single nought (0).
Red = 2 or two noughts (00).
Orange = 3 or three noughts (000).
Yellow = 4 or four noughts (0,000).
Green = 5 or five noughts (00,000).
Blue = 6 or six noughts (000,000).
Violet = 7 or seven noughts (0,000,000).
Grey = 8 or eight noughts (00,000,000).
White = 9 or nine noughts (000,000,000).

In the case of resistors, the three colours used are those of the body, tip and spot respectively (see Fig. 1). The first two colours represent digits, while the third indicates the number of noughts following the digits. The answer is in ohms. Thus, the value of the resistance mentioned in the question can be determined in the following manner:

Brown body = 1
Black tip = 0
Blue spot = 000,000
10,000,000 ohms, or 10 megohms.

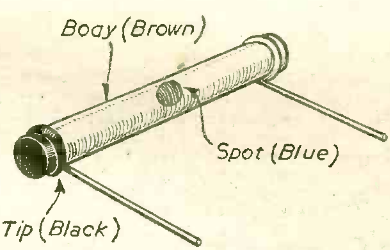


Fig. 1.—The method of colour-coding as applied to fixed resistors. The colours indicated denote a value of 10 megohms.

With condensers, the three colours are all in the form of spots, as shown in Fig. 2. The value is shown in mmfd. (millionths of a microfarad). Taking as example the condenser referred to in the question, we can obtain the value as follows:

Red spot = 2
Green spot = 5
Orange spot = 000
25,000 mmfd., or .025 mfd.

2. Sound Level and Amplifier Output

Although both names—decibel and phon—are often used to indicate the volume level of various sounds, their precise meanings are by no means identical. Whereas a phon is a unit of loudness, the decibel is not a unit at all except in so far as it is used to indicate the ratio between two power levels.

The loudness of a sound is determined by the effect of that sound on the human ear, at an average audio frequency. Thus, a sound which is just verging on audibility has a loudness of zero phons; on the other hand, the loudness of the noise heard by a mechanic standing close to a running aeroplane engine is about 120 phons. The sound level in phons of any sound is measured in terms of the pressure (in dynes per sq. cm.) produced on a surface such as a microphone diaphragm or the drum of the ear. The zero reference level is taken as .0002 dyne/sq.cm., or 10-16 watts/sq.cm. In determining volume level in phons, comparison is made with a 1,000 cycle note.

As previously stated, the decibel (one-tenth of a bel) is used to show the ratio between two power levels such as, for example, the output and input of an amplifier. The human ear is by no means as sensitive to changes in volume level, if volume be interpreted in terms of power, as one may expect. For example, if the output of an amplifier were reduced from 3 watts to 2 watts by means of a switch, the difference would scarcely be noticeable. Similarly, there would hardly be any perceptible difference if the output were increased from

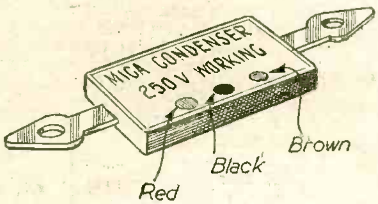


Fig. 2.—Colour-coding on a small fixed condenser. Its value is .0002 mfd.

3 to $4\frac{1}{2}$ watts. But if an output of $\frac{1}{4}$ watt were increased to $\frac{3}{8}$ watt the change would be readily detected.

It has been found that if a logarithmic scale of notation is employed, the increase or decrease in the number of decibels is proportional to the increase or decrease in volume as detected by the ear. For example, an increase of 4 decibels has the same effect on the ear whether the increase represents a change from, say, .3 to .75 watts, or from 3 to 7.5 watts.

The number of decibels, up or down, can be found from the formula:

$$\text{Decibels} = 10 \log_{10} \frac{W_2}{W_1}$$

where W_2 is the second power output and W_1 is the first. Thus, if the output of an amplifier were increased from 2 to 4 watts, we could say that the output had been raised by 3 db. If it were reduced from 8 to 4 watts, the output would be 3 db. "down." Similarly, if an amplifier gave an output of 5 watts when the input was .05 watt, the rise would be 20 db., or the output would be 20 db. "up" on the input.

3. Cross-modulation

Cross-modulation is a form of interference experienced when the modulation of a powerful nearby transmitter is superimposed on the carrier wave of a weaker signal on a nearby frequency to which the receiver is tuned. It is due to the fact that the powerful signals "spread" to a certain extent and, being of comparatively high voltage, cause the first valve of the receiver to detect or rectify.

This form of interference can occur in a receiver which is highly selective, in that there are several tuned circuits. But if there is only one of those tuned circuits between the aerial and the first valve there may be a fairly high input from the local transmitter when the set is tuned to a frequency as much as 50 kc/s separated from it. Because of the process of rectification, the interference is passed on, without filtration, to subsequent tuning circuits and valve stages.

The remedy consists either of applying variable-mu volume control (manual or A.V.C.) to the first valve, or of inserting a band-pass filter between the aerial and the first valve stage. The former will prevent the valve from acting as a detector, and the latter will obviate the transfer of the interfering signal.

4. Static

Both forms of static referred to in the question—atmospheric and man-made or artificial—result in interference. It is impossible to eliminate the former, but the latter can be prevented or cured if its source is determined.

In general, both forms of interference are noticed in the form of "crackling" or "rustling" noises as a background to the sound reproduction. But whereas atmospherics are generally heard at varying intervals of time, man-made static normally occurs at more or less regular intervals. Atmospheric noises generally start at fairly low intensity, build up to a crescendo and then stop, the whole sequence occupying two or three seconds. The single disturbance is similar, in some respects, to the breaking of a wave on the shore.

Man-made static, on the other hand, is observed either as a constant "crackling" noise, as a low-pitched unmusical noise, or as a series of crackles, depending upon whether it is due to electrical sparking at the brushes of a motor, for instance, an electric discharge through a neon tube, or the making and breaking of contacts in an electrical circuit. Before searching externally for the cause of trouble it should be ascertained that it does not arise within the receiver itself, due to a bad contact or faulty component. This can normally be checked by the simple process of disconnecting the aerial; if the noise continues at the same strength as before, a search for the cause should be made within the set.

5. Short-wave Radiation

The radiation of short-wave signals is a complex subject, and the range of radiation is governed by numerous factors. Among these are the time of year, degree of ionisation of the upper reflecting layers in the atmosphere (this, in turn, is largely dependent upon conditions of daylight or darkness), the frequency in use, and various periodic changes extending over a number of years and connected with astronomical and meteorological phenomena.

All this is getting rather away from the main point of the query, which is concerned simply with the question of frequency and hour of day. Since we have to formulate a general answer, it can be stated that wavelengths toward the bottom of the range mentioned can be received over the greatest distances when daylight prevails at both the transmitting and receiving stations. During hours of darkness wavelengths toward the upper end of the range are more reliable for long-distance communication. Between the two, reliability for long-distance working can be graduated from the lower to the upper extreme, between broad daylight and darkness.

The reason for the variations referred to is that these short waves are reflected from ionised layers in the upper atmosphere; the direct transmission by ground wave is practically negligible. We have, therefore, a "skip-distance" between the radiation leaving the transmitting aerial and returning to the earth's surface. The dimension of the skip-distance is dependent upon the angle at which the radiation leaves the transmitting aerial, and the height of the particular ionised layer which reflects it.

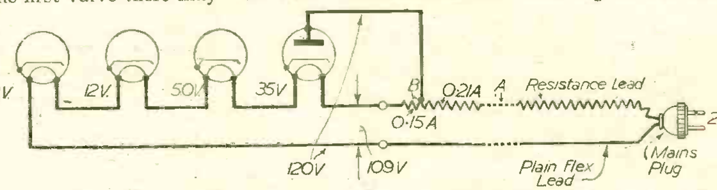


Fig. 3.—This simplified diagram shows the method of wiring the heaters and line-cord resistance in a typical three-valve-plus-rectifier receiver of the "midget" AC/DC type.

6. Line-cord Resistance

The valve heaters are wired in series, and therefore the voltage required to supply them is equal to the sum of the voltage ratings of the individual valves. This can be seen to be 109 volts. Since the mains supply voltage is 230, we therefore have to "drop" 121 volts. In the case of the A.C. supply to the rectifier valve we require 120 volts, which means that only 110 volts have to be "dropped."

To see exactly what factors have to be considered it will be best to look at the simple diagram shown in Fig. 3. It will be seen from this that one lead is of plain copper-wire flex, while the other is the usual spiral of resistance wire on an asbestos-cord core. The supply voltage to the set at the remote end of the line cord is 109, so to obtain our 120 volts for the rectifier, a tapping must be taken.

A slight complication arises now. Whereas the total current to be passed by the resistance as far as the tapping point is .21 amp. (.15 L.T. plus .06 H.T.), whilst only .15 amps is passed by the remainder. Our little problem therefore resolves itself into two parts: to find the resistance of the portion of the line cord marked A in Fig. 3; and to find the resistance of the part marked B. The voltage to be dropped by A is 110, and since the current passed is .21 amp. the resistance required will be 110 divided by .21, or approximately 524 ohms. The voltage to be lost across B is 11, and the current passed is .15 amp.; the resistance must, therefore, be 11 divided by .15, or just over 73 ohms.

Elementary Electricity and Radio—9

The "Straight" Receiver Analysed

By J. J. WILLIAMSON,

(*Continued from page 417, September issue.*)

A "STRAIGHT" receiver is one wherein all R.F. (radio frequency) amplification is performed at signal frequency; thus superheterodyne receivers, which have R.F. amplification at I.F. (intermediate frequency), are not included.

Tuning

Tuning circuits enable one frequency or a band of frequencies to be selected whilst rejecting unwanted signals; this property is known as "selectivity."

An ordinary radio telephonic signal is composed of

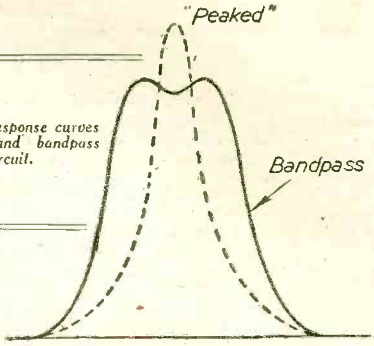


Fig. 38.—The response curves of a "peaked" and bandpass tuned circuit.

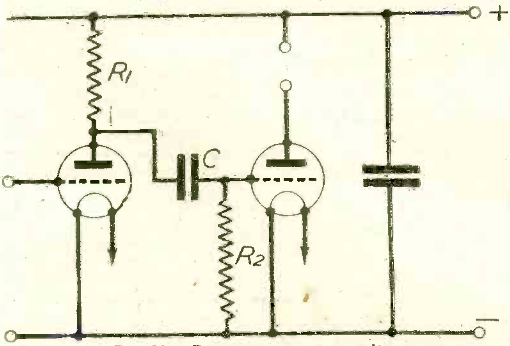


Fig. 39.—Resistance-capacity coupling.

several frequencies equally distributed above and below the carrier frequency, i.e., upper and lower sidebands.

For the reception of continuous waves (C.W.) as used for morse signals, the tuned circuit may be made far more selective without causing a loss of intelligibility.

Fig. 38 gives typical response curves for a "bandpass" (full line) and a "peaked" tuned circuit.

As we must be able to "tune" the circuit, i.e., adjust it to different frequencies, its resonant frequency must be capable of variation; this is achieved by making either the inductance or capacity variable. Receivers usually employ a variable condenser and transmitters a variable inductance, with which to adjust the "tuning."

Radio-frequency Amplification

Certain points have to be taken into account when considering R.F. amplification.

Using a resistance as an anode load is undesirable, owing to the "shunting" or "short-circuiting" effect of the resistor's self-capacity at high frequencies, and the consequent falling-off of the R.F. voltage developed across the load. A tuned circuit is normally used and greater selectivity thereby attained.

The amount of R.F. amplification possible is limited by certain factors. As the number of R.F. amplifiers is increased, the prevention of feed-back and consequent oscillation becomes more difficult, because of the larger R.F. potentials developed and the additional stray capacities caused by the components involved.

Couplings

The feeding of the voltages (alternating) developed across the anode load to the grid and filament of the next valve is known as coupling. A coupling should pass all frequencies within the working range of the particular stage to which it is attached evenly, i.e., its opposition should remain constant over a given frequency range.

Resistance-capacity Coupling (R.C.C.)

A *pure* resistance has a constant opposition to all frequencies, and would therefore fulfil the given requirements. Unfortunately, it is impossible to make a pure resistance, its self-capacity being unavoidable. As stated in the paragraph dealing with R.F. amplifiers, the "shunting" effect of the resistor's self-capacity restricts the use of R.C. coupling in R.F. amplifiers, but when L.F. amplification is to be obtained, this "shunting" is less serious. R.C. coupling possesses the disadvantage that a resistance placed in the anode

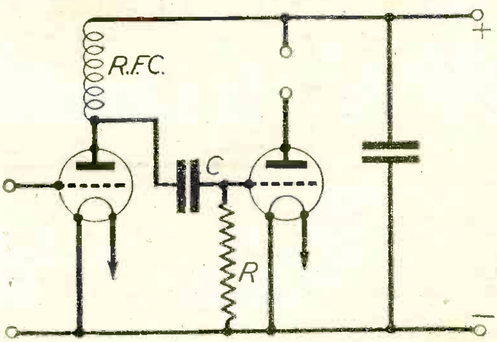


Fig. 40.—A choke-capacity system.

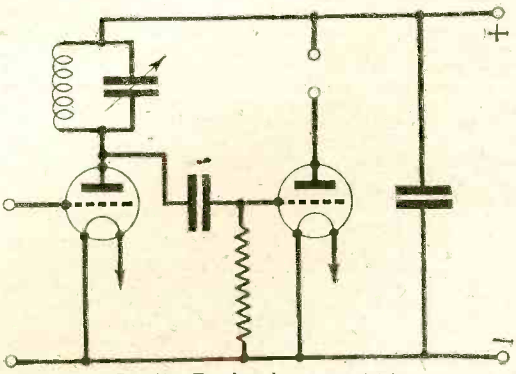


Fig. 41.—Tuned-anode-capacity circuit.

circuit will cause a reduction of potential upon the anode of the valve. Fig. 39.

Notice that C in Fig. 39 is necessary to prevent the application of the supply voltage (H.T.) to grid and filament of V_2, but it is capable of passing on the alternating P.D's.

The "grid-leak" R_2 permits the charge that accumulates in C to leak away, otherwise the valve's operation would become intermittent. This is one source of "motor-boating" and other noises heard when the grid leak or bias circuit is broken.

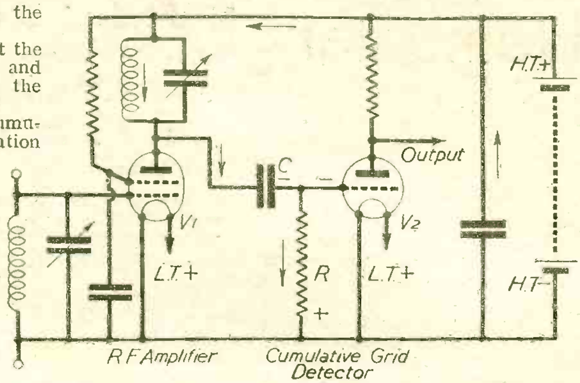


Fig. 45.—Fundamental arrangements for cumulative grid detection.

Choke-capacity Coupling (C.C.C.)

The remarks applied to R.C.C. with respect to self-capacity effects are also true for C.C. coupling. Also, the opposition of a choke increases with frequency, thus P.D's (R.F.) developed across the choke would increase with frequency until the choke's self-capacity became predominant, when they would decrease. Fig. 40.

The choke does not cause such a reduction in anode voltage as in the case of R.C.C., as it can be made to have a high reactance with a low D.C. resistance. An L.F. choke (iron-cored) is usually used in output stages where the anode voltage must be kept as high as possible.

Tuned-anode-capacity Coupling (T.A.-C.C.)

T.A.-C.C. is mainly used in R.F. amplifiers when added selectivity is desired. Fig. 41.

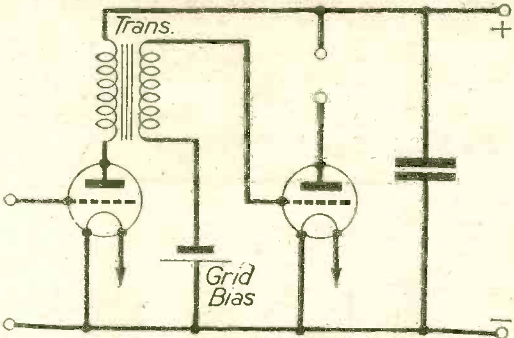


Fig. 42.—A simple L.F. transformer coupling.

Transformer Coupling

Added magnification can be obtained by the use of a step-up transformer; unfortunately, distortion can be introduced. The remarks concerning self-capacity, etc., under C.C.C. also apply to the transformer. Fig. 42.

Anode-bend Detection

As the name implies the anode or lower bend of the triode's characteristic curve is used. Fig. 43 shows how the positive half-cycles cause a greater change of anode-current than the negative half-cycles, thus causing the mean value of the anode-current to vary. The necessary circuit is shown in Fig. 44. Notice the small battery A, which provides the necessary grid-bias voltage to permit the signal voltage applied to grid and filament to vary upon the "bend."

The anode-bend detector is insensitive, but introduces little distortion.

Cumulative Grid Detection

The use of correct values for C and R in Fig. 45 will produce detection.

The signal voltage applied to the grid and filament via C will cause grid-current to flow upon its positive half-cycles, charging up C in "pulses" at R.F. C will discharge via R (the grid-leak)—providing a complete circuit exists—causing a P.D. to be developed across the grid-leak; this P.D. will be varying at L.F. because of the "storing-up" or "reservoir" effect of C and thus the anode current will fluctuate at L.F. as well as R.F., and detection takes place.

A cumulative grid detector is very sensitive but, because of grid-current flow, introduces distortion.

Reaction

Reaction is the process whereby energy is fed back from anode to grid circuits in such a way that energy losses in those circuits are reduced, and the magnification obtained is greater (the effective resistance of the grid-circuits is reduced).

Too much feed-back will cause oscillation, i.e., negative resistance exists.

Fig. 46 is a typical reaction circuit; R.F. potentials developed across R in the detector's anode circuit are fed via C_1 L_1 to the detector's grid circuit (also anode circuit of V_1) C_1; being variable, permits control of the reaction.

Low-frequency Amplification

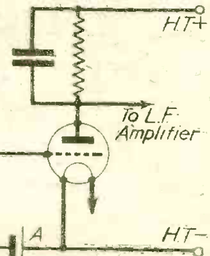
The purpose of an L.F. amplifier is to amplify all frequencies in the L.F. range equally and without distortion. Fig. 47 shows a typical L.F. amplifier with transformer coupling.

The type of coupling used, operating conditions of the valve, etc., are details that must be carefully selected if a L.F. amplifier is to give good quality amplification.

Voltage and Power Amplification

R.F. and L.F. amplifiers are designed to give a large signal voltage across their anode loads, i.e., they are voltage amplifiers

(Continued on page 480)



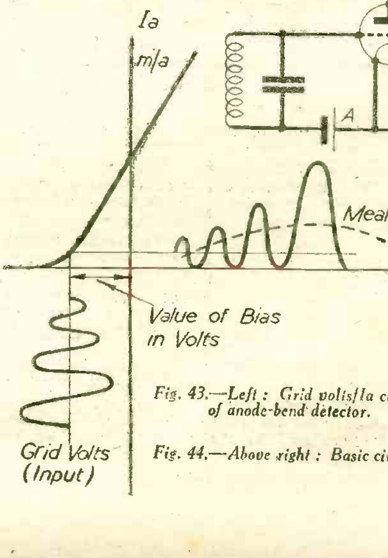


Fig. 43.—Left: Grid volts/Ia curves of anode-bend detector.

Fig. 44.—Above right: Basic circuit.

F.H. WILSON

CONSTRUCTORS' KITS

See August issue for illustration and details of Constructors' A.C. and Battery 3-v. Kits. Delivery approximately one month.

COILS. Aerial and osc. iron core Superhet coil unit, 6 push buttons with 3 position tone control, adjustable permeability tuning, complete with button. New. Colour coded circuits supplied, £1/10/-.

Midget Aerial and Osc. Superhet. 465 k/cs. three wave-band coils, mounted on panel, new, 12/6 per pair. Also Short-Wave Coils on Paxolin Formers 16-50 metres approx., 1/6 each. Midget Medium Wave Oscillator only, 1/6 each.

IF TRANSFORMERS. 450/470 k/cs. iron core permeability tuned, centre tapped, first class component, new. 12/6 per pair.

MAINS VOLT DROPPING RESISTORS. .2 amp. 1,000 ohms on ceramic formers, 2 variable sliders, 6/-, .3 amp. 750 ohms, 1 variable slider, 6/-.

10-WATT WIRE-WOUND RESISTORS. 2,000, 500 and 150 ohm, 2/6 each.

PADDERS. Twin ceramic .0003 mfd. (max.) and .0006 mfd. (max.), 1/6 each.

CHASSIS. Undrilled steel, painted, new, 10½ x 8 x 2¾in., 7/6; 8 x 6 x 2¾in., 4/6 each. Drilled for 3-v, 8 x 6 x 2¾in., 5/6.

WESTECTORS. Type W6, 5/- each.

SWITCHES. New, Yaxley type midget, single bank, single pole, 4-way, 2/9 each. Single bank, 3-pole, 3-way, 3/6 each; 3-bank, 2-pole, 4-way screened, 7/6 each; 4-pole, 3-way, midget, 4/6 each; 2-bank, 2-pole, 3-way, 5/- each.

PARALLEL FEED TRANSFORMERS. Midget. Colour coded circuit, 6/-. H.F. Choke Amplion, 2/6 each. Short-wave double wire wound Filament Choke for electronic reaction coupling, 2/- each.

VALVE HOLDERS. 4-, 5-, 6-, 7-pin Paxolin, 6d. International Octal, moulded bakelite, 9d. each. Short-wave Ceramic 5- and 7-pin, 1/6 each.

CONDENSERS. Tubular, .0005 mfd. to .005, 6d. each; .02 to .1, 9d. each. Mica, .01, .001 mfd., 2,200 volt test, 1/6. Silver mica, .00015, .0002, .0005, .00005 mfd., 9d. each.

VOLUME CONTROLS. ¼ and ½ meg., with switch, 6/6 each. 25,000 and 50,000 ohms, less switch, 4/- each.

VARIABLE CONDENSERS. Single .0005 mfd., 2-speed drive with pointer, knob and dial, no escutcheon required. Single hole fitting for portables, crystal sets, etc., 6/-. .0003 mfd. reaction condensers, 2/6 each. Short-wave Tuning Condensers, 30 mmfd., 2/6.

SPEAKER OUTPUT TRANSFORMER. Heavy duty Pentode, 10/- each.

PAXOLIN. Polished, flat, strong, 18 x 2½ x 3/32nds approx., 1/6 each. Soldering Tags, 3d. dozen. Terminal Strips, from 3d. to 9d. Eyelets, 1/2 to 1/6 gross. **Resistors**, ½-watt, 6d.; 1-watt, 1/- each, most values available. Spiro Clips, 2 a 1d. **Flexible Coupling Joints, large, 1/-. Dial Lamp Holders**, 6d. each. A1, A2, E Panels, 6d. **Systoflex**, coloured, 4d. per yd. length.

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1 K.W. ELECTRIC FIRE Element, size 16in. x 1¼in. x 1in., for 220 v. mains A.C. or D.C., as new, 6/- each post free.

ROTARY CONVERTER. D.C. to D.C., input 48 volts; output 2,500 volts at 1 kW., condition as new. Price £10, carriage paid.

¼ WATT WIRE END Resistances, new and unused, assorted sizes (our assortment), 5/6 per doz.; post free.

SOLID BRASS LAMPS (wing type) one-hole mounting, fitted double contact small B.C. holder and 12-volt 16 watt bulb, 3/6 each, post free, or 30/- per doz., carriage paid.

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

220 VOLT DYNAMO 9 AMP. output by Lancaster Dynamo Co. shunt wound, speed 1,500 R.P.M., condition as new. Price £10, carriage paid.

KLAXON MOTORS. 220 v., D.C., 1/10 H.P. shunt wound, ball-bearing, fitted reduction gear giving speed of 700 r.p.m., high-grade job, condition as new. Price 50/- each, carriage paid.

KLAXON MOTORS, as above, with right angle drive, but need slight repair, mostly fields open circuit, not guaranteed, laminated fields, 20/- each, carriage paid.

AUTO TRANSFORMER. Rating 2,000 watts, tapped 0-110-200-220-240 volts, as new. Price £9, carriage paid.

RESISTANCE MATS, size 8in. by 6in., set of four, 80-80-150 and 690 ohms, to carry ¼ to ¾ amp. Price, set of four, 5/- post free.

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

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

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

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

MOVING COIL movements, needing slight repair, modern type, famous makers, deflection 5 to 10 m.a. Price 15/-, post free.

RIGHT ANGLE DRIVE, mounted in gun-metal box, all ball bearing, ¾in. dia. shafts, as new. 12/- each, carriage paid.

RECORDING AMPMETER, in ironclad case, meter movement wants repair, no pen, clock perfect, range 0-3 amps. Price £7, carriage paid.

200 AMP. KNIFE SWITCHES, S.P. D.T. in first-class condition, 15/- each.

DYNAMO maker C.A.V. output 20 volts, 10 amps., speed 1,500 r.p.m., ball bearing, £5.

ROTARY CONVERTER D.C. to D.C., input 11 volts, output 1,100 volts, 80 watts, will operate successfully on 6 volts input. Price 50/-.

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

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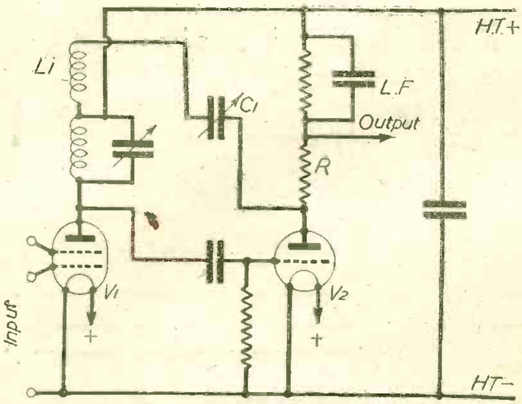


Fig. 46.—A typical form of reaction circuit.

in order that as large an alternating potential as possible is supplied to grid and filament of the next valve.

In the case of the output valve, which has to supply power ($P=IV$) to a reproducer (speaker, 'phones, etc.), the circuit has to be arranged to handle large charges of current as well as voltage.

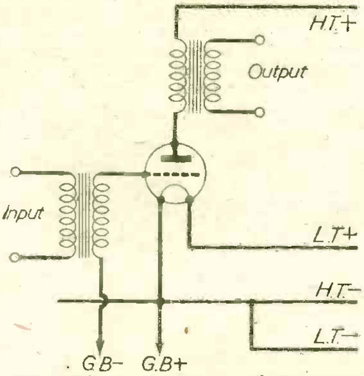


Fig. 47.—A low-frequency amplifier.

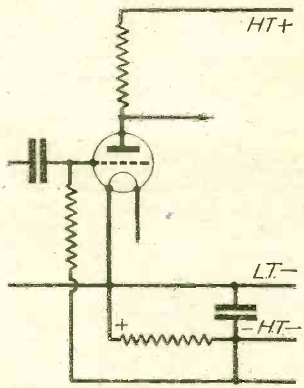


Fig. 50.—Auto-bias from the H.T. supply.

Decoupling

The "rippling" currents through the various valves of a receiver have to pass through the supply, thus, owing to the resistance of the supply, "rippling" voltages are produced across it, causing the supply voltage and the potential applied to the valves to fluctuate. This application of "rippling" voltages to the valves will result in spurious oscillation and general instability, therefore the resistance of the supply, to which they are due, must be avoided.

The connection of a suitable condenser across the supply will give the "ripples" an easy path past the supply's resistance, thus preventing the production of alternating potentials across it. Various methods of preventing the "ripples" on the direct current (D.C.) from passing through the supply exist, as in Figs. 39, 40, 42, 44, etc., where "by-passing" or decoupling condensers and resistances are used.

Biasing Methods

Several methods of producing a grid biasing voltage exist, the most commonly used will be treated :

(1) Fig. 48 shows a typical battery biased circuit.
(2) Fig. 49 gives a circuit using filament biasing.

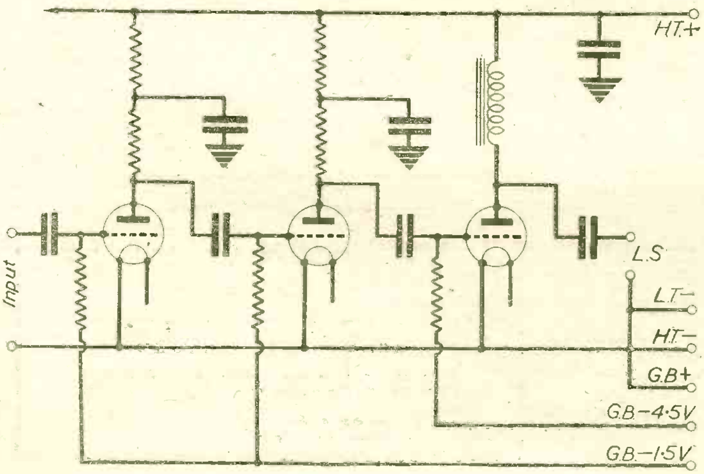
When using battery valves the insertion of a resistance in the filament circuit will provide us with a biasing voltage. The resistance must be small, otherwise the current heating the filament will be reduced sufficiently to impair the valve's operation.

Compared with the other methods about to be described, the filament biasing system is not widely used, but this does not mean that it is without application. In fact, in certain circuits, the system has much to recommend it. When considering biasing arrangements, which depend on the H.T. supply or current for the production of the required bias voltages, it must be remembered that the total voltage available from the H.T. source is effected to the extent of the bias voltages, or, in other words, the term "free bias" is not strictly correct, as one does not obtain something for nothing.

(3) H.T. (high tension) biasing. A resistance inserted in the main H.T. negative line will cause voltages to be developed which can be fed to grid and filament. Fig. 50.

(4) A condenser and grid-leak will produce biasing voltages as explained under cumulative grid detection.

(To be continued.)



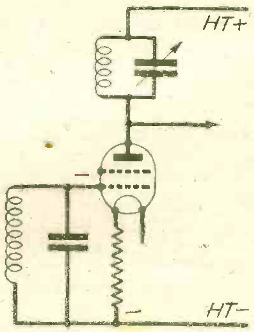


Fig. 49.—Above : Filament biasing.

Fig. 48.—Left : A typical circuit using battery bias supplies.

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).

Single-valve Regenerative Receiver

SIR,—In response to several readers' enquiries I append the details of the coils for the U.S.W. one-valve receiver, which was described in the May issue. The coils were home-made and also the coil holder. The number of turns, diameter, etc., were as follow:

Wavelength covered approx.	S.W. gauge of wire	No. of turns	Winding length	Diameter of coil
12-21 metres	18 enamelled	9	1in.	1.25in.
18-30 metres	18 enamelled	15	1.5in.	1.25in.
30-50 metres	30 enamelled	40	1in.	⅞in.

The first two coils are self supporting, the last is close wound on a ⅝in. diameter former.

Wavelengths well below 12 metres can be covered and, using an L.P.2 valve, super regeneration was obtained, using a two-turn ½in. diameter coil. The coils are all centre-tapped, but for higher efficiency several taps should be made on each coil and the best chosen.

The coil base was made from a thin bakelite strip, 1½in. by ½in., and two valve pins securely fixed ¾in. apart. This made an excellent coil mount, into which the 18-gauge wire fitted tightly. The 30-50 metre coil was drilled through at each end and thick gauge wire inserted to which the 30 s.w.g. wire was soldered.

Since the constructional details were published I have incorporated a ½ Ω variable resistance as a grid leak and it has improved the operation of the set considerably, eliminating all whistling due to incorrect values of grid leak.—A. SCOTT (Manchester).

Wireless Receivers in Cars

SIR,—On page 309 of the July PRACTICAL WIRELESS, you state that it is illegal to carry a wireless receiver in a car. This does not exactly reflect the position. The restriction concerned is Section 4 of an Order in Council under the Defence Regulations (Statutory Rules and Orders, 1940, No. 828). After prohibiting wireless apparatus installed in a road vehicle, this states:

"Any wireless receiving apparatus shall, notwithstanding that it is not fixed in position, be deemed for the purposes of this paragraph to be installed in a vehicle, if it is in the vehicle in circumstances in which it may be used or readily adapted for use."

It follows from this that a wireless receiver can be carried in a car from one place to another provided it is *not* in circumstances in which it can be used or readily adapted for use. In order to comply with the Order, it is sufficient if the wireless set is "dismantled by the removal of valves or batteries." I quote from a letter from the Home Office to the National Caravan Council in 1941. The parts removed can be sent or taken separately and replaced when the receiver is removed from the car at the end of the journey.—F. E. EYRE (London, W.C.).

[*We repeat that it is illegal for anyone to carry a wireless set in a motor-car. Removal of the valves or batteries would not comply with the Defence Regulation. The object of this particular Regulation is to avoid illegal transmissions and anyone who proposed to illegally transmit would merely secrete the batteries and valves. We do not, therefore, accept the Home Office interpretation of this Order, nor do we think that magistrates would support it.*—ED.]

S.W. Broadcasts

SIR,—The following list of S.W. broadcasts which are now available might be of interest to other S.W. listeners. The times are G.M.T. and my receiver is a battery det.-L.F.

EAQ Aranjuez, Spain, 30.43 m., 6.15 p.m. PRL8 Rio de Janiero, 25.6 m., 8.30–9.30 p.m., English hour. ZNR Aden, 24.76 m., 4 p.m. HCJB Quito, 24.08 m., 7.30–8.30 p.m., English hour. XGOY Chungking, 48.85 m., 3 p.m., CR7BE L. Marques, 30.8 m., 5 p.m. FZI Brazzaville, 25.06 m., 7.45 p.m. TAP Ankara, 31.7 m., 6.15 p.m., TGWA Guatemala, 19.76 m., 6.30 p.m. VLI3 Sydney, Australia, 19.57 m., 10.30 a.m. Vatican, 17.19 m., 6.30 p.m., Tuesday.

I have received the "Free Yugo-Slav Station," remarked on by a reader, the wavelength being approximately 35.08 m.; times announced, 2 p.m. Monday and Tuesday. "Allied Forces H.Q., North Africa," may occasionally be heard at 4 p.m. on approximately 24.9 m. Also, LS4 Buenos Aires, 14 m., at 2.30 p.m. There are, in addition, a great number of U.S.A. broadcasts.

I hope PRACTICAL WIRELESS will continue to be as successful and interesting as it is at present, and that the time is not far distant when we shall be able to have a weekly edition again.—F. G. RAYER (Longdon).

"P.W." in the Forces

SIR,—For some time before joining up I was a regular reader of PRACTICAL WIRELESS, and derived much useful knowledge from it.

I now have it sent to me each month, and am thereby able to keep my theory, at any rate, in trim. "P.W." also lightens many browned-off hours.

I write this as I would like you to know how much myself and other members of the Forces appreciate "P.W."—JOHN ROMBAUT (Putney).

Station WDL

SIR,—With reference to G. A. Lockie's query in a recent issue, station WDL is Boston, U.S.A. This station broadcasts news in English on 30.77 m. regularly at 10.00 and 13.00 hours B.S.T. Volume is usually fair.

I would like to get in touch with any other radio enthusiast in Scotland who is interested in S.W. experimental work.—T. PAGE (Edinburgh).

Replies to Queries

Voltage Dropping

"I have a rectifying valve and mains transformer which give an output of 250 volts. I wish to know if I can, by means of resistances or any other methods, reduce both the voltage and the current, which is at present 60 milliamps, so that it could be used for supplying power to a short wave set free from hum. A maximum output of 180 volts at 30 milliamps is required. Could you please tell me the value of the resistances or how to calculate them?"—J. H. (Manchester).

THE output from the rectifying valve, i.e., the D.C. voltage, can be reduced to any required value by means of series resistors. It is not possible for us to give you the values of these components, as they depend on the current flowing. You can, however, calculate them quite easily from the formula:

$$R = \frac{E \times 1{,}000}{I}$$

When E = voltage to be dropped, and I = current flowing in the circuit in milliamps.

A Resistor Problem

"Two 10,000 ohm resistors, A and B, are rated at 5 and 10 watts respectively, therefore B will have a larger current-carrying capacity than A. According to the formula:

$$\text{Resistance} = \frac{\text{Voltage to be dropped} \times 1{,}000}{\text{Current through resistor}}$$

The resistance of the resistors depend on the voltage to be dropped or the current passing through them. Therefore, if A and B have different current-carrying capacities, how can they have the same resistance?"—J. L. (Banstead).

THE wattage rating of a resistor does not affect its resistance value. It is solely a factor which limits the current which can be passed through the resistor without producing over-heating or any breakdown of the resistance element.

The voltage drop produced across a resistor depends upon the current actually flowing through it, and, of course, its resistance, and this value might be much less than the maximum current permissible according to its wattage rating. Two or more resistors can have identical resistance values, and yet be of totally different wattage ratings.

Coil Data

"Please will you tell me the correct windings and number of coils to cover from 10 metres to 200 metres, on a two and a half inch diameter former."—E. G. (Mottingham).

WE cannot undertake to provide constructional details of coils to individual requirements; therefore, we would recommend our book—"Wireless Coils, Chokes and Transformers," wherein will be found all the information you require. The price of the book is 6s. (6s. 6d. post paid).

A.C./D.C. Fault

"I am writing to you for advice regarding an A.C./D.C. set which a friend of mine asked me to try and repair. The trouble is this. On switching the set on everything happens quite normally regarding lighting valves, dial lights, etc. When, however, it is warming up, a sound very much like that of a motor bike is heard in the speaker. This sound grows in intensity until the set is properly warm, when it becomes unbearable. The volume control does not affect it at all, neither does changing the wave band. The voltages seem to be quite normal. Could you advise me as to what procedure to take to find this fault."—H. C. H. (Swansea).

WE would advise you to examine the smoothing condensers, as it would appear that one, or both, may be faulty.

1.4 Volt Valves

"I am proposing to build a 1-v-1 battery set, using 1.4v-filament valves. It seems that the detector will have to be an H.F. pentode, as I cannot find any trace of a triode of the above type being made. Would you please let me know if this is correct and supply me with a suggested circuit for this stage unless, of course, you can let me have a diagram for the whole receiver, for which I would be very much obliged."—M. A. T. (Salop).

NO triodes are produced in the 1.4 volt filament valves; therefore you will have to utilise a pentode in the detector stage. The main circuit connections are the same as for the triode, plus a lead to the screening-grid, which will enable it to obtain a low H.T. voltage in the region of 30 to 36 volts.

H.F. Pen. and Bias

"I am still puzzled about the electrical arrangements for using an H.F. Pentode as a detector and also for use as a feed for pick-up. It is not the switching, but whether grid bias must be used (a) for both pick-up use *and* H.F., as stated by the valve makers (Mullard SP4), or (b) whether the grid bias is only actually applied when switching to pick-up. As the valve rectifies H.F. currents as a detector, and then on pick-up has L.F. currents applied to it, it would seem that the bias is not required for H.F."—E. H. (Blandford).

IT is not usually necessary to apply bias to an H.F. Pen. or screen-grid valve when it is used in the detector position, provided leaky-grid rectification is being used. When, however, a pick-up is employed, it is possible that a low value of grid-bias would be beneficial, but this depends on the characteristics of the valve and, if any doubt exists, it is best to try one or two experiments with and without bias. It is usual to insert a bias resistance in the cathode lead in such instances, and return the earthy-end of the grid-leak to the cathode-end of the cathode bias resistor. The pick-up can then be connected between the grid and the common negative earth-line, and the valve will receive bias when the pick-up is in use, but not when it is acting as a detector.

> **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.**

Converting a Meter

"I would be obliged for your advice re converting a D.C. meter to A.C. I have D.C. Avominor instrument which I should like to use for A.C. readings. Would it be safe to use a rectifier and if so what type would I have to get (if it is possible to get them)? I see in this month's 'Practical Wireless' there is a firm advertising instrument rectifiers. Would these be any good?"—H. B. C. (Watford).

A METAL rectifier can be used with a D.C. moving-coil instrument to enable A.C. to be measured. The type of rectifier required depends on the maximum scale reading of the meter as a milliammeter. More complete details of such arrangements can be obtained from Messrs. Westinghouse Brake & Signal Company, Ltd., Pew Hill House, Chippenham, Wilts.

Condensers in Parallel

"I am building a mains unit for a friend which must have an 8 mfd. paper type condenser. He is in possession of two 4 mfd. paper type condensers of the right voltage. Can I join these in parallel in the place of the 8 mfd., and will they serve the same purpose as that which is marked in the circuit as a reservoir condenser?"—J. B. (Clapham).

CONDENSERS connected in parallel are additive and, therefore, two 4 mfd. condensers in parallel will give a total capacity of 8 mfd. and your idea is, therefore, quite in order.

Substituting a Valve

"Could I use an output triode instead of the output pentode in the 'Short-wave A.C. Two-valver' in your issue dated January 13th, 1940? If so, what would the connections be? I am going to make this my first mains-operated set."—C. H. W. (Hornsey).

A TRIODE would not give the same amplification as a pentode and thus you would not gain anything by substituting the valve. If, however, it is a case of economy and you wish to use the triode for the time being, then the screen voltage dropping resistance must be omitted, and the tone control resistance, condenser and switch would also not be needed. The bias resistance value would have to be changed, no doubt to suit the new valve.

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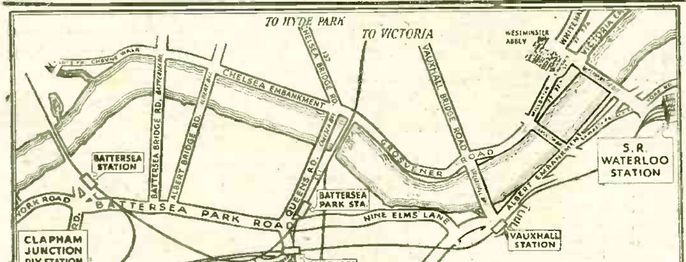

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