MAINS UNIT FOR ALL-DRY PORTABLES

Practical Wireless

9D EVERY MONTH

Editor F. J. CAMM

Vol. 21 No. 468 NEW SERIES JUNE, 1945

Using a Television Camera in the Dumont Laboratories in New York

Practical Wireless
and PRACTICAL TELEVISION
13th YEAR OF ISSUE
EVERY MONTH.
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Editor F. J. CAMM

COMMENTS OF THE MONTH BY THE EDITOR

The Television Report

THE Report of the Television Committee appointed in September, 1943, which has been awaited with such keen interest has now been published, and it gives the answer to all those who, claiming to be in the know, have sailed the interesting seas of vaticination.

The Report indicates that we shall start off with television when the war ends more or less from the point where we left it in 1939. It will be remembered that the television service from Alexandra Palace involved the transmission of separate vision and sound signals from two transmitters operating on frequencies of 45 mc/sec. and 41.5 mc/sec. respectively.

The vision transmitter emitted positive images as opposed to the negative image adopted by the Americans, and produced a peak radiated power of 17 kW. corresponding to the picture highlights, while the sound transmitter radiated a power of 3 kW. The transmitters delivered power to two separate aerial systems mounted one above the other, giving a total height of 606 ft. above sea-level.

The first public service of high definition television in the world was radiated by the B.B.C. from the Alexandra Palace in November, 1936. The transmissions were at first provided during alternate weeks by two rival systems, Baird and Marconi-E.M.I., but in February, 1937, the Television Advisory Committee came to the conclusion that the latter was the better system, and thereafter that alone was employed.

By 1939 the service had reached a high standard, but the number of television receivers did not exceed 20,000, probably owing to the cost (£20 to £75). This gave rise to the belief that prices would fall, and therefore it would be wise to wait, and also that the service was purely experimental and that it would be unwise to buy a receiver which might soon be rendered obsolete.

Interlaced Scanning

THE standard of picture transmission was 405 lines, 50 frames interlaced, giving 25 complete picture frames per second. In the normal process of scanning, the picture to be transmitted is divided up into a great many lines, each of which is traversed by the scanning apparatus. In sequential scanning, each contiguous line is scanned progressively in turn, but with interlaced scanning all odd lines are scanned first, subsequently returning and scanning the even lines required to complete the picture frame. The effective range has been estimated at about 25 miles, although results had been recorded in interference-free districts up to 35 miles.

According to the Report the demands of war have made it impossible to maintain organised research, and therefore little progress has been made. The war has produced little information and no discovery of a fundamental character bearing directly on television, although radiolocation owes much to it.

The Committee have reached the conclusion that the right course in existing circumstances is to reopen the television service on the basis of the 405 line system rather than to wait for the development of a new television system as the result of research. They were influenced in reaching this decision because of the high degree of reliability attained in 1939, and they are of the opinion that many of the receivers on the market in pre-war days failed to do justice to the signals which were transmitted. There are reasons for assuming that with improved transmission the entertainment value of the 1939 service will soon be surpassed. It is improbable that much progress can be made in this country for some years, and it is better to restart the old service rather than wait for the new, as this will keep the staffs together.

Service in the Provinces

EXTENSION of the service over a wide area would commence by the inauguration of service in six of the most populous centres in the provinces, starting perhaps with the Birmingham area. Should the introduction of a new system mean that two entirely separate programmes would be needed, one for the old and one for the new, the financial problem would become serious. It would be unjustifiable to proceed with a rapid extension of the old television system to the provinces if the intention was to discard it after a very few years. It is thought that the old system will continue to appeal to many people even after a new system has been introduced.

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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

Broadcasting on Large Troopship

THE 27,000-ton motor ship *Georgic* is now the finest and best-equipped troopship in the world. It has recreation rooms, cinema, up-to-date and well equipped sleeping quarters, spacious troop mess halls, and an elaborate system of broadcasting involving the laying of miles of new wiring, and the installation of hundreds of loudspeakers.

Sir A. Fleming Dies

SIR AMBROSE FLEMING, one of the pioneers of wireless, and inventor of the thermionic valve, died at Sidmouth on April 19th, at the age of 95.

When working at Cambridge with Clerk Maxwell Sir Ambrose investigated electro-magnetic waves, and in 1898 he was associated with Marconi's early demonstrations. A year later he designed the wireless station for Poldhu, Cornwall, and on December 12th, 1901, Marconi, in Newfoundland, heard the signals transmitted from Poldhu.

Mobile Wireless Unit

THE Cable and Wireless, Ltd., mobile wireless unit, which moved from Naples to Rome on the liberation of the capital, has now moved to the forward operational area in Northern Italy, and is transmitting telegrams direct to Cable and Wireless, Ltd.'s central telegraph station in London.

"Attention! Aux Six Tops"

A BOOKLET has just been sent to the B.B.C. from Monsieur J. Pailhiez, of Rennes. The title is "Ici Londres," which the author interprets as "This is London Calling," preface to all B.B.C. French transmissions.

"Ici Londres" teaches French readers to understand English heard over the radio. M. Pailhiez writes that the booklet was devised and carried out under the German occupation. All he had to help him were the memory of three months spent in London twelve years ago, a pocket dictionary and regular listening to the B.B.C. He chooses two Home Service programmes as especially good for students of English; "The Daily Dozen" because it teaches the names of the parts of the human body and verbs of movement, and the morning religious service, easily followed by any Christian.

M. Pailhiez tells his listeners about B.B.C. services in French and in English directed to France, and also about the Home Service and G.F.P. as well as the B.B.C.'s A.E.F. programme broadcast for Allied Forces on the Continent. He translates all customary phrases used in programmes, such as "Attention! aux six tops," French for the preface to the Greenwich time signal, "Stand by for the six pips."

The author could not get English books during the occupation and begs to be sent some which will enable "my further books to be better." He concludes with, "I offer you my most sincere congratulations on your excellent work during the war. More power to the B.B.C.'s elbow in helping us to make a solid Franco-British *entente*, the certain guarantee of a durable peace."

Interior of the wireless room on the cable ship "Mirror," owned and operated by Cable and Wireless, Ltd., which has been on constant active duty in the Mediterranean since the Allied landings in North Africa. This room has direct radio press transmissions to London.

Broadcasts to Schools

SOME school broadcasts were given during the Easter holidays. These broadcasts offered pupils an opportunity of keeping abreast of current affairs at a period in world history when events were moving more rapidly than ever before.

The new term for school broadcasts started on Monday, April 23rd, when the various series begun last autumn were continued.

The talks for elementary schools include the final term of an interesting series on "Music and the Dance," on Wednesdays, in which the influence of dance rhythms and forms on music will be discussed.

In the Senior History broadcasts on Tuesdays, stories will be told of three men of different generations who have served Africa. They are Wilberforce, Livingstone and Albert Schweitzer, whose seventieth birthday was celebrated not long ago. Other stories of men remembered by their work for the British Empire include Sir Stamford Raffles, Sir James Brooke and Sir Ronald Ross. Biographies of Chaucer and Charles Dickens will be heard in the Senior English series on Tuesdays, as well as dramatic readings from "The Lawyer of Springfield," by Ronald Gow, Shakespeare's "Henry V." and three programmes on Dickens's "Barnaby Rudge."

For Secondary Schools

IN the series for secondary schools there will be six talks on Fridays about mathematics by W. W. Sawyer, mathematical lecturer, Leicester Technical College, followed later in the term by talks on Samuel Butler's "Erewhon" and "The Way of All Flesh," Shakespeare's "Antony and Cleopatra," Dryden's "All for Love" and Shaw's "Cæsar and Cleopatra." In the Fourth Form features on Tuesdays the making of a documentary film will be described, and there will be an imaginary interview with Emma Cons, founder of the Old Vic. Other broadcasts are to be given by James Stephens, the poet, and Edith Evans, the actress, on their work, and there will be productions of parts of "Henry IV" and a medieval play.

Although it is not yet possible to return to the full pre-war issues of special pamphlets, leaflets with notes for the class teacher are available for many of them, and these can be obtained by interested schools, together with the schedule, from the Secretary, Central Council for School Broadcasting, 55, Portland Place, London, W.1.

Services' Educational Broadcasts

THE B.B.C. has been invited by the three fighting Services to contribute to their educational schemes during the demobilisation period, and has undertaken to broadcast 18 programmes a week for this special audience.

These programmes, which will be in the daytime, will be about 20 minutes in length, and will start shortly after the end of hostilities in Europe. They will deal with a wide range of subjects—literature and music, current affairs and industry, history and geography, citizenship and science—and will employ a variety of production techniques, the discussion, the talk, dramatisations, concerts, interviews and readings.

The broadcasts will supplement the work of the Service instructors in the classroom, and an inter-Services committee will advise the B.B.C. in the planning of them. They will be heard by men and women in the Forces awaiting demobilisation both in this country and in occupied territory.

After going off the air when the Germans advanced into Luxembourg, this station was dismantled, but started operating again at the end of last December. The illustration shows a radio engineer making a final connection to one of the high-power valves.

"The Harbour Called Mulberry"

ON March 5th "The Harbour Called Mulberry" was broadcast as the "starred" programme of the week, and on April 7th in the afternoon it was repeated in the Home Service.

The story of the planning and construction of this prefabricated harbour was released piecemeal by various authorities concerned with the operation, and it was left to the B.B.C.'s Features Department to tell the world the first comprehensive story of this magnificent achievement.

Using a "walkie-talkie," an American patrol sends back a report as it moves cautiously into Cologne.

The programme, which bids fair to become a radio classic, received almost unanimous praise both from radio critics and listeners and even though the broadcast began at the comparatively late hour of 9.30 p.m., and lasted for 90 minutes, B.B.C. listener research figures showed that a very high percentage of listeners heard it.

Both script and production were the work of Cecil McGivern, a Newcastle man who has been responsible for many outstanding broadcast features, amongst them "Fighter Pilot," "Bombers Over Berlin," "Junction X" (the story of British railways at war), and the last three Christmas programmes—"Absent Friends," "The Fourth Christmas," and, in conjunction with Laurence Gilliam, "The Journey Home."

Mine-sweeping by Radio

A RADIO-OPERATED device which detonates mines 20 miles distant by dialling a combination of numbers, as on a telephone, was one of a number of secret weapons, details of which have just been released. It can be used against either land or sea mines.

A D.C. Multimeter

A Useful Instrument for the Experimenter

SINGLE-RANGE moving coil meters can now be obtained from various high-class manufacturers without difficulty, and although the general principles of multimeter construction may be known to many readers of PRACTICAL WIRELESS, it is probable that actual practical constructional details will be welcomed. It should be noted that one manufacturer states that they hope to be able to supply special resistors for their single-range meters at a fairly early date, so that a first-class instrument covering any required ranges can be built.

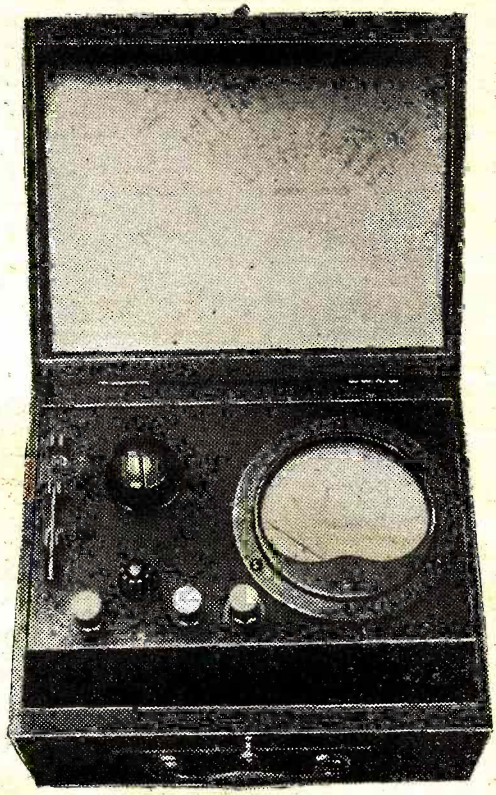
The circuit is shown in Fig. 1. There are three voltage ranges and three current ranges, and a range for ohms up to 100,000 incorporated in the instrument. Additional ranges, when needed, are provided in a manner to be explained later.

A 3½in. diameter 1 mA. meter is used, secured to a bakelite panel 8in. x 5in. by means of three small bolts through the fixing holes in its flange.

Three terminals are also mounted on the panel; one for common plus, and one each for current and voltage readings. They may, for added convenience, be of the type which secure either a straight wire or a spade end. The common plus terminal is marked with a red celluloid washer.

A small three-way switch is needed for selecting the voltage ranges, and a potentiometer for obtaining, in conjunction with the battery, ohms readings. These are mounted on the panel as shown.

The two shunts are selected by a knife switch of the change-over type. This has the advantage of providing good contact, and is absolutely sure in action. If a questionable switch were used here, and in consequence a shunt not properly connected in circuit, the meter might be damaged due to excessive current being passed through it.



Front view of the multimeter, with the lid open, showing the panel and control knobs.

Making the Shunts

When all the parts are mounted, the shunts may be made. There are various methods of doing this, and in each case care should be taken to obtain on all ranges a degree of accuracy comparable to that of the unshunted instrument.

To determine the resistance required for the shunts the ohms parts of the meter circuit can be used. A connection should be taken from the terminal marked "ohms" to the plus terminal, and, with a 4½ volt battery in circuit as shown, the potentiometer adjusted until the meter shows .99 mA. A piece of resistance wire is now connected across the meter, the length in circuit being adjusted until the meter shows exactly

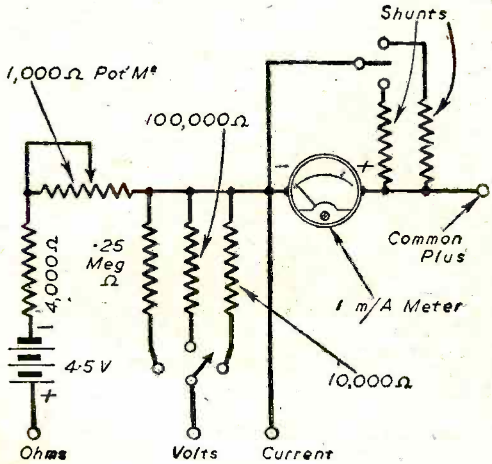


Fig. 1.—Circuit.

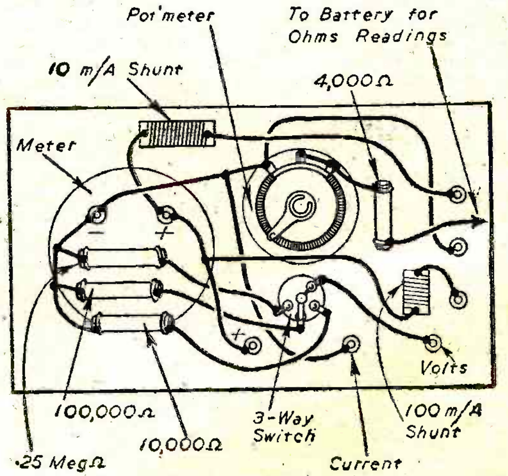


Fig. 2.—Wiring Plan.

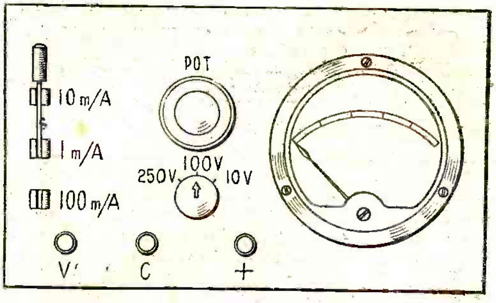


Fig. 3.—Panel Layout.

.1 mA. The wire from an old filament rheostat can be used, if not too thick, or the thin iron wire sold in rolls for binding flowers.

The reason for having an initial reading of less than 1 mA. is as follows. With the first reading the meter itself is in circuit, but when this is shunted the total resistance will be reduced, so that slightly more current will flow through the circuit. This change, as the meter is of very low resistance compared with the potentiometer and fixed resistor, could be ignored, but it is well to take it into account if high accuracy is required. As the meter has a resistance of 68 ohms, making the shunt as above will give a degree of accuracy as high as that of human error in reading off the deflections.

This shunt will give the 10 mA. reading. It should be connected as shown, and the battery changed to 45 volts, and the same procedure repeated. But in this case adjust for 1 mA. reading (which will, of course, be 10 mA. with the shunt in circuit), and then disconnect the battery. Switch the 10 mA. shunt out of circuit, and find a length of wire which will reduce the reading to .1 mA.—which on the new (100 mA.) scale will be 10 mA. The battery must be disconnected each time the length of wire in circuit is adjusted.

When the correct lengths of wire have been determined, wind them on small oblongs of stout card or paxolin. They may then be permanently wired in, as shown.

Ohms Scale

The ohms scale should now be considered, as by means of it accurate resistors for the voltage ranges may be selected. With a 4½-volt battery it will be seen that the potentiometer must be adjusted until the total resistance in circuit is 4,500 ohms. The pointer will then show 1 mA. Now presume a resistance of 10,000 ohms to be connected in circuit. The total resistance will then be 14,500 ohms, and, according to Ohm's Law, .31 mA. will then flow. This will be seen on the dial, as shown. A 10,000 ohm resistor should be chosen, therefore, which gives this deflection, and it can then be added to the circuit to provide the 10 volts scale.

It is not necessary to work out the ohms deflections, for these are shown upon the scale illustrated.

The resistor for the 100 volts reading may be obtained by making use of the 10 mA. shunt. Switch the 10 mA. shunt into circuit and with the switch set to the 10 volts position connect a battery of a fairly high voltage (about 100). Note the reading carefully. Now disconnect the battery and put the switch to the central position so that the meter is not shunted. A resistor should now be selected which gives the same reading, 100,000 ohms being the value required.

The .25 megohm resistor should be chosen to give a reading on its scale the same as that of the 100,000 ohm one on its particular scale.

When the special resistors can be supplied by the meter manufacturer they may be used to replace those obtained as just explained, although probably without any increase in accuracy. The reason for not merely taking a resistor of the value ascribed to it is that it may be as much as 10 per cent. out, with a low quality component, which would give a consequent inaccuracy in the voltage readings obtained with it.

Casing Details

The complete meter is mounted in a box 8in. by 6in. by 3⅞in. inside measurements. A deep hinged lid with catch is used, and a carrying handle is fixed to the front. There is a space left in front of the meter, and this is divided off by a wooden partition to carry the small battery for ohms readings and test leads.

The box may be made from ⅜in. thick wood, with plywood top and bottom, and varnished or stained as desired.

A sheet of paper can be affixed inside the lid showing the connections and scale. Actually it is not difficult to read the various scales off the 0 to 1 mA. scale, but it is some advantage to have a fully marked scale, especially for ohms readings, and the constructor may follow individual preference.

Additional ranges for high-voltage and experimental checking are provided, if wanted, by specially selected resistors which are externally connected to the meter, the latter being set for the 1 mA. scale.

Voltages will be as follows: 2,000 ohm resistor, 2 volts; 5,000 ohm, 5 volts; 50,000 ohm, 50 volts; 500,000 ohm, 500 volts; 1 megohm, 1,000 volts. Needless to say, care should be taken with high voltages to prevent a flash-over, and it is thus best to have a high-quality resistor external to the meter.

Shunts are wound on paxolin, and fitted with spade ends to secure under the terminals marked "plus" and "current." Additional current ranges sometimes useful are 0–2 mA. and 0–1 amp.

Final Notes

Any batteries used with the meter should be in a reasonably good state so that their voltage does not vary with the current being taken.

Opening the meter to affix a full scale will nullify the manufacturer's guarantee, so, if desired, this can be left until the six-month period covered has elapsed.

LIST OF COMPONENTS

Taylor M.C. meter type 350 with 3½in. scale, flush mounting, 1 mA.
Wire for shunts.
3-way switch.
1,000 ohm wire-wound potentiometer.
4,000 ohm 1 watt resistor.
Specially selected resistors for voltage ranges, etc.

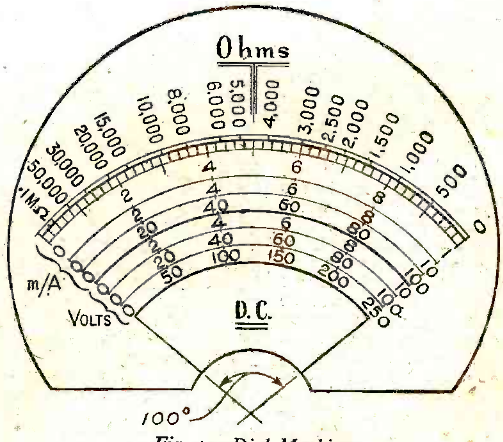


Fig. 4.—Dial Markings.

Radio Servicing as a Career

A Brief Explanation of the Possibilities in Radio Servicing, and of the Requirements in Building Up a Small Business

A WARNING was given in last month's issue of PRACTICAL WIRELESS against placing undue optimism in the radio business as a means of livelihood after the war. Despite that warning there will be many who are determined to give it a trial; and many of those with the proper kind of experience will make a success of the venture.

The suggestions which will be made here should in no way be construed as being at variance with the remarks in the article already referred to. They are made in an attempt to give some guidance to those whose qualifications are satisfactory, and to those who feel confident that they can hold their own in a competitive field.

Having come to a general decision that he is to start a small radio servicing business on his own account, the mechanic must next decide on the particular aspect of the work in which he proposes to specialise. Will the object be to serve the needs of the public in a certain locality; would it be better to undertake the service work passed out by local dealers; or will an endeavour be made to undertake work, in the nature of repairs, for radio users in any part of the country?

Three Lines of Attack

It would be foolish to proceed beyond the planning stage until a decision has been reached on this three-sided question, because the procedure will differ in each case. If the first arrangement is preferred it will almost certainly be necessary to spend a certain amount of money in advertising in the local Press and also, perhaps, on the screen of the local cinema. A shop, with window, in a good position would be desirable to give an added punch to the "publicity campaign"; this is in addition to the workshop. A small van or car will also be a practical necessity, although it may be possible to "make do" with a box tricycle for a time. Incidentally, if a shop is to be opened it would be desirable to sell radio equipment and sets if possible. It should be remembered, however, that with the anticipated stricter control of the industry after the war, it may be difficult to secure an agency, whilst it may still be necessary to obtain a licence to sell. Additionally, of course, a few hundred pounds capital will be required to provide an initial stock.

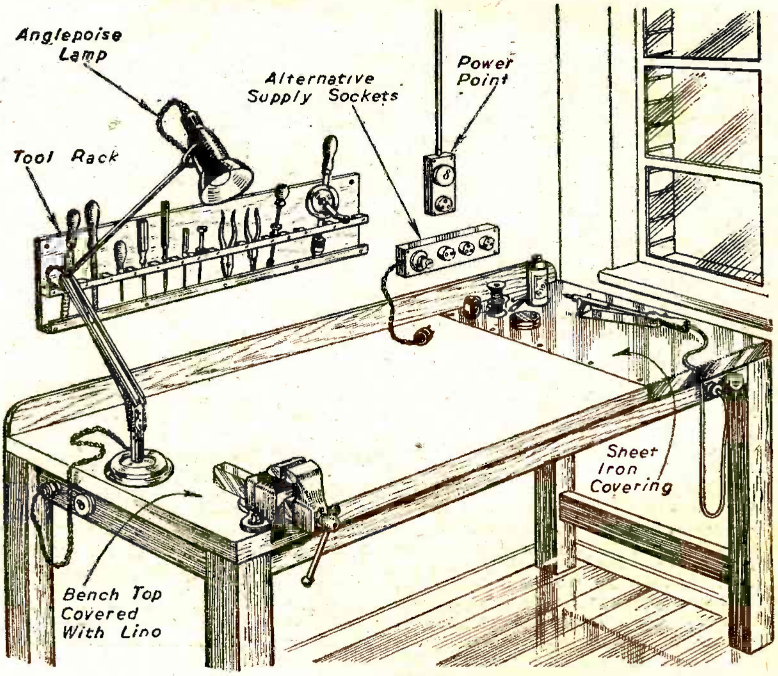
If the second method is preferred, any small workshop—but preferably well lighted—will serve. That means a big saving in rental. A vehicle will still be desirable, but may not be essential, depending upon the arrangements that can be made with local dealers. The only "stock" that will be required will be in the nature of coils, condensers, resistors, valves and transformers. This is quite apart from tools and test equipment, which are absolutely essential. Before starting, dealers should be consulted and arrangements entered into whereby they will pass out all repair and service work which comes to them; it might also be possible to arrange that you will do outside servicing in their name.

"Wholesale" Servicing

It is clear that there should be real bona fides on both sides. The dealer should pass out all his repair work—not just the awkward jobs—and you should not divulge to his customers, when doing "outside" work, that you are in business on your own account and not working for the dealer. If such strictness is not possible, care should be taken that work is not accepted directly from the dealers' customers. Any breach of faith on either side would be almost sure to ruin the working arrangement.

In working on these lines it is very important that an arrangement should be made with as many dealers as possible, for it would be unwise to rely on regular employment from a single source. This will make it even more important that all transactions are completely scrupulous, and that a "square deal" is given to each one of the dealers with whom an association is started.

The third system of working is generally applicable only to the repair and re-winding of speakers, transformers and similar items. For it to be successful specialised experience will be required, and advertising in a widely-circulating radio periodical (such as PRACTICAL WIRELESS) will be essential in order to obtain the requisite business. This type of work can very well



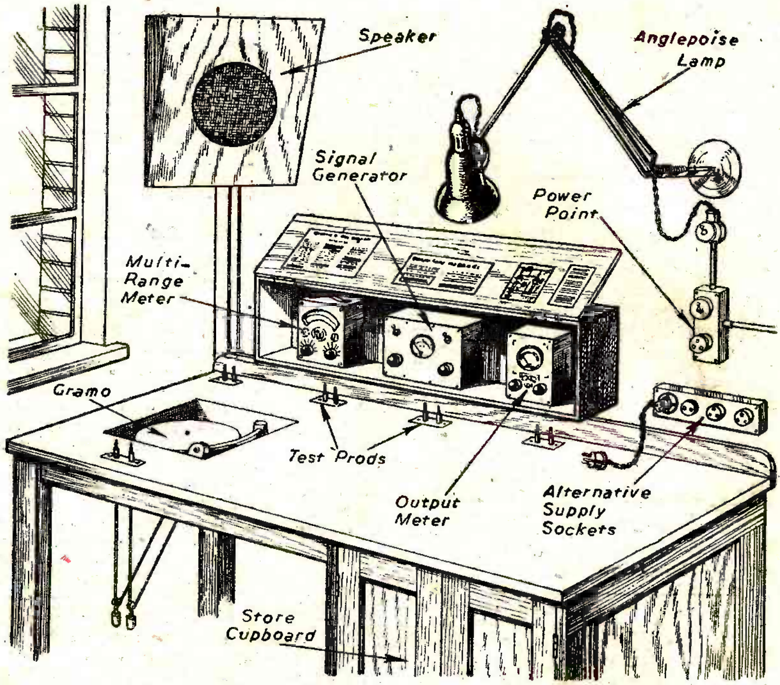
A convenient layout for the work-bench.

be combined with either of the other two arrangements, and will help to even out the flow of work.

Selling Radio Equipment

If it is proposed to sell radio equipment of any kind, it would be wise in the first place to consult a radio wholesaler, who will generally be pleased to give the necessary guidance if bona fides can be produced. Information concerning local trading conditions and regulations would no doubt be available if application were made to the secretary of the local Chamber of Commerce. It should be clearly understood, however, that dealers are unlikely to pass out repair work to a competitor, and therefore that you cannot expect to get their servicing contracts, if you are yourself to be a dealer.

The dealers may, in fact, prefer that you should obtain all your necessary spares and equipment from them—no doubt on special terms. That would relieve you of the necessity of contacting wholesalers and the Board of Trade in connection with the supply of equipment and permission to sell it.



Suggested layout for the test-bench.

Whatever arrangements are made regarding the form which the business is to take, a workshop will be essential. So will good, reliable test equipment. It would be futile to start on amateur lines if it were intended to build up the business to one which could be described as successful and profitable. And it is very strongly recommended that anyone who is not completely familiar with modern test gear should refrain from taking up radio servicing as a career. There is a vast difference between amateur radio and professional radio; the former is primarily for entertainment, while the latter governs the supply of bread and butter!

Test-bench Layout

The actual layout of the workshop must be dependent upon its size and shape, but there should be two benches. If possible, both should be under a window. One will be used for testing purely and simply, while the latter will be the work bench for soldering, etc. The test equipment will comprise the most expensive item, and the following should be regarded as minimum requirements: multi-range meter, modulated signal generator and output meter. A valve tester, resistance-capacity bridge and oscilloscope are also desirable, but not absolutely essential. In any case, these items could be added later. Some form of chassis cradle, in which the chassis can be rotated, is very desirable, but this can probably be made. However meagre is the quantity of test gear, it is very uneconomical to take chances with quality; buy only equipment of reputable make.

It is suggested that provision be made for mounting the principal items of test gear on the wall behind the test-bench, so that they are out of harm's way and do not clutter up the bench. The multi-range meter will require to be readily removable if a second one is not available for "outside" work. It is very desirable that some form of hinged cover be provided so that all test gear can be closed up and kept free from dust when not in use. This can be arranged by placing the instruments in the back of a shallow cupboard, with a door hinged along the top so that it is well out of the way when open.

Connections to the instruments can be made either to a terminal strip running along the underside of the cupboard, or by fitting long leads of stout insulated wire down the wall behind the bench and up through holes along the back of the bench. The leads should be fitted with light weights on rollers, so that they fall back out of the way when not in use. This arrangement is similar to that used in telephone exchanges for the plug cords, and may be familiar.

Loudspeaker and Gramophone

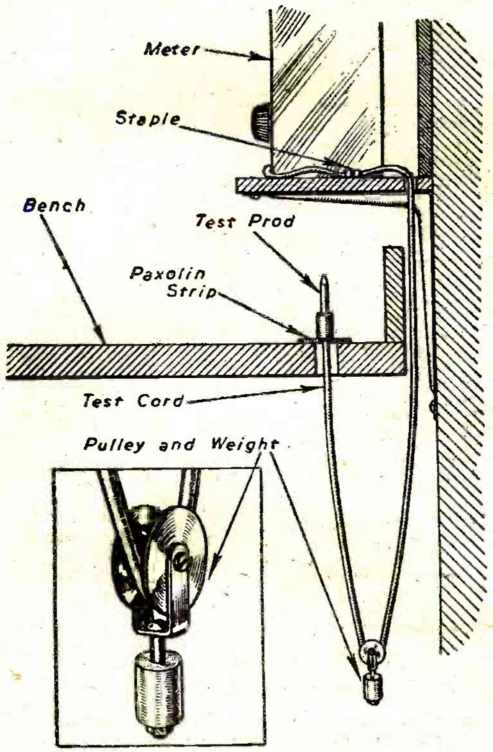
A loudspeaker will be required, and this should be provided with a multi-ratio transformer, so that correct matching can be obtained to any set that may be under test. It is a convenience to have a second speaker, without transformer, for use with receivers which call for the use of a low-impedance speaker. The speakers should be mounted on the largest baffles that can reasonably be accommodated, so that they are capable of really good reproduction. These baffles are best mounted in two corners of the workshop, facing slightly downward.

It is a convenience to have a gramophone turntable mounted at one end of the bench, unless use can be made of an old radio-gram., the gram. part of which is in good condition. This is very useful for testing amplifiers and the low-frequency portions of receivers. If constant-frequency or sliding-frequency records are available, the gramophone unit will also provide a convenient and accurate means of checking reproduction and linearity of amplification.

Bench Work

The work-bench should be placed as far as possible from the test-bench, so that any dirt and dust is kept away from the instruments. A convenient height for this bench, as well as for the other, is between 2ft. 6in. and 3ft., according to the height of the mechanic.

A 3in. vice will be required, and this is best mounted at one end of the bench, say, left. At the other end there should be a sheet-iron covering about 18in. long to take the soldering iron and its rack. Two irons will be required, one about 4oz., and the other a small one



A good method of arranging the test cords.

with pencil bit. The smaller one will be in most constant use, and it is a good plan to make a clamp so that one iron can be held rigidly; this will be very convenient for tinning wires, tags and the like, when both hands need to be free to hold the work and the solder.

The other essential tools are: a pair of flat-nose pliers, a pair of round-nose pliers; a pair of side cutters; two or three assorted screwdrivers, with insulated handles; a trimmer-condenser tool; one or two 8in. hand files in fine and second-cut grades; a set of B.A. spanners, both open-ended and box; a hand drill with set of drills; a centre punch; and a light hammer. There are many other tools that will be required at different times, and these will be accumulated as needed. A tool rack will be necessary, and this can be mounted along the wall behind the bench.

Electric Supplies

The questions of power supply and artificial lighting have not yet been considered. It is clear that there should be a 15-amp. socket in the workshop, whilst it is highly desirable that there should be two: one for each bench. As various types of plug will be fitted to the sets under test, it is an excellent plan to make an adaptor consisting of a board on which are mounted a 15 amp., 10 amp., 5 amp., and bayonet sockets. These should be wired in parallel and connected to a short lead with plug to fit the wall socket. To make the adaptor almost completely universal, it is a good plan to duplicate all the sockets; there should then be little difficulty in providing supplies for the set under test, the test equipment and the soldering irons. Because there is such a multiplicity of sockets, it should not be forgotten that the main supply is still a 15 amp. socket.

In a small workshop, a single, central light point will generally suffice, provided that there is an adjustable bench lamp on each bench. This can be swivelled so that the light can always be put exactly where it is required; far better than tying a bit of string to a pendant light and fastening this to a nail in the wall!

Reference Books

Well, those are some of the points that must be watched if you propose to start work as a service mechanic. They are not exhaustive, by any means, but should give sufficient guidance when drawing up the preliminary plans. It has been assumed that you already have a set of reference books; if not, you will certainly need "Radio Engineer's Vest Pocket Book," regardless of any others you may have. You should also have "Practical Wireless Service Manual," "The Practical Wireless Encyclopædia," "Wireless Coils, Chokes and Transformers—and How to Make Them," and "The Superhet Manual." All are published by Newnes, the publishers of PRACTICAL WIRELESS, and a full list of these and many other wireless books can be obtained from George Newnes, Ltd. (Book Department), Tower House, Southampton Street, Strand, London, W.C.2. Lists are free, but a penny stamp should be enclosed with the inquiry to meet the requirements of the paper restrictions regulations.

F.M. Stations in U.S.A.

THERE are now 46 frequency-modulation stations on the air in the United States, and it is reported that more than 300 are planned for after the war. About five hundred thousand F.M. receivers were sold before production was halted by the war.

* * *

Catalogue Received

WE have received a copy of an advance catalogue from Messrs. Radio Instruments, Ltd., Purley Way, Croydon, Surrey, containing details of transformers and chokes that will be available as soon as materials are issued for their manufacture. The transformers and chokes are the result of numerous developments that have taken place since 1939. No prices are given in the catalogue, but a quotation and further information may be had on request to the manufacturer.

Leeds Radio and Television Society

CONSIDERABLE progress has been made by the newly formed Radio Society in Leeds, with headquarters at Swarthmore Settlement. Several lectures have been enjoyed by the members during the past few weeks.

Members are busy constructing a communications receiver for club use. A morse practice set is available for those interested, and one meeting is entirely devoted to "would be" brass pounders. This oscillator is a single valve, mains driven affair, kindly provided by one of the members.

A library is one of the objects of the Society, and a start has been made in collecting books.

Membership is increasing rapidly, and the Society is looking forward to a bright future. Anyone interested is welcome. Meetings every Friday.

Aids to Hearing—3

Tone Correction. Construction of Two-valve Portable Hearing Amplifier

By a Member of the Technical Staff

(Concluded from page 202, April issue)

THE basis circuit, shown in the previous article of this series, is capable of giving adequate amplification when used in conjunction with a transverse current type of microphone, of normal sensitivity. If, however, one is able to secure a good make of crystal microphone, an additional stage will, no doubt, be necessary, as the output of a diaphragm type of crystal "mike" is roughly only a quarter that of the carbon model. If the cell type of crystal instrument is used, even higher gain will be required, but this does not necessarily mean more valve stages than the three suggested for the diaphragm type, but an alteration in the value of the coupling components, or the substitution of a transformer coupled stage in place of resistance capacity coupling. It would not be wise to attempt to use more than two L.F. stages preceding the output valve, as the danger of positive feed-back would be present with its consequent instability. Apart from these considerations, the amplifier would become somewhat bulky, and impose a heavier drain on the batteries, which would mean more frequent replacements.

While the transverse current microphone is capable of giving very satisfactory response, and has the greatest sensitivity of the three types mentioned above, it has the inherent characteristic of a light background hiss, but in all fairness, it must be stressed that this depends a great deal on its construction and total amplification, and I certainly think that in many instances this defect, for such it must be called, is often over-emphasised by those who favour crystal and moving-coil instruments, etc. With the T.C. carbon instrument, it is necessary to employ a transformer between the microphone and the grid circuit of the first valve, to provide the necessary matching and to allow the energising current to be fed to the instrument. This introduces another component into the amplifier assembly, but in more normal times it was possible to secure midget components which occupied very little space. The crystal microphones do not require a transformer, therefore that is an item also in their favour.

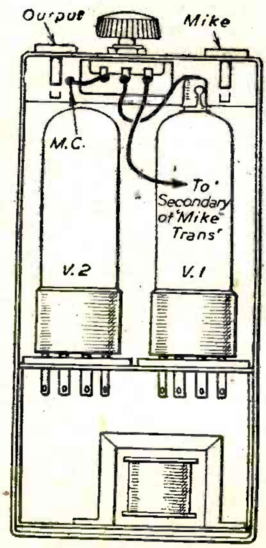


Fig. 2.—General assembly of the amplifier in case.

A Suitable Circuit

The theoretical circuit of an amplifier used by the writer is shown in Fig. 1. It utilises two of the 1.4 type of Mullard valves, and it is capable of giving very satisfactory amplification. For obvious reasons, the design is kept as simple as possible; the tone correctors, of which there are two, are of the fixed type. Had one not been concerned with the saving of space, etc., greater advantages would be secured by making them variable,

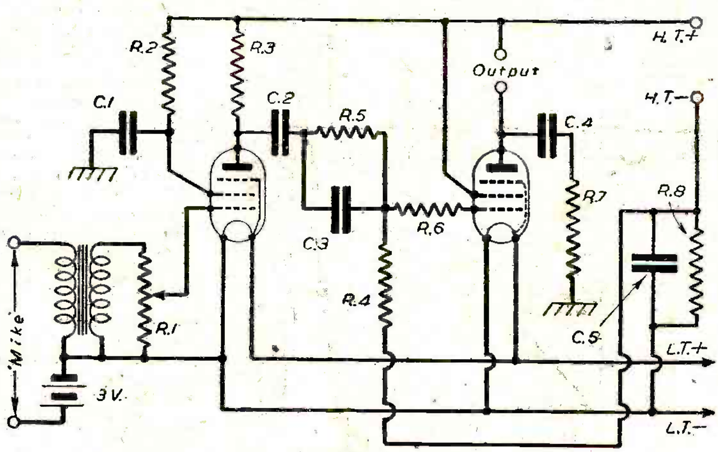


Fig. 1.—Theoretical circuit showing high- and low-note boosters.

as conditions do arise when it would be beneficial to cut or boost the top or bottom fringes of the frequency band, or certain particular sections. This would be possible in a model which was intended for static use, such as in the home or on a desk, and the only modification to the circuit shown necessary to obtain these features is to substitute variable resistances or potentiometers for the fixed resistors R5 and R7.

Resistance capacity coupling is used throughout. This helps from the quality point of view, and saves a great deal of space, as the resistors and condensers involved are very small compared with an L.F. transformer, even of the midget type.

The first valve is an H.F. pentode, which is capable of giving good gain when used with the component values shown. Its output is taken via its coupling condenser, C2, through the high-note booster, and grid stopper R6 to the control grid of V2, which is an L.F. pentode. Between the anode circuit of this valve and the common negative line, is connected the low-note booster, which is formed by the condenser C4 and the resistor R7. It may seem strange to incorporate a high-note booster, and then introduce a low-note booster, which is nothing more than a high-note cutter. The reason for this is to provide, as near as possible, the most balanced reproduction (according to one's individual requirements). The high-note booster does not suddenly cease to function at a given frequency, its effect carries on, in some degree, into the bottom end of the band and attenuates those frequencies which may be required. The low-note booster helps to correct this sufficient to warrant it being incorporated in the circuit. As stressed before, the best response must be determined, according to individual cases, and, in the writer's opinion, according to prevailing conditions and the characteristics of the sounds to which the user is listening. There is a vast deal of difference between, say, listening to conversation in the street, and a speaker in a hall, church or room. Similarly, no two voices are the same, and the ranges covered by the male and female speaking voices have such a wide variation as to make a marked difference on their audibility to a deaf person.

For convenience in wiring and assembly, the volume control R1 is connected across the grid circuit of the first valve, and it should always be used to keep the strength to the signal down to that level necessary for comfortable hearing. It is not advisable to allow the signal to reach a point when the reproduction is very loud.

Construction

The actual layout of the assembly is not super-critical: the scheme shown in Fig. 2 has given every satisfaction

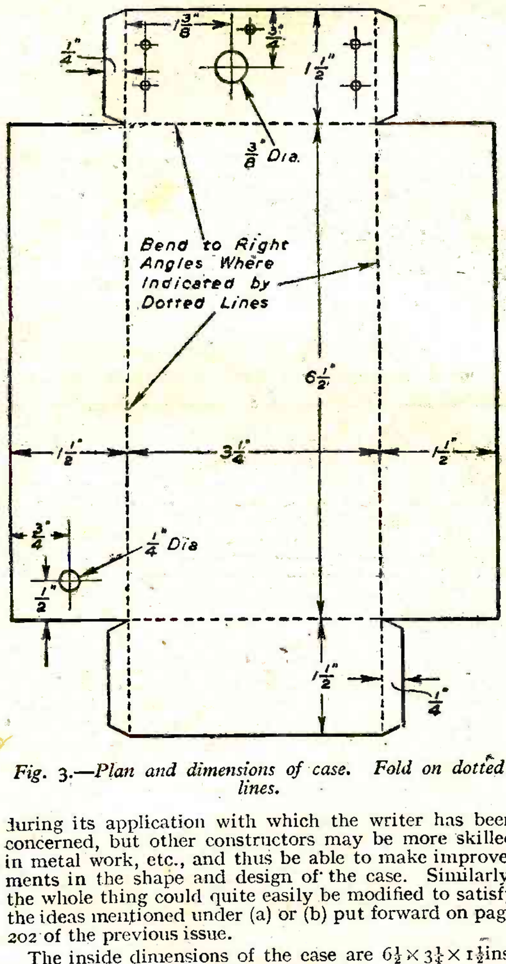


Fig. 3.—Plan and dimensions of case. Fold on dotted lines.

during its application with which the writer has been concerned, but other constructors may be more skilled in metal work, etc., and thus be able to make improvements in the shape and design of the case. Similarly, the whole thing could quite easily be modified to satisfy the ideas mentioned under (a) or (b) put forward on page 202 of the previous issue.

The inside dimensions of the case are $6\frac{1}{2} \times 3\frac{1}{4} \times 1\frac{1}{2}$ins. This is not so bulky, considering two standard valves and a microphone transformer are used. With midget valves, the overall size could, of course, be reduced, but even so, no difficulty should be experienced in carrying the model described in the hip-pocket.

The case is made out of tin-plate. Aluminium would be lighter, but this material is not too easy to obtain these days, and its use would have necessitated using small rivets or nuts and bolts in place of solder. The main case is cut out of one piece of tin, the shape and dimensions being given in Fig. 3. The sides are folded up at right-angles to the front, soldered joints being made at each corner. Before doing the folding, all holes should be drilled, care being taken to remove burrs and rough edges. The valve platform is made from another piece of tin, in which two 1in. diameter holes are drilled to accommodate the valveholders. Depending on the type of valveholder secured (octal), it may be necessary to reduce their area by cutting away some of the paxolin forming the body of the holder. Fig. 4 gives the dimensions of the valveholder platform, and it will be noted that it is large enough to form the assembly plate of practically the whole amplifier. When the necessary components and wiring have been completed on it, it is slipped into the carrying case and held in position by two 6BA bolts, which pass through the sides. For servicing or valve replacement, it is an easy matter to remove the bolts and withdraw the assembly, the only connections which have to be considered being those made to the output sockets.

The lid is formed in the same manner as the case, with the exception that no turn up, i.e., edge, is made along its short bottom side (the top of the case is the volume control end). Two small brass hinges, of the type used for very small wooden cases, cigar boxes, etc., are soldered along the bottom edges of the case and lid, thus allowing the latter to swing wide open when required. It is held in its closed position by a countersunk 6BA bolt passing through its upper edge and into a 6BA nut, which is soldered on the inside of the top edge of the case. Care must be given to the making and fitting of the lid. It is suggested that the outer surfaces of both case and lid are covered with leatherette or Rexine, therefore no overall dimensions are shown for the lid, as these must naturally depend on the thickness of the covering material, etc. A little care in measurement, when the case is finished and covered, will provide the necessary information.

Procedure

Mark out the tin-plate for the case. Drill all holes, and then bend up, making the bends dead on the marking lines, and then solder joints. Remove all traces of flux by washing the case in hot soda water, and well dry. Cover with leatherette and leave to harden.

The valve platform can now be cut out and drilled. Bend the top and side edges upwards so that they make a sharp right-angle bend. Check fitting into case. Fit valveholders, noting positions of locating keyways, and proceed with wiring and gradual assembly of associated components. It should be noted that in the wiring plan the layout and wiring has been opened out in the interests of clarity, therefore during the actual assembly, etc., the shortest connections should be made, the components being arranged to allow this to be achieved.

In a piece of apparatus of this type it is really essential to make soldered connections, and it is equally important to avoid using excessive flux *and* solder.

The battery leads (H.T. and L.T.) are brought out through a small hole in one side of the bottom of the case. They can be of quite small gauge flexible wire, and plaited together to form a neat cord. Their free ends terminate at a four-pin (or two two-pin) plug(s), which fit into suitable sockets on the battery contained. It will be noted that no on/off switch is fitted to the amplifier. This forms part of the battery container assembly.

Those not familiar with octal valveholders may think that they look rather confusing, but if the locating keyway is used as reference point, and valve pins checked from it, no difficulty should be experienced. Of the eight sockets on each holder only six are connected for V1, and five for V2. The control grid of V1—which is connected to the moving arm of the volume control R1—is its top cap.

The condenser C5 and the resistor R8 provide automatic grid bias for V2; therefore there is no need for a bias battery, and, what is even more important, the bias looks after itself according to the anode current of that valve, i.e., depending on the applied H.T. Maximum results are obtained with 90 volts H.T., but, as a battery of this size is too bulky for normal work, 45 volts will give good amplification. For static use the use of the larger H.T. battery is worthy of consideration for the reason already given, and also from the point of view of prolonging the life of the smaller model.

The L.T. can be supplied by a 1.5 volt dry battery. A large torch cell of this voltage is quite good, but,

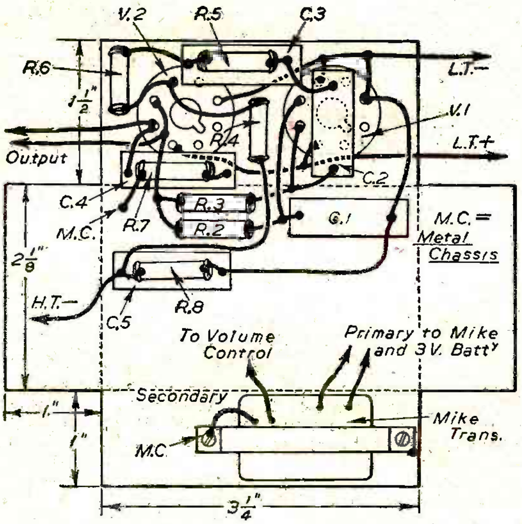


Fig. 4.—Wiring plan and flat shape of valveholder platform.

naturally, the larger the battery the less frequent the replacements.

Battery Case

No diagrams of this are given, as so much depends on the batteries obtainable, etc. Its construction can follow the lines laid down for the amplifier case, but it is suggested that the interior is lined with stout paper, preferably of the waxed type. In one end of the case fit a toggle type of on/off switch, and connect it in series with the L.T. negative. For connection purposes a four-pin chassis mounting type of valveholder can be used, the filament pins being connected to the switch and L.T. positive, and the anode and grid to the H.T. positive and negative respectively. If the free end of the battery cable from the amplifier is then fitted with a four-pin plug (one can easily be made from an old valve base), and the leads connected to correspond to the holder, easy and sure connections will be made.

The Microphone

The one used by the writer was, as mentioned earlier, a very neat lapel type of transverse current. This was fixed in the lapel of the coat, and was not large enough to attract undue attention. A thin twin silk-covered length of flexible wire, fitted with a two-pin plug to suit the input sockets, made the necessary connection to the amplifier. When not required the plug should be withdrawn to prevent unnecessary waste of the "mike" battery, which is housed in the battery case.

Components

It will be noted that, with the exception of the midget transformer, all the components are perfectly standard lines. The resistors are Dubilier of the ¼ watt type; if these are not to hand, there is sufficient room to allow the use of ½ watt types. The volume control is also a Dubilier product, its diameter being approximately 1¾in.

LIST OF COMPONENTS

One potentiometer: 0.5 megohm (R1).

Seven fixed resistors: Two 0.25 megohm (R3, R5); two 1.0 megohm (R2, R4); 5,000 ohms (R6); 10,000 ohms (R7); 750 ohms (R8).

Five fixed condensers: 0.05 mfd. (C1); 0.001 mfd, (C2); 0.0002 mfd. (C3); 0.01 mfd. (C4); 0.1 or 1 mfd. (C5).

Two vales: 1N5G, 1C5G (Mullard).

Book Received

The "Trader" Handbook

COMPILED specially to be of use to motor and cycle traders during the remainder of the war period and during the early days of the transition to peace conditions, a new edition of the "Trader" Handbook has just been issued. Although paper restrictions have called for modifications, most of the usual features which made the volume invaluable for reference purposes have been retained, and several additions which ought to prove extremely useful have been included.

Classified lists of all the Government departments, including regional offices, with which the motor and cycle trader is likely to have dealings are included, as well as information about the various controls, purchase tax, Liabilities (Wartime Adjustment) Acts and the Location of Retail Businesses Order.

The encyclopædia of general law affecting the trader has been completely revised to include wartime legislation. A new feature is a complete directory of all factoring firms, with their branch addresses, which are on the approved lists of the trade organisations, the firms handling motor goods being grouped in the classes of goods in which they specialise.

The classified buyers' guide and the directory of manufacturers and wholesale suppliers are retained, as are also the list of named and branded goods, vehicle service data, and details of wage rates current in the trades.

The "Trader" Handbook costs 10s. 6d. post free, and is published by the Trader Publishing Co., Ltd., Dorset House, Stamford Street, London, S.E.1.

DEVELOPING TELEGRAPH SERVICE TO CANADA

FOUR Cable and Wireless and Canadian Marconi officials have arrived in London to discuss with Cable and Wireless, Ltd., head office, means of developing communication between Britain and Canada, in view of the increasing volume of traffic on this route.

They will give special attention to press traffic and, in addition to investigating the technical problems involved, will study the working of the Press Liaison Department with a view to establishing a similar department in Canada.

The party consists of: Mr. Alan Pearce, Cable and Wireless, Ltd., Montreal; Mr. Leonard Stanley Payne, Chief Engineer, Canadian Marconi Company; Mr. Douglas Forrest Bowie, Traffic Manager, Canadian Marconi; and Mr. Archie George Lewis Douglas, Divisional Manager, Cable and Wireless (West Indies), Ltd., under whose jurisdiction comes the wireless relay station at Barbados.

Valve Overloading

Some Notes on Its Causes and Effect

It is evident that those who refer glibly to overloading of valves in various circuit positions are not always clear regarding the cause of this overloading. The explanation is perhaps most easily given by referring to Fig. 1, which shows the grid voltage-anode current characteristic curve for a typical small power triode valve. Three different input and output wave forms are indicated, it being assumed that the grid bias voltage remains the same in each case.

In the case of the first input, where the grid is swung one volt positive and negative by the unmodulated carrier input, the change in anode current is the same —about $1\frac{1}{3}$ milliamps—for both the positive and negative half-cycles. It may also seem that the anode waveform

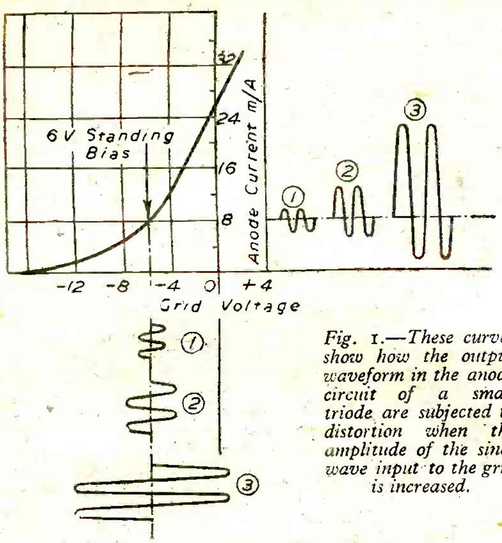


Fig. 1.—These curves show how the output waveform in the anode circuit of a small triode are subjected to distortion when the amplitude of the sine-wave input to the grid is increased.

is similar to the grid waveform. In consequence, we say that amplification is distortionless.

When we apply an unmodulated carrier voltage of plus and minus two volts, however, it can be seen that whereas the positive half-cycle causes an increase in anode current of about five milliamps, the negative half-cycle produces a reduction in anode current of only about three milliamps. In the third case the input grid swing is again increased—to seven volts positive and negative. The anode waveform is then distorted to an enormous degree, partly because the grid is driven negative to a point near to cut-off on the negative half-cycle, and partly because the grid is made positive on the other half-cycle due to the input signal voltage exceeding the standing negative bias voltage. In the two latter cases distortion occurs; in one instance it is relatively mild, while in the other it is chronic.

Using Valve Curves

For the benefit of any readers who are not very accustomed to "juggling" with characteristic curves, it may be pointed out that the anode waveform is obtained from the input or grid waveform by the simple process of projection. Thus, by drawing a number of vertical lines from the waveform representing the grid input up to the characteristic curve, and drawing horizontal lines from the points of contact, the anode-current curve can be drawn by joining up the new points produced. The procedure is illustrated in Fig. 2, where the method of projection can easily be followed.

The reader, although agreeing with the above general explanation, may yet ask why the changed waveform can produce distortion. In putting this question he may remember that in the case of detector valves and class C high-frequency amplifiers we deliberately alter the waveform, but do not (at least we hope not) introduce distortion.

It is not easy to give a completely satisfactory answer to this question without delving into mathematics, but if the reader is prepared to accept a principle propounded by one Fourier, a fairly simple explanation is possible. Fourier stated that any waveform, however complex, can be produced by combining a number of sine waves. Conversely, any complicated waveform cannot be present unless there are two or more sine waves present in its make-up. From this, we can see that in our distorted anode waveform there must be a number of sine-waves, which may be unwanted harmonics. Fourier has also shown that a square wave generally requires a far greater number of sine waves for its production than does any other symmetrical waveform. For this reason it will be clear that the form of distortion represented in the third example in Fig. 1, where the peaks of the waves are squared off, is the most serious.

Preventing Distortion

How can distortion of the kind referred to be prevented? There are two obvious methods; first, by reducing the input; second, by increasing the anode voltage and the negative bias voltage. But if the valve is already operating at maximum anode voltage the second method is not applicable, and so resort must be made to a different type of valve, the characteristic curve of which has a longer straight portion, and which operates at a higher negative grid potential.

In the case of a detector valve of, say, the anode-bend type, the position is quite different. There we wish to rectify and to discard one half of the cycle, as shown in Fig. 3. We are concerned only with the audio-frequency portion of the input, and the smoothed output is represented by the dotted curve which joins together the tips of the peaks of anode current. Overloading of this type of valve would occur only when the input were sufficient to cause the valve to run into grid current. That is, when the positive half-cycles were of such magnitude that they counteracted the negative bias

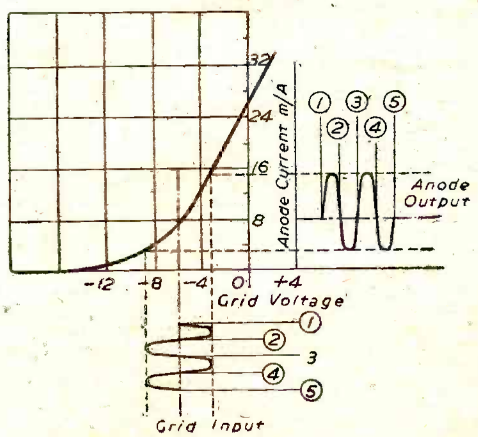


Fig. 2.—This diagram shows how the anode waveform can be projected geometrically from the grid input waveform on an anode current-grid voltage curve.

so that the grid became positive at full amplitude. The result of this would be that the peaks of rectified anode current would be squared off and therefore the smoothed output would not follow the same curve as the envelope of the input. The result would be amplitude distortion.

Harmonic Production

In passing it is of interest to note that use is sometimes made of amplitude distortion in the production of wanted harmonics. This use occurs principally in U.H.F. transmitters where frequency multiplication is required after a crystal-controlled oscillator stage. The method is to bias the frequency-multiplying valve heavily so that the valve operates close to the cut-off point. Thus, when an oscillation is applied to its grid, the negative half-cycles are squared off by the time they appear in the anode circuit. The output is then rich in harmonics, and by inserting a suitable tuning system in the anode circuit the required harmonic can be picked out and passed to the next stage. When using a triode for frequency multiplication the strongest harmonic is the second, although others are present. In the case of a pentode, the third harmonic would normally be the strongest. It should be borne in mind that overloading, in the correct sense of the word, does not take place in a frequency multiplier, although the action is similar to that in an overloaded stage as far as the negative half-cycles are concerned.

Overloading H.F. Stages

The overloading referred to in the earlier part of this article applies in principle to both H.F. and L.F. amplifiers, but there is an entirely different form of overloading which can affect an H.F. amplifier. The result is not generally described as overloading, but as cross-modulation, and is often confused with lack of selectivity.

If the receiver is tuned to a distant transmitter separated by, say, 50 kc/s from the frequency of a local transmitter which produces a strong signal, it may be found that the local station produces interference, even though the tuning circuits are normally quite sufficiently selective to separate two signals separated by 50 kc/s. What happens is that the signal from the local station breaks through and reaches the grid of the H.F. valve The amplitude of the signal is such, however, that rectification takes place in that valve. The modulation from the local station is therefore impressed on the carrier of the more remote station, so producing the effect known as cross-modulation. It should be noted that if the remote station should be switched off, the local station will not be audible without re-tuning; this is a test for cross-modulation.

The remedy is to replace the input tuning circuit by a bandpass filter and/or to use a long-grid-base variable-mu valve in the first H.F. stage. This type of valve is not likely to give rectification to the unwanted signal—because of the long grid base; in other words, because the grid requires a relatively high negative bias to produce anode-current cut-off. Additionally, as the standing bias is reduced to increase sensitivity for the reception of the distant station, so is the negative signal voltage required to produce cut-off increased.

Leaky-Grid Detector Overload

A grid-leak type of detector, although the most sensitive is readily overloaded; it is for this reason that the grid-leak detector has been superseded by the diode in all except the simplest types of receiver in which reaction is required. Unlike the anode-bend detector, it requires to operate on the straight part of its characteristic curve, and the output can be represented as shown in Fig. 4. The audio output is represented by the centre, chain line. Curvature is given to this line by the self-bias provided by the grid condenser and leak, which serve to apply a varying negative bias in accordance with the amplitude of the applied signal. Thus, if the amplitude exceeds a certain minimum, the negative half-cycles will drive the valve beyond cut-off, so "chopping off" the lower portion of the output, as indicated by a full line in Fig. 4. When this happens the centre (audio) curve will also be modified, and distortion will result.

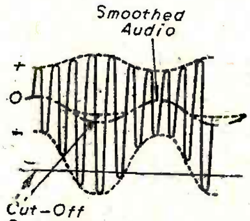


Fig. 4.—The output from a grid-leak detector, showing how distortion may occur, due to overloading.

Power-Grid Detection

Distortion caused in this way can be corrected to a large extent by increasing the anode voltage applied to the grid-leak detector; this has the effect of moving the characteristic curve to the left and upward. There is a limit to the input that can be handled without distortion, even when the anode voltage is increased, for even the maximum permissible anode voltage may give an inadequate handling capacity.

It should be mentioned, incidentally, that this method of reducing the risk of overloading was fairly popular a number of years ago, and the grid-leak detector operated in the new conditions was described as a power-grid detector, for obvious reasons. Besides increasing the anode voltage, it was also found necessary to reduce the values of the grid condenser and leak in order to modify the time contacts of the circuit; but that is a point outside the present subject.

The chief objection to power-grid detection is the high standing anode current taken by the valve. Another objection is that it becomes necessary either to employ a very high H.T. voltage, or to minimise voltage drop in the anode circuit by using a low-resistance choke to form the anode load.

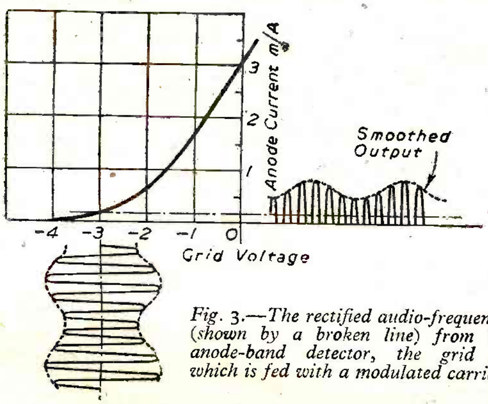


Fig. 3.—The rectified audio-frequency (shown by a broken line) from an anode-band detector, the grid of which is fed with a modulated carrier.

Meter Range Multipliers

Universal Shunt. Making Shunts. Ohmmeter. By 2CHW

(Concluded from page 198 April issue)

AN alternative method of increasing the scale range of a current meter is that shown in Fig. 1. This makes use of what is termed a universal shunt (Rs) which is connected in the normal manner across the meter terminals. The resistance element can be a single item, having tapping points at suitable predetermined points, or it can be formed by a number of resistors connected in series, the values of the individual elements being such that their junction points provide the necessary tappings, and their sum total being equal to the total value of Rs. A big feature about this system, is that the effective shunting values of the

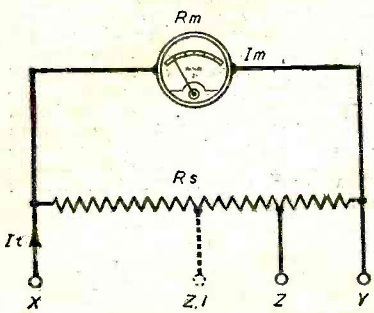


Fig. 1.—Using a universal shunt which can be provided with tapping points for different F.S. readings.

various tappings will hold good for any meter irrespective of its internal resistance. In the previous article, it was shown how to calculate the value of individual shunts, depending on the internal resistance of the meter, and the number of times its full scale reading had to be multiplied.

If we now consider Fig. 1, the current flowing in the meter will be equal to It $\times \frac{Rs}{(Rm + Rs)}$, *if* the current enters at X and leaves at Y. A simple example will prove this, the result being checked by the methods given in the previous article. Supposing the meter has an internal resistance of 100 ohms, and that the value of the shunt Rs is also 100 ohms. If the meters F.S. is 1 mA., and if 2 mA. is applied to the circuit, i.e., X Y, we get:

$$Im = 2 \times \frac{100}{(100 + 100)} = 2 \times \frac{100}{200} = 2 \times 0.5$$

or 1 mA., which is the actual value which will flow through the meter; in other words, the full scale reading will be doubled because 2 mA. is actually applied.

If, instead of considering the path of the current as being X Y we make it enter at X and leave at Z, then the current flowing through the meter will be equal to:

$It \times \frac{Rs}{n\,(Rm + Rs)}$ when n represents the number of times we wish to multiply the current applied in the first example, i.e., in the example given 2 mA. The value of the resistance element X Z being equal to Rs/n.

It is usual to use a fairly high—comparatively speaking—value of resistance for Rs, and if several tapping points are provided the meter will be capable of covering a number of ranges of current.

To secure the greatest advantage from this system, it is best if one can use a meter having a full scale reading of, say, 0.5 mA., then the value of Rs can be calculated to give a F.S. of 1 mA., and suitable tappings made to cover multiples of this. Suppose, for example, Rs was 100 ohms, and this gave a full scale reading of 1 mA., and the first higher multiple required is, say, 5 mA., then the value of X Z would be Rs/5 or 20 ohms; therefore, X Z would be 20 and Z Y would represent the difference, i.e., 100−20 or 80 ohms. If the next tapping had to be for 10 mA., the resistance between X and Z1, the latter representing the additional tapping, would be 100/10 or 10 ohms, and so on.

It is a matter of taste whether one brings the tapping points out to separate terminals of sockets, or whether use is made of a selector switch, but which ever system is adopted, it is essential to see that really good contacts are made, and this applies in particular to switches.

Making Shunts

If a suitable low internal resistance meter is used, and it is always advisable to do so if possible, the values of the shunts will naturally be low especially as the F.S. reading increases. This necessitates great care being taken in fixing the actual value of the resistances, and one is well advised to make several checks before passing any shunt as O.K.

Resistance wire (Eureka) of satisfactory gauges—according to the current it has to carry—provides the best medium for shunts, and it is fairly easy to obtain. It is quite possible that the "spares-box" might yield suitable material in the form of old resistance elements off discarded filament rheostats, or even pieces of heater elements from an electric fire, etc. The main points to watch are, securing the correct length (resistance), and the making of good permanent contacts between the shunt wire, meter and sockets or switch.

When very low values are required, matters will be simplified somewhat by using a heavy gauge, which will have a lower resistance per foot than a smaller gauge which would normally be sufficient for the current to be carried; therefore the fixing of the exact length of wire will not be so super-critical.

There are various ways of making and finishing off the shunts; the crudest form is to simply connect the correct length of resistance wire across the meter terminals, or one can wind the wire in a neat coil or around a suitable former. It is always best, however, to make the coils "astatic" so that they do not produce around them a "field." If the wire is simply coiled up, its inductance effect is increased, but if the system shown in Fig. 2 is used, this is eliminated and an astatic winding formed. The necessary length of resistance wire is folded in half: if it is not of the insulated kind, cover it with suitable gauge systoflex. Select a piece of insulating material, fibre, ebonite or even well-dried wood dowelling, and wind on the folded wire as shown in Fig. 2, the two free ends being made fast to small bolts fixed in the former. When completed, and when well checked, a coating of shellac can be given to the winding,

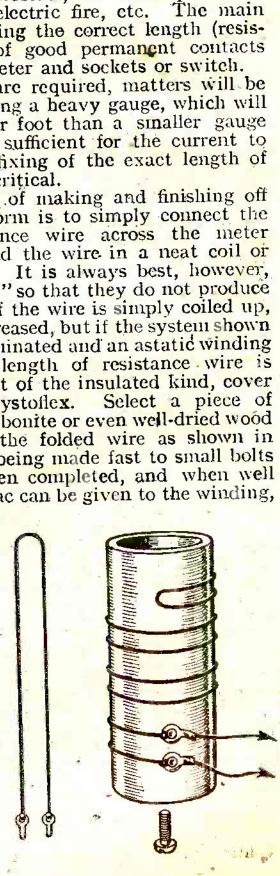


Fig. 2.—The most satisfactory method of winding and mounting shunts. Note how resistance wire is folded in half.

etc., and the coil former or bobbin can be mounted by means of a screw or bolt in one end.

The advantage of using a gauge of resistance wire having a very low resistance value will be obvious when this method is used, as apart from the advantages already mentioned, it will allow, at least, for many of the shunts, sufficient length to permit a folded-back coil to be made.

Series Resistors

When considering the volt reading section of a multi-purpose meter, the series resistors necessary to allow the basic current meter to be calibrated in volts have a high resistance. For these it is more satisfactory to

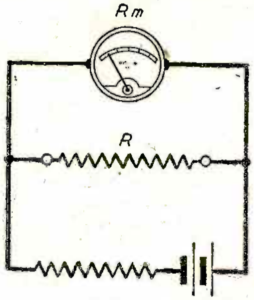


Fig. 3.—This method can be used for measuring resistances of low value, the resistance circuit under test being represented by R.

use the carbon compound type of resistor, as they simplify matters a great deal and occupy such little space. In normal times, it is possible to buy these at a slight extra charge, having a very small tolerance, or, to all intents and purposes, dead accurate to the specified values. During present conditions this is not possible, at least, so far as the constructor is concerned, so the ultimate selection of the component for any particular range will, no doubt, involve a little time spent in trial and error tests. If one of these resistors happens to be just a shade too low in value, its resistance can be *increased* by gradually scraping away a little of the element. With care, this procedure can be applied to bring the resistor "spot on" to the desired value.

As with the current ranges, the various volt ranges can be brought into circuit by a selector switch, or by using separate sockets or terminals. One is not so concerned in this section of the multi-purpose meter with the very low resistance contacts, therefore a well-made switch is worth incorporating. The contact resistance of such a component will be minute compared with the value of the series resistor it brings into circuit.

Ohmmeter

Still using the low reading current meter, it is possible to measure quite a useful range of resistance values, by simply adding a low voltage dry cell. The connections will be the same as those for a voltmeter, i.e., with a series resistor in circuit with the milliammeter, but a dry battery is connected in series with the voltmeter and the resistance under test. If the two leads from the voltmeter were connected across the battery, it would indicate its voltage; if then the circuit is broken and the unknown resistance inserted, the voltmeter reading will naturally drop, and it is by using these two readings that the meter scale can be calibrated in ohms.

If R equals the value of the resistance under test; Rm the internal resistance of the meter; Eb the voltage of the battery, and Em the voltage read on the meter, when the test resistance is in circuit, then:

$$R = \frac{Eb \times Rm}{Em} - Rm$$

but it must be remembered that in this case Rm represents the total internal resistance, and includes the value of the voltage series resistor. Another formula more simple than the above is:

$$R = R\left(\frac{Eb - Em}{Em}\right).$$

While the above method is quite satisfactory for a wide range of resistance values, as the voltage of Eb can be increased, etc., if desired, it is hardly sufficiently accurate for measuring low values of resistance. The need often arises in radio to measure, say, the resistance of a coil or switch contact, etc., and in such instances, the following procedure is advised (Fig. 3). Connect in series with the milliammeter a high-resistance which, with a low voltage will produce nearly a full scale deflection on the meter. Connect the resistance to be measured *across* the meter and note the new reading. The value of R (the resistance under test) can be calculated from:

$$R = Rm\left(\frac{I_2}{I_1 - I_2}\right)$$

when I_1 represents the first reading on the milliammeter, I_2 the second (when R is connected across the meter) and Rm the normal internal resistance of the meter.

A HANDY CRYSTAL RECEIVER

We recently had the opportunity of testing a neat and compact crystal receiver produced by Messrs. Electradix Radios. The set is one of a series produced by that firm, and it is intended to form a very useful stand-by receiver, or for use by those who wish to undertake what is now commonly known as personal listening. The model we tested, and which is shown in the illustration, is known as the B.B.C. Blackbird, its retail price being 39s. 6d. It is sturdily constructed, the various components being mounted on a porcelain base and completely enclosed within a well finished cover. Two controls are provided, one being the tuning condenser, and the other the adjustment for the semi-permanent crystal detector. On test we found, as is usual with this type of detector, that once the most sensitive point has been selected it will stay set for a considerable period, and does not need continual readjustment as did the earlier types of cats-whisker crystal detector.

When used in conjunction with an aerial of reasonable efficiency, and a good pair of high-resistance headphones, results from the Home and Forces programmes are very satisfactory. To allow the maximum degree of selectivity to be obtained, alternative aerial sockets are provided and these should, in most districts, allow stations to be received free from interference, although one cannot, of course, expect the high degree of selectivity normally associated with a valve receiver employing two or more tuned circuits.

The B.B.C. Blackbird crystal set.

Apprenticeship and Training Systems in the Radio Industry

Apprenticeship and Training Formed the Subject of a Discussion at a Meeting of the Radio Section of the I.E.E. Held Recently

THE discussion was opened by Dr. J. Grieg, M.Sc., who stated in his introductory remarks that radio is a relatively new industry and apprenticeship is one of the oldest industrial contracts. What new problems of training are presented by the development of this new branch of engineering?

There is already an established tradition and an accumulated experience of apprenticeship in the engineering industry as a whole, but in these days recognition of responsibility for the training of young persons in industry applies not only to employees in the rather closely defined category of apprentice but to all classes of personnel. The purpose of the present discussion is to deal, not with those general problems of training which are common to all or to most branches of engineering, but with such special features or problems as are characteristic of the radio industry.

It has apparently always been accepted that the scope of apprenticeship should cover the acquiring of skill throughout the entire range from the almost purely manual to the almost purely mental. The radio industry comprises not only the design and manufacture but also the installation and operation of radio equipment. To a large extent the manufacture of electrical equipment is distinguished from that of non-electrical equipment primarily by the much wider diversity of materials employed. It is therefore pertinent to ask at what points and in what directions purely electrical knowledge and skill become requisite in radio manufacture.

On the craft side it may be said that the employment of the wide range of insulating materials necessitates a knowledge of special machine-shop and processing techniques which constitutes an addition to the stock-in-trade of the craftsman engaged in radio manufacture. It can hardly be claimed, however, that such a knowledge or skill is of an essentially electrical character.

One of the important questions concerning trade apprenticeship in radio is whether there should be general recognition of an electrical trade containing the basic elements of electrical skill common to most branches of the industry. Such a trade might comprise:

(1) A moderate degree of skill in fitting and machining operations as applied to the metals and insulators commonly employed in the radio industry.

(2) A moderate skill in sheet-metal work, including welding.

(3) A high degree of skill in soldering, brazing and in the wiring of electrical apparatus.

(4) Experience in the assembly of complete items of radio equipment.

(5) Experience in using common testing instruments and in making simple tests on radio equipment.

The position in regard to the training of technicians and potential professional engineers appears to be very similar to that in heavy electrical engineering, but there are interesting points of difference. Both classes of personnel should have a background of experience acquired in all the main departments of factory or operating organisation, this experience being more detailed for the technician than for the graduate engineer. While the nature of the experience to be gained in many of the shops of a radio factory is little different from that in other branches of electrical manufacture, there are some notable exceptions. For example, in the manufacture of valves, cathode-ray tubes and other electronic devices, physics and chemistry have important first-hand applications, and a considerable proportion of the experience of the technician or junior engineer here lies more in the fields of physics or chemistry. For the young physicist or chemist destined to act in a specialist professional capacity in valve manufacture there is a need for the inculcation during a training period of something of the engineering approach to production problems. For a young technician engaged in this class of work it may well be difficult to say in individual cases whether the bias should be towards physics or towards engineering. Possibly the choice might be determined in such cases by the preference of the individual. It is, however, clear that there is a need for a technician qualification in physics and something of the character of an apprenticeship must be developed to meet the requirement.

The universities and technical colleges are partners with industry in the education and training of personnel. This partnership, already close in many directions, will be extended as a result of the pending educational reforms. Has the radio industry special requirements which will influence in any distinctive way the general scheme of collaboration between industry and the educational establishments? Radio research, for example, demands competence in branches of electrical theory at levels much beyond those of university undergraduate courses.

Perhaps the most important aim in the development of the training system for the radio industry is to retain and foster that inquiring and adventurous spirit which, so far, has characterised its members.

In the discussion that followed, stress was laid on the haphazard nature of much pre-war training, and many speakers emphasised the point that the radio industry had depended largely on ex-amateurs for its technical workers; it was suggested that this source of supply had now virtually dried up, though it could be shown that the radio amateurs of this country have formed a pool of appreciable magnitude from which men ready for advanced training have been available. The tendency of the industry to discourage amateurs was criticised as unwise, though one speaker pointed out that the knowledge of this type of recruit was generally unbalanced through lack of formal training in fundamentals.

It was agreed that the more or less accepted classification of technical radio workers into craftsmen, technicians and engineers was satisfactory enough, though some minor changes in terminology were employed. But many speakers thought that far too much stress has been laid in the past on the need for specialised training in "craftsmanship" for the radio industry; that term, as generally understood, tended to emphasise the need for a degree of manual dexterity that did not in fact exist, except in rather exceptional cases.

A suggestion was made that the grade of "craftsman-designer," well established in other spheres, should be thrown open to suitably trained entrants to the radio industry.

The "incoherent growth and newness" of radio was thought to preclude any attempt to establish as yet any rigidly defined methods of training or grading of technical workers. Most speakers urged that young entrants should have every opportunity to change from one grade to another, according to their abilities.

In summing up, Dr. Grieg thought that the importance of physics was well established, and that the aim in planning courses of educational training for the higher grades should be to produce physicists with a radio-engineering sense.

Mains Unit for All-dry Portables

Details of a Useful Unit for the Experimenter

MANY all-dry sets are now in use and are in many ways very desirable sets for these unsettled times when one is, perhaps, constantly moving about the country, as they are more completely portable than the midget mains sets. The chief disadvantage from most viewpoints is their battery consumption which, while permissible as a portable for outdoor jaunts, is apt to be costly and inconvenient if used as a household set. If, however, it could be arranged that when indoors it was run from mains, and batteries only used outdoors or as emergency supplies, this point would be overcome. The following is the description of a unit that makes this possible. Alterations to the set are, unfortunately, unavoidable, but slight and do not affect its efficiency in any way. It should be noted that the following applies only to a four-valve set.

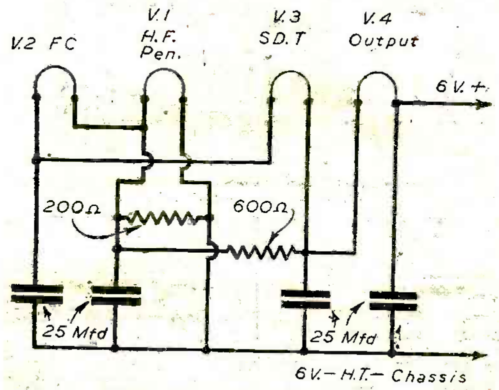


Fig. 1.—Circuit diagram showing filament resistance.

A three-valve set would require slightly different treatment, as would a five-valve, mainly as regards the L.T. supply, which would not be so conveniently obtained, unless a series resistance was used to drop it to the required voltage from the battery supply.

Method of Operation

The principle used is similar to the A.C./D.C. set as far as the receiver itself is concerned, but the input to it must, of course, always be D.C. The mains power unit provides this in one case, and may be operated on either A.C. or D.C., and the batteries in the other. All filaments must be series fed and of the same current rating. In most sets this will mean changing the output pentode, as it is common to use a 1C5 type in this position, which has a .100 mA filament. The 1A5 or 1T5 or a similar type should replace this, as this has a 50 mA filament, as have the rest of the all-dry types used in these sets. This will not, in most cases, affect volume, and when the set is run on batteries will effect quite a saving in H.T. Six volts will now be needed for L.T., and can be provided by two 3-volt cycle batteries in series, which will be found quite economical, more so than 1.5 volt supply, so far as cost of batteries goes. The 90v. battery will be retained for H.T. The mains unit provides 106v. at 60-65 mA smoothed D.C., which is dropped to 6v. at 50 mA for L.T. and 90v. at 10-15 mA for H.T. The negative for these is common and is in direct contact with one side of the mains supply.

Modifications Required to Set

The filament circuit should be modified first, 6v.— going to chassis and H.T.—. Any connections previously made to the filaments should go to chassis, *except grid leaks and coils in the grid circuits.* All bias resistances (usually only the output pentode has one) can be removed as bias is now automatic. Between the positive side of each filament and earth a 25 mfd. condenser of about 12v. working should be connected. Across the filament of the detector (V.1) a 200 ohm resistance should be connected, and across the filaments of V2 and V3 together a 600 ohm (Fig. 1). This is needed because with H.T.— going to the filament of V1 only, all H.T. for the set flows through this filament. Similarly V2 filament passes the H.T. current for V3 and V4, and V3 filament that for V4. V3, usually a single diode-triode, passes a very low H.T. current, however, so it was not shunted separately but with V2, the frequency changer.

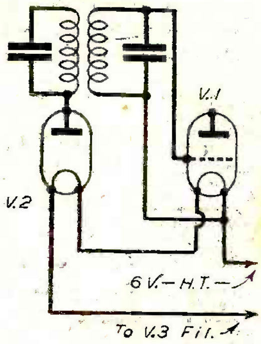


Fig. 2.—Grid connections.

Next the grid connections must be made, beginning with the detector V1. This valve requires no bias and its filament is at the same potential as H.T.—, so its grid is left as before, connected to chassis via the secondary of the I.F. transf. (Fig. 2).

V2, the frequency changer, similarly requires no bias on either grid, but its filament is 1.5v. above the H.T.— line, which means that if its grid coils are taken to earth 1.5v. negative bias is applied. The earth end of the frame aerial (or coil) is therefore joined to the negative side of its filament, as shown in Fig. 3. The oscillator section may have its grid leak (R) across the grid condenser, as shown in Fig. 3, in which case the oscillator coil goes to the filament also, or the grid leak may go from grid to L.T.—, when the oscillator coil may go direct to the common negative line and the grid leak to the filament instead (Fig. 4). The tuning condensers still go to earth, as the 25 mfd. filament bypass condenser completes the H.F. circuit.

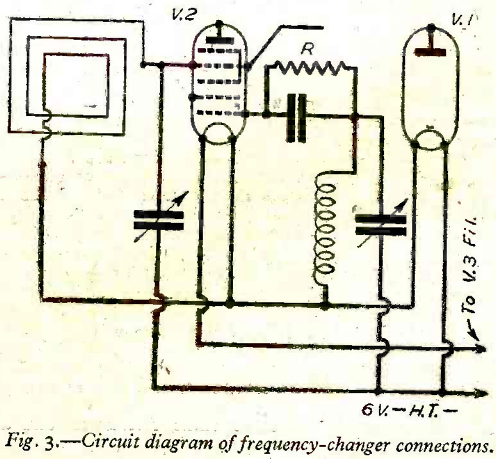


Fig. 3.—Circuit diagram of frequency-changer connections.

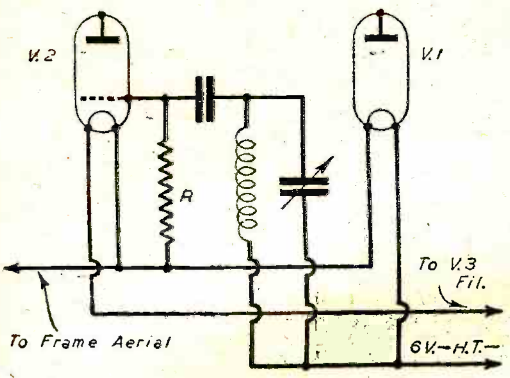


Fig. 4.—Alternative connections for the oscillator coil.

Wavechange switching is not shown in the diagram, as this does not enter into the modifications required so far as the operation of the switch is concerned. However, it will probably be found that the common connection on this switch will go to the chassis. This should now go to the negative side of the fil. of V2. The on/off section of the switch, whether on the w/c

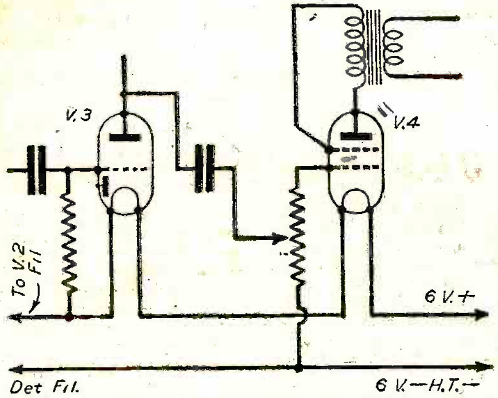


Fig. 5.—The oscillator section.

switch or volume control, should break the H.T.—6v.—line to chassis. V3 also requires no bias, so its grid leak goes to its filament again. The output pentode, however, requires 4.5v. bias. Since the negative side of its filament is 4.5v. above the common negative line, if its grid leak is joined to this line, 4.5v. bias will be applied. The volume control forms the grid leak for either V3 or V4 (Fig. 5).

The earth socket to the set should be isolated by a .1 mfd. condenser of about 500v. working.

Now the filaments are in series, the filament by-pass condensers are wired, and grid connections are modified so the set is ready for running from mains or battery Test it out with batteries now, and if possible check the H.T. consumption.

Power Unit

The theoretical circuit is shown in Fig. 6. The rectifier is a 25Z6 (GT) or 25Z5, 25Z4, or a Brimar 1D6. Its heater takes 25v. at .3 amp. and is fed through R3, an 800 ohm .3 mains dropper with two variable taps, one of which feeds the anode of this valve. If a 25Z6 or 25Z5 is used, the anodes will require strapping together, as will the cathodes. Smoothing is carried out by C1, L1 and C2 being respectively an 8 mfd. condenser; 60H 150 mA choke of 1,500 ohms resistance, and a further 8 mfd. condenser. The output from this network is dropped by R1, a 1,500 ohm resistance to approx. 90v. for H.T. and by R2, a 2,000 ohm row. resistance, to 6v. at 50 mA for L.T.

The chassis of the unit is best made of wood, as in certain circumstances the negative line of this unit is live with respect to earth, hence the isolation of the earth lead on the receiver. Fig. 7 shows the general layout and measurements of this. The whole is made of ¼in. wood.

Fig. 8 shows the layout of end "A." End "B" is just a similar sized piece of ply liberally perforated with ⅜in. diameter holes to dissipate the heat from the mains dropper. The connections to the valveholder in end A, which are the output sockets, are 90v.+ to the plate socket, 6v.+ to the grid socket, and the filament sockets

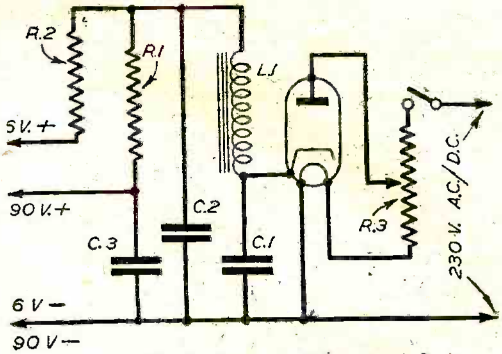


Fig. 6.—Circuit diagram of power unit.

C1—8 mfd.
C2—8 mfd.
C3—.5 mfd.
R1—1,500 ohms 1 watt.
R2—2,000 ohms 10 watts.
R3—800 ohms .2 amps, Mains Dropper.
L1—60 henry. choke, 1,500 resistance.
Rect.—25Z6GT, 25Z5, 25Z4, Br. 1D6.

run together to the negative line. The finished unit is encased in a box of perforated zinc open at ends "A" and "B" and screwed to the edges of these with wood screws.

Fig. 9 shows the under-chassis wiring and layout. R2 is a tubular resistance and is

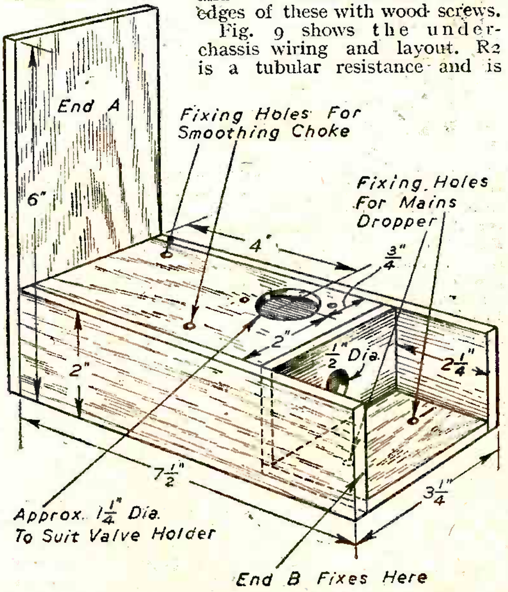


Fig. 7.—General arrangement of the chassis.

fixed by a 6 B.A. bolt and an insulated holding piece. The smoothing choke is mounted crosswise on the top of the chassis. If possible leads 1, 2 and 3 to the mains dropper should be covered with porcelain beads. If not, use stiff wire and space them well apart.

When the unit is wired it will require adjustment to give the correct voltage at the output sockets, particularly the 6v. sockets. An artificial load equal to the set must be used. If the H.T. consumption of the set is 10 mA, by Ohms Law—Resistance = Voltage/Current in amps. = 9,000 ohms, so that a 9,000 ohm resistance should be placed across the 90v.+ and negative sockets. Similarly across the 6v.+ and negative a 120 ohm resistance is required. Here a 6v, .04 amp. bulb is useful if available. Now test by a meter the resistance of the smoothing choke and set the rectifier heater tapping at 680 ohms from the mains end. The smoothing choke is to pass 60 mA (50 mA L.T. current and 10 mA H.T.) and the voltage drop across it must be calculated. If it as stated (1,500 ohms) this will be 90v., which from a 230v. supply leaves 140 volts smoothed H.T. The 2,000 ohm filament resistance drops 100v. at 50 mA, so only 106v. is required. The remaining

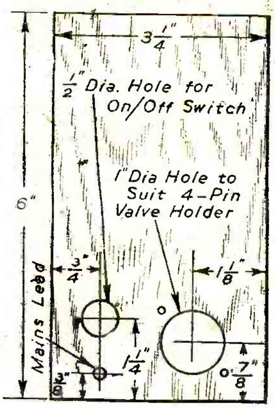


Fig. 8.—Layout of the chassis end.

34 volts must be dropped by the second variable tapping on the mains dropper. This will be carrying .3 amp. heater current and .06 amp. H.T. current, so 95 ohms from the mains end will be about the correct setting for this. Now, with a D.C. voltmeter across the L.T. (6v.+ and 6v.—) switch on and watch the voltage rise as the rectifier heats up. Adjust the tapping to increase or decrease the voltage as necessary and check the H.T. voltage also. If possible check also that 50 mA is flowing through the 120 ohm resistance.

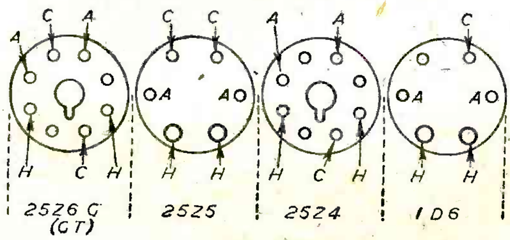


Fig. 10.—Connections to valve holders.

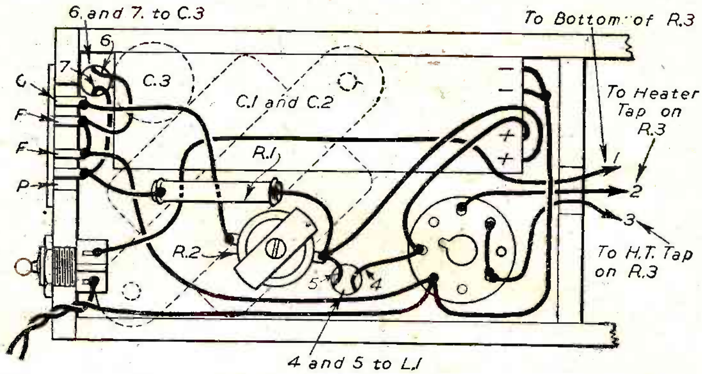


Fig. 9.—Under-chassis wiring.

The unit may now be connected up and *the set switched on*, the switch on the unit being the on/off switch on all occasions when the unit is being used. If the set is switched off before the unit or the unit switched on before the set, high potentials are applied which may damage the set switch. To overcome this, the mains unit negative connections can be taken direct to the chassis by an extra lead from the set, which cuts out the set switch and makes it essential to switch off the unit to silence the set.

The connections to the 25Z6 G (GT), 25Z5, 25Z4 and 1D6 are given in Fig. 10.

B.B.C. Year Book for 1945

It has been the aim of this, the sixth B.B.C. Year Book of the war, to record not merely the broadcasting history of 1944, but to see how the work of five years of wartime broadcasting has led up to the year 1944; and to give a comprehensive account of the principles and aims that have guided those in charge of programmes since the beginning of the war.

The book opens with five articles from well-known authorities, none of whom are members of the B.B.C. staff, but each of whom is in a position to discuss broadcasting with special knowledge. The first article in the book is by Monsieur Georges Bidault, Foreign Minister of France, and an indomitable leader of French resistance during the years of the German occupation. Monsieur Bidault describes movingly the vital contribution made by British broadcasting to French resistance.

Other articles in the opening section come from Sir Edward Appleton, whose contribution, "Recent Radio Progress," gives new and interesting information about the effect that technical progress in Radar and Radio Location is likely to have on sound broadcasting and television in the near future; from Mrs. Arnot Robertson, who gives an individual view on listening to war reports throughout the war; from L. A. G. Strong, who supports with sympathy and humour the claims of Regional Broadcasting; and from Wickham Steed, who writes of his own five years' war effort in addressing world-wide audiences, and winning what at times has been almost a personal battle with Dr. Goebbels.

The leading articles are followed by some two dozen signed articles from B.B.C. Controllers, Heads of Departments, and Editors with special knowledge.

A full section deals with the main problems of the overseas services, covering broadcasts to the Dominions, to the Colonies, to India, to the U.S.A., to Latin America, to the Arab-speaking audiences, to China and Japan.

The B.B.C. Year Book for 1945 is priced at 2s. 6d. (2s. 10d. post free), and it may be obtained from the B.B.C. Publications Department, The Grammar School, Scarle Road, Wembley, Middlesex, or from any bookstall.

The "Mixing" of Frequencies

A Discussion of Modulation and "Beat" Effects

A *modulated wave* is often described as consisting of "an audio-frequency *superimposed* upon an h.f. carrier."

While useful as a preliminary description, it is not very satisfactory as a true definition. For example, Fig. 1 (a) accurately depicts what is called in Physics "simple superposition," and so does any complex wave with its constituent "harmonics." But the amplitude-modulated wave, Fig. 1(b), is obviously something essentially different to "superposition" in this sense.

In fact, it is fairly clear that (b) cannot be correctly considered as an h.f. wave "carrying" *a separate a.f. component*, as such. There simply is no separate a.f. component: the picture represents a *radio-frequency* wave whose amplitude is varying in a certain regular manner.

True, when this modulated-wave has passed through a detector, or *rectified*, an a.f. component does appear in the output—together with a number of other frequency components. It is sometimes said the detector "extracts" the modulation, thereby suggesting that somehow an independent audio-frequency does form a constituent of the complex modulated-wave.

But "extracting" here is no mere process of "filtering-out" The detector is a *rectifying* device. If rectifying an unmodulated-signal of constant amplitude, the output will comprise, among other things, *a mean d.c. component*, Fig. 2(a), i.e., *an average increase* of the *d.c.* anode current of the valve.

If rectifying a modulated signal as in (b), this average d.c. component will be *varying* according to the amplitudes of successive r.f. cycles. The detector has *given rise to* an independent a.f. current component. In a sense, we may say it has "extracted" a modulation envelope, but this envelope should not be regarded as an "a.f. wave" superimposed on the "carrier" as an independent quantity—it is the detector that *generates* a separate current corresponding to music and speech.

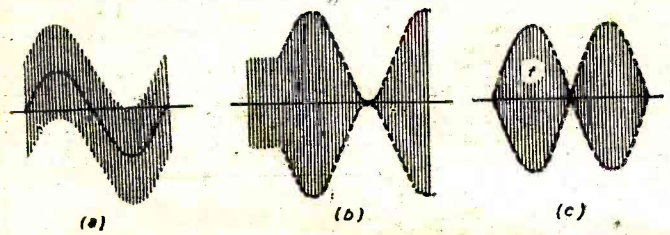


Fig. 1.—Which of these diagrams represents a true Amplitude-Modulated Wave? Can you explain why? If not, see text.

Sideband Frequencies

It becomes more clear that the word superposition must here be used in a special sense when it is remembered that the modulated-wave consists of a carrier and sideband frequencies.

It is quite correct to speak of superimposing the "sidebands" on the carrier. But this is a very different statement to the above. The sidebands are *radio-frequencies*, i.e., sums and differences of the carrier and modulating frequencies. To take a simple case: if a carrier at 1,000 kc/s is modulated by a 1,000 c/s (1 kc/s) "tone," two sidebands are generated of frequencies, 1,000 kc/s, and 999 kc/s respectively.

Or, in general, if a carrier of frequency f_c is modulated by a low frequency f_m, *three frequencies* are radiated, namely,

the original carrier frequency, f_c.
the Upper Sideband frequency, (f_c+f_m),
and, the Lower Sideband frequency, (f_c-f_m),

It is interesting to note that these sidebands are not "mathematical fictions." The higher sideband frequencies can be tuned separately by sufficiently discriminating gear, and it is even possible to have *suppressed carrier* transmission, where sidebands, only, are radiated.

Suppressed-Carrier Transmission

This will partly explain the type of "modulated-wave" shown in Fig. 1(c).

It would be quite wrong to represent an ordinary modulated-wave in this way—a mistake often made. In the first place, "percentage modulation" has no meaning when applied to this sort of modulation—or, rather, the figure will always be 100 per cent. as shown.

What exactly is the difference between this and true amplitude-modulation, Fig. 1(b)? The answer is that the carrier-frequency has been suppressed. Fig. 1(c) represents a simple *beat* between two sidebands of equal amplitudes. We shall discuss "beats" in a moment; if two waves are of the same amplitude, the resulting beat will always be something similar to 100 per cent modulation as in (c).

Most readers will know, too, that heterodyning two waves of slightly different frequencies will give rise to a *beat difference*, which in this case will be,

$$(f_c+f_m)-(f_c-f_m)=2f_m,$$

i.e., the "modulation envelope" is at *twice* the modulating frequency in the case of a simple beat between the sidebands.

The fact that such *frequency-doubling* occurs will be clear if we consider rectification of Fig. 1(c). The result of complete rectification is illustrated in Fig. 3. There will be a mean rectified "a.f. component," but, as indicated by the dotted line, it will not be a sine-wave, but a number of pulses of *twice the audio-frequency*—two pulses per cycle.

In other words: without the carrier, the signal received will be severely distorted and largely unintelligible. Conditions can be restored by reintroducing the carrier frequency *at the receiver*.

This sounds simple. Actually, it is enormously difficult. For, not only must the carrier be reintroduced in the correct amplitude and phase, but these quantities, as well as the frequency, would have to be maintained

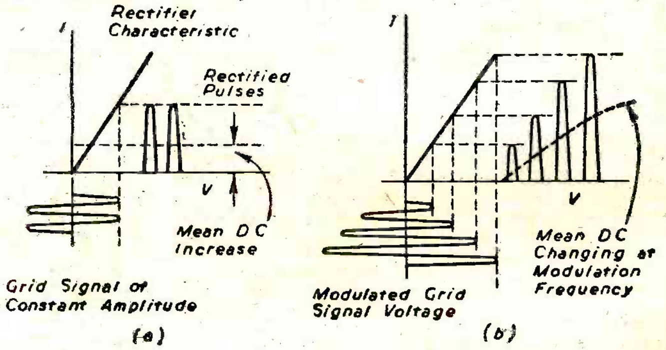


Fig. 2.—Representing Rectification Process.

at a degree of stability that would require expensive precision gear, with a great deal of technical skill in handling it.

The requirements render suppressed carrier-transmissions almost impossible as an ordinary practical proposition, though it is important to realise that *all the intelligence is conveyed by the sidebands,* and not the so-called "carrier."

The "Beat Principle"

What is transmitted, an amplitude-modulated wave or a carrier and sidebands?

A highly technical discussion on that topic raged a few years ago. When stripped of all technicalities about "sum and difference frequencies," etc., we begin to see that the amplitude-modulated wave is a *beat resultant*

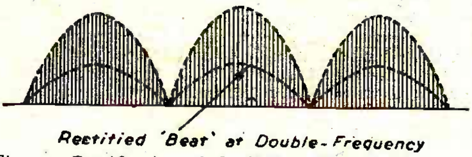


Fig. 3.—Rectification of the "Beat Wave," Fig. 1 (c).

of *three* frequencies, just as Fig. 1(c) represents the beat between two.

This raises another interesting question. Every experimenter is acquainted with "heterodyne whistles." In fact, any desired note in the a.f. range can be generated electrically by heterodyning two radio-frequencies having the required "difference" (f_1-f_2).

What really goes out from a radio-transmitter is apparently a large number of *inaudible* radio-frequencies—carrier, and a whole spectrum of sidebands. We can look upon these as beating to give the modulated-wave. But which ever way we look at it, the voices and music heard from the loudspeaker are a sort of artificial series of "heterodyne notes" of the same nature as the artificial note we produce when beating two frequencies.

This makes it still more evident that nothing in the nature of an audio-frequency is transmitted. If we use a receiver with too highly selective circuits, we fail to reproduce some of the notes played at the distant studio because the radio-frequencies representing them are suppressed.

Moreover, in these days we are getting quite familiar with all sorts of electric organs, etc., producing music on the beat principle. The technique of radio-broadcasting could be described along similar lines, i.e., making use of the speech and music to generate radio-frequencies which will "heterodyne" to give rise to similar sounds at the receiver.

Nevertheless, although a true modulated-wave is nothing more than a beat between different frequencies, it must not be imagined, as is sometimes done, that a simple beat between *two frequencies*, Fig. 1(c), consists of a "carrier" and "sidebands." The point is mentioned, because the writer has come across quite serious statements which do more than suggest this.

Nature of Simple Beats

The only "sidebands" present if we heterodyned, say, 1,000 kc/s and 1,100 kc/s, are these two frequencies themselves—and they can hardly be called "sidebands." The *beat difference* will be a supersonic frequency at 100 kc/s.

It is usual when discussing these things to write down the equations for some non-linear valve characteristic (as in a detector), insert the terms representing the two beating frequencies, and show that, among other things, "sum and differences" are produced similar to sidebands when modulating.

This leads many students to think that a *detector* is necessary in order to give anything in the nature of a beat effect, and, secondly, that, somehow, "sidebands" are generated—though it is not at all clear what that term means in a case where two frequencies are already of such magnitudes as to render meaningless any reference to upper and lower sidebands.

A *beat* is purely a physical effect which occurs when two sounds or electrical waves differ in frequency by an amount which causes one to gain slowly in its phase relationship to the other: At times, they will be in step and at other equal intervals they will be 180 deg. out of step, resulting in the effect shown in Fig. 1(c).

This continuous phase-shift takes place at the *difference* of the two frequencies, e.g., at 100 kc/s in the case of 1,000 and 1,100 kc/s. But the word "difference" here obviously means something very different to what is expressed by (fc−fm) in the case of a carrier and modulating frequency.

What, then, has a detector to do with matters? The beat effect, itself, requires no detector or non-linear characteristics. But no *independent current* at the beat frequency can be obtained without a rectifier; the reason is exactly the same as why any other modulated-wave cannot operate telephones or a loudspeaker without rectification—and the "beat wave" is a sort of modulated resultant as in Fig. 1(c).

"Sum and Difference" Frequencies

The foregoing discussion shows that the terms "*sum* and *difference*" must be interpreted rightly in the case of simple rectification of a beat, i.e., they mean nothing corresponding to "sidebands" in a modulated-amplifier.

We have seen that modulation involves the production of a sum and difference of radio and *audio*-frequencies. Having generated these sidebands, the modulation envelope and its extraction by a detector can be explained along the same lines as "beats."

But when we have *two radio frequencies* that will heterodyne, there is no question of generating sidebands. The "difference-frequency," as seen, is not anything in the nature of an h.f. "sideband," but simply a mechanical effect taking place at a frequency (f_1-f_2)—"mechanical," in the sense that it may occur, for instance, between mechanical systems such as two tuning forks.

Besides the names *beat*, or *heterodyne*, the effect is also known in physics as *interference.* Moreover, a little consideration will show that a "difference," in this sense, can occur only if the two beating frequencies are *within the same octave*, i.e., provided f_1 is less than $2f_2$. Thus it would be meaningless to talk of a "beat" between, say, 300 kc/s and 700 kc/s!

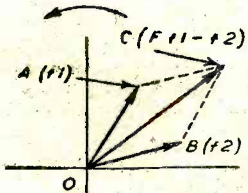


Fig. 4.—S.C. representation of a "Beat." If OA denotes an alternating quantity whose rotation (frequency) is slightly greater than OB, the vector OA will gain on OB by a constant amount every revolution, and the resultant OC will vary in magnitude between zero and maximum, and rotate slowly at the difference-frequency (f_1-2).

What would take place if these two frequencies were combined? No "beat difference" could occur, since this would be of (700 - 300) = 400 kc/s, i.e., greater than the lower frequency! The answer is, that f_1 and f_2 stand in the same relationship as a "high" and a "low" frequency, when f_1/f_2 is equal to twice, or more.

In other words, simple superposition of the 700 kc/s wave on the 300 kc/s wave would take place, in a like manner (though looking more complicated) to what is shown for two widely different frequencies in Fig. 1(a).

If we applied this to a rectifying device, *modulation* of 700 kc/s by 300 kc/s would take place, exactly as in the case of an a.f. and carrier: sidebands would be produced, respectively, at 1,000 kc/s and 400 kc/s. Note, however, that these sideband frequencies will now beat among themselves, and with the "carrier," which is at 700 kc/s.

Therefore: *If two frequencies f_1 and f_2 are in beat relationship ($f_1/f_2 < 2$), there is no question of one modulating the other and thus producing sidebands—a "beat modulation," Fig. 1(c), will take place directly at a frequency (f_1-f_2).* But, *if the ratio $f_1/f_2 = 2$, or more, no beats can take place directly, but f_1 could now be modulated* *by the lower-frequency f_2, with production of higher and lower sidebands $(f_1 + f_2)$ and $(f_1 - f_2)$.*

The "Sum Frequency"

But is there anything corresponding to the *upper sideband* in the output of a detector rectifying a *beat?*

If, as an experiment, we inserted tuned-circuits in the anode circuit of a detector, a large number of frequency components would be discovered, i.e., by simply tuning to them. One of these, as seen, is the beat difference $(f_1 - f_2)$, but we should also find a *sum frequency* $(f_1 + f_2)$ —which is at 2,100 kc/s. if f_1 and f_2 were 1,100 and 1,000 kc/s.

Where does this come from? In an attempt to answer the question, the "upper sideband" explanation again sounds very plausible, i.e., a "sum frequency" of the same kind as $(f_c + f_m)$, when dealing with an h.f. carrier and a.f. But, again, the analogy is misleading, or actually meaningless, e.g., what can possibly be denoted by an upper "sideband" of 2,100 kc/s. in a case like this?

Fortunately, the explanation is quite simple. When we heterodyne f_1 and f_2, we have so far, referred only to the beat-difference—the amplitude variation in the resultant beat-wave, Fig. 1(c). However, the resultant *high-frequency* whose amplitude is thus varying, can be shown to be *the average of f_1 and f_2*, which is, $\frac{1}{2}(f_1 + f_2)$.

The proof of the statement is mathematical. The reader will have to be content with accepting it, though he can easily satisfy himself that, after the frequency-*doubling* or production of a strong second harmonic which occurs during rectification, he will find the sum frequency $(f_1 + f_2)$ in the output of the detector.

But, after all, the second harmonic of the carrier frequency in a modulated-wave may be similarly obtained—together with many higher harmonics. Every detector is necessarily a non-linear device that generates harmonics (though it may be adjusted to give a reasonably linear *a.f.* output). The point to note is that the frequency $f = \frac{1}{2}(f_1 + f_2)$ in Fig. 1(c).

"Multiplicative Mixing"

A term that has been used in connection with modern frequency-changers is *multiplicative* mixing. An electron mixer, such as the triode-hexode, extracts a modulation envelope, or the beat-frequency of a superheterodyne, without any special process of rectification in the ordinary sense, i.e., no separate detector is necessary.

In other words, the frequencies f_1 and f_2 (one of which is due to the oscillator portion of the frequency-changer) are applied to different grids of the valve. They beat, of course, but a result similar to Fig. 1(c) does not appear as an intermediate stage, i.e., requiring further rectification to give a current output at the beat frequency.

Instead, the output takes the form illustrated in Fig. 1(a), where the h.f. is at the average frequency $\frac{1}{2}(f_1 + f_2)$, whilst the "l.f." component—the difference-frequency—exists as an *independent* current, as shown. Thus, we might say that an effect similar to rectification takes place, without employing any ordinary detector stage—though the result may be described in terms of curvature of a particular characteristic of the f.c. valve.

However, the interesting point, is, that the term *multiplicative* is quite appropriate to explain matters. For, if we took the trouble to add the successive instantaneous values of the two waves, the resultant would take the form of Fig. 1 (c), i.e., a resultant beat-wave (which requires rectification) is obtained by *additive mixing*, or, in other words, simple superposition. Note, however, that additive mixing of a high and low frequency would give Fig. 1(a).

But, if we *multiplied* the instantaneous values, the resultant would be as in Fig. 1(a)—the beat-frequency appearing as an interpendent (or rectified) component. It thus appears that "non-linear" detecton process is equivalent to *multiplying the instantaneous values of two waves*—or that this gives a result similar to detection.

The subject is an interesting one in itself, but space will not permit discussing it at much greater length now. What is true, is that the equivalent of *rectification* is also necessary in order to accomplish modulation of a high frequency by a low frequency, i.e., to give Fig. 1(b).

A valve must be adjusted to a non-linear or an asymmetric condition, both for modulation, and "de-modulation"—to use a term that is not strictly correct. This further emphasises what we said at the start: modulation is not simple superposition (additive mixing), but involves *multiplicative mixing*—though that term is seldom used with reference to the subject.

In a future article, it may be possible to discuss further aspects of the modulation question from this point of view.

Assembling, Testing and Calibrating Precision Wavemeters

Paper Read Before the Institute of Practical Radio Engineers

By F. M. BALDWIN

WAVEMETERS are precision instruments used for measuring wireless frequencies, calibrated in wave-lengths or frequencies, the assembling, testing and calibration of them serving as an interesting illustration of the meticulous care necessary in the design of precision test-equipment in general. Wavemeters are constructed to operate throughout the radio spectrum, but this paper will concern itself with those having a frequency coverage of from 30 to 200 megacycles only. Ranges above this, in frequencies, are still on the "secret list" and cannot, therefore, be now discussed.

The actual building of these devices is left to skilled instrument makers, but testing, checking and calibration is the prerogative of precision radio engineers of practical ability above the ordinary. This may be best appreciated when it is stated, they are but permitted non-accuracy tolerances of very small percentages indeed.

All components are tested previous to assembly, these consisting of resistors, variable and fixed condensers, inductances and chokes. The resistors are checked on standard Wheatstone bridges and those discarded as rejects that fail to meet tolerance specifications. Tolerances are also checked by bridge with fixed condensers—capacity tolerances; then resistance and insulation tests are checked by meggers. Variable condensers are first examined for insulation, a 2,000-volt test panel being employed for this purpose and for the observance of sparking or arcs between vanes or across insulated media. They are then checked on a standard capacity bridge for minimum and maximum capacity, also for interval capacity to assure uniform variance throughout rotation. These condensers are hand-made and precision finished and are subjected to a thorough mechanical inspection before being passed as perfect. No pigtail connections are employed due to irregular movement of such leads causing small variations in capacity; electrical contact from rotor to the frame is made via bearings, these being barrel or cone type, though in some instances a strong spring contact is employed for the purpose of contact. Bearings are never oiled, the only lubrication permitted is a thin film of c.p. petrolatum. Insulation is further inspected for chipping or flaws and if present become rejects. Vanes are correctly spaced and must remain accurately so throughout the entire movement of rotation. Precision-positioning of the central spindle is regarded as important, otherwise minimum capacity is not constant, so that end play or side wobble is not tolerated. If pinned extension spindles are employed these are also similarly positioned.

The markings of the dials will be discussed later; they are fitted with a geared vernier drive having a reduction of 200 to 1. The pointer is transparent and marked with a hair-line indicator. Errors due to vernier action leaving the cursor offscale must not exceed 0.2 of a degree of calibration, this being the permissible allowance over the entire scale.

Tuning inductances are checked for flaws in the windings, incorrrect mounting and dimensional accuracy. Turn spacings must be even, the windings tight and ends securely locked. Inductance values must check against a standard inductance bridge ; then a Q-meter is employed to check for " goodness " ; chokes being similarly dealt with.

After-Assembley Checking

When assembled, these instruments are subjected to another rigid mechanical test, checked for faulty construction, misplacing of components—however slight —and all soldered joints meticulously checked for adherence of weld. All bolts and nuts are gone over and locking washers or devices scanned to see that specifications are complied with. An electrical inspection follows, the wiring being checked against diagram and colour-coding from point to point, this usually being carried forward by aid of high and low-reading ohmmeters. Then follows insulation checks at defined points and specifically between the H.T. line and the chassis—which must show at least 100 megohms. As these wavemeters are of the absorption type, they are heavily screened to eliminate external interference, everything that is possible being bonded to earth in order to minimise or eliminate stray capacities.

Taken generally, the circuit is made up from a H.F. amplifying valve feeding into a circuit of resonance—tuning circuit, with the signal being " tapped off " from the inductance to be rectified by a diode-type of valve and thence to a triode L.F. amplifying valve. An indicating meter is employed, usually a milliammeter, and this in series with either the anode or cathode leads of the L.F. valve. The triode valve and meter (often a micro-ammeter) is employed here for the reason of the set-up being robust, accurate in indication and minus damping effects upon the tuning circuit and diode.

Functional Testing

Voltage checks are now taken at various points in the circuit, as also is current, so as to assure uniformity of both instruments and production methods. Then follows a series of signal-frequency injections for checking overall frequency coverage, the test instrument used for this being a " precision calibrator," this checking a set of separated frequencies evenly segregated on the scale, say, between 20 deg. and 80 deg. markings, and as the condenser vanes are so shaped for the purpose, the resultant graph of this check is virtually linear, although before and beyond the 20 deg. and 80 deg. calibration points deviation, slightly from the linear, may be observed. Additionally, some slight adjustments may be necessary in order to assure " dead-on " calibration, but it should be obvious that at the frequencies under discussion and the types of condenser and coil employed few adjustments are available. Small trimmer condensers would be useful in this respect, but no suitable types are available of the small capacities required that will retain sufficient stability for the purpose. It thus is apparent that preliminary matching of coil and condenser, overall construction and mounting of components must be accurate to seemingly unnecessary extremes. There are, of course, wavemeters fitted with small parallel condensers in order to improve function at the higher frequency end of a coverage, but these are not regarded as trimmers.

Sensitivity is checked by injecting a series of frequencies of specified, constant voltage, and the deflection shown by the micro-ammeter must be similarly constant and uniform throughout the checking range. Frequency discrimination is also watched, a defined series of frequencies being applied and at individual tuning points the pointer of the meter must rise and fall very sharply with a minimum of movement of the tuning condenser. It is again obvious that to maintain this the inductance-to-capacity ratio must be as designed, hence Q-valve for coils used in these instruments must be very high in value. Freedom of harmonic indication is checked by turning the condenser scale through its length, and at each traverse, one of the predetermined test frequencies is injected so as to ascertain that but one deflection of the meter pointer is indicated at the exact frequency under observation. If, during this test, the indicator pointer jumps or wobbles it is assumed that a faulty H.F. connection is the cause, and due to such an effect, accuracy of tuning will be absent, so that the fault or faults must be immediately located and rectified or put right. Warming up wavemeters previous to calibration is very necessary, the time allotted for this being ascertained by observing the tuning points for the various frequencies and checking until frequency drift is absent.

Should a valve burn out when the instrument is in use the entire wavemeter becomes useless, for any valve substitute necessitates recalibration—due to no two valves having similar characteristics, or very rarely so, if drawn from stock ; thus each instrument is supplied with three complete sets of valves, one set in situ and two sets of spares, all of which have been carefully matched to 0.1 of a degree plus or minus over the entire frequency range of individual instruments.

Calibration

First the condenser tuning scale is removed and replaced with a stout or rigid metal scale. Then the tuning condenser is rotated, and the vernier drive checked at every ten scale divisions for accuracy of alignment between the scale engraving and the cursor hair-line. Any errors are noted and these added or subtracted from the actual calibration points, a permissible tolerance not being allowed to exceed plus or minus 0.2 deg. Though this operation must be performed with some exactitude, it is by no means difficult to accomplish. For frequencies up to 150 megacycles, readings are taken at each megacycle and at each half-megacycle and then recorded. From 150 to 200 megacycles, single megacycle points only are recorded. Now with an accurate set of readings available on the 0 to 100 checking dial, or available from its use, the instrument scale can be converted to a 180 deg. marking, this being accomplished by an engraving tool in the nature of a " dividing head " fitted with a very fine " cutter." The resulting series of lines are clear, defined and thin with frequency readings absolutely accurate. The new scale is then fastened into position on the wavemeter and the readings rechecked with the original in order to observe whether or not errors of calibration have been engraved during the cutting process. The cursor hair-line is also a fine cut, and this must coincide precisely with any and all calibration points on the scale. An extremely small error in frequency is tolerated, though with all-round care during this part of the process most instruments check as " dead on." Calibrating devices are laboratory instruments of absolute accuracy, mainly crystal-controlled, though some have multi-vibrator locks and even double multi-vibrators functioning with a one-megacycle lock that checks against a ten-megacycle lock. It requires about one hour of pre-warming of the circuits of such devices before they are used.

U.H.F. Wavemeters

While no actual description may be given of wavemeters designed for the very high frequency ranges, one or two points relative to the testing of them will be in order. Chiefly these are the measurement of interval coupling frequencies, a standard signal generator being used in conjunction with valve-voltmeters. Measure of frequency and voltage amplitude of multi-vibrators, carried out with signal generators and oscilloscopes. Checking of frequency discrimination with signal generators and valve-voltmeters. Checking decibel levels above and below determined frequencies. The checking of operating voltages and indicating devices and several other checking operations about which nothing can now be mentioned.

It should be rather obvious from the foregoing that even with a minor fault such instruments must be returned to the maker for servicing.

ON YOUR WAVELENGTH

By THERMION

Who *Did* Build the First Receiver?

I MENTIONED in a previous issue that my friend Hugo Gernsback, editor of a number of American technical journals, claimed that he had built the first wireless receiver capable of being marketed, and that he advertised the machine for sale in the *Scientific American* round about the year 1905.

Unless this statement is challenged Gernsback must claim the credit, but I have a notion that receivers were being built in this country long before then. Whether any of them were ever marketed I am unable to say. It would mean checking through the advertisements of technical journals between the years 1900 to 1905. I am sure, however, that the Marconi Company, who were interested in the patents, as well as some members of the Radio Society of Great Britain, could throw some light on this subject.

In the meantime, the Federal Communications Commission in recognition of the fortieth anniversary of the first home radio set, at a special meeting granted Hugo Gernsback permission to operate his 1905 receiver. He had to sell not only a receiver, but a transmitter to do the broadcasting as well. Incredible as it may now seem, both were sold for about 30s. The transmitter was a 1in. automobile spark coil, two $2\frac{1}{4}$in. brass balls acted as oscillators, and a telegraph key and three dry cells completed the transmitter. The receiver comprised a relay, a coherer, an electric bell, and a dry cell. Transmitter and receiver weighed less than a modern radio receiver. When you pressed the transmitter key the bell would ring at the receiver, which was located about a mile away. There was no voice transmission, of course. It was wireless telegraphy as distinct from telephony.

Between 1905 and 1910, many thousands of these receivers were sold. In 1905 there was no law concerning wireless, and everyone who desired could transmit. As a result there was chaos in the air, and so the genuine experimenters pressed for legislation, and the issuing of licences.

Spark transmitters have been outlawed by the F.C.C. for many years, but at the annual dinner of the Veteran Wireless Operators' Association, before its 600 guests on the Hotel Astor roof, in New York, Gernsback was permitted to demonstrate his set of ancient vintage.

In order that this transmission from a flea power transmitter could take place, the F.C.C. had to waive Section 2.77 of the regulations, so that an unlawful and outlawed transmitter could operate legally. They even assigned a special call letter to it—W2XEF. In these days of sensitive radio instruments receivers pick up the emissions of incredibly distant and weak radio stations, so I shall be glad to know whether any of my readers logged W2XEF, on the night of February 17th, 1945, as these letters were transmitted at the commencement and the ending of the programme.

Wrist-watch Radio

ACCORDING to the new president of the Radio Industries Council we may shortly have midget radio receivers which can be worn on the wrist like a watch. Tiny receivers of this sort are by no means novel. In the very earliest days of broadcasting receivers of the crystal type were built in match-boxes. The police of one section of the South Coast were equipped with receivers built into their helmets!

As the founder of the first journal to deal with amateur radio in this country—it was entitled *Amateur Wireless* and appeared as a supplement to my journal, *Everyday Science*—I have published details of midget receivers by the score, some of them quite as small as a wrist-watch. When *Amateur Wireless* (it ceased publication after I left it) appeared as a separate weekly publication, several tiny receivers were advertised in its columns.

I do not share the views expressed by the president of the R.I.C. I do not think that there is any demand for tiny receivers of this sort except as a novelty which would have a short-lived demand. The president did not say how such receivers were to be powered, and no one has yet produced midget dry cells which can give lasting service. There is no point in producing a midget receiver if you have to carry at least $\frac{1}{2}$ lb. of battery in your pocket, lashed to the receiver on your wrist by cables.

However, I should be interested to hear from readers who have produced really tiny receivers, and should welcome photographs, circuit and wiring diagrams, and constructional and operating details. Prizes will be awarded for those accepted for publication.

The End of the War

THERE seems every possibility that by the time this issue reaches the public the European war will be over. We can then look forward to the weekly publication of this journal, the dropping of controls on paper and wireless components, and the publication of our post-war designs. I am keenly anticipating meeting many of my friends whom I have not seen since the war started.

For myself, I propose to take a well-deserved holiday, having worked through the war without holidays of any sort, in order to ensure that this journal went to press. Perhaps a little later on it may be possible to organise a reunion luncheon or dinner, when we can suitably inter all thoughts of war, and recreate the interest in the freedoms for which we have fought.

Our Roll of Merit

Readers on Active Service—Fifty-fourth List

D. H. Goldsmith (Sgt., C.M.F.).
B. H. Miles (L.A.C., R.A.F., W.A.F.).
F. Devins (L.A.C., R.A.F., B.L.A.).
L. Roberts (L.A.C., R.A.F., S.A.).
F. D. Sparks (L.A.M./E., Army).
I. Trott (Pte., R.A.O.C.).
M. Brown-Greaves (Leading Radio Mech., R.N.).

THE B.B.C. CHARTER

Can't we fight to get a charter
Where the listeners have more power
To decide what "Entertainment"
Is provided hour by hour?
How delightful it would be to know
That very, very soon
We who have to pay the piper
May at last select the tune.

Now we only have one function—
To stump up our licence fee,
Then to take what's foisted on us—
Though with it we don't agree.
Alternatively we're allowed
In privacy to scoff—
To say naughty, rude and wicked words,
And switch the broadcast off.

We're tired of great didactic brains
Deciding what we need.
It's time we had more voice in this—
It really is, indeed.
We've got to find the "doings,"
So our's the right to choose.
Let listeners have the casting vote
To welcome or refuse.

"TORCH."

Television Broadcasting Practice in America—1927 to 1944

A Paper Read Before the Institution of Electrical Engineers by DONALD G. FINK

(*Continued from page 235, May issue*)

(1.3) Evolution of Programme Service

PRIOR to 1936, the American public was an incidental partner in the television enterprise. But in that year, broadcasting of programmes especially designed for public consumption began, although no regular source of receivers was available and no official sanction had been given for other than experimental transmissions. The occasion was one of considerable international competition between England and the United States. The first move came from the British Broadcasting Corporation. Plans for the opening of the London station in Alexandra Palace were announced early in 1936. This was the clue for the R.C.A.-N.B.C. transmitter to "get busy." On the 29th June, 1936, R.C.A. started a field test of its television system with 100 of its engineers in and around New York as the observers. The images were transmitted by double sideband, at 343 lines, 30 frames per sec. Film was used copiously in the early stages. But by the 6th November of that year, the New York *Times* announced "the first complete programme of entertainment over the N.B.C. system," viewed enthusiastically by the Press. Four days before, on the 2nd November, the Alexandra Palace station had begun a regular public service. The American service was not public in the same sense, and did not become so for five years. But programmes designed to entertain R.C.A. engineers were transmitted regularly from this point, and more or less regularly since.

By 1938 the R.C.A. field test had progressed to the point where its directors were ready to take a step in the direction of inviting the public to participate actively. It was announced in October, 1938, that, coincidentally with the opening of the New York World's Fair in May, 1939, regular public service would be offered.

In the meantime, vestigial-sideband transmission had been adopted as standard by the Television Committee of the Radio Manufacturers' Association and had been incorporated in the N.B.C. transmitter. The scanning pattern has been increased to 441 lines, and the effective video band to 4 to 4.5 mc/s. In February, 1940, the Federal Communications Commission adopted rules permitting "limited" commercial operation of stations.

The stage seemed set. The N.B.C. transmitter was offering 10 to 15 hours of programme a week, including elaborate dramatic presentations from the studios, regular outside rebroadcasts of sporting events of every description, educational programmes and films. But in April, 1940, the F.C.C. retracted the offer of limited commercialisation, following an announcement by R.C.A. that receivers would be offered to the public in greater volume and at reduced prices. The F.C.C. stated that this action by R.C.A. tended to freeze the then accepted standards, those formulated by the Radio Manufacturers' Association, without official sanction from the Government. This action effectively held up further progress until the standards had been studied and essentially reaffirmed by the National Television System Committee. In July, 1941, the impasse was cleared and television broadcasting for the public officially began.

From 1936 to 1941 the programme departments of the N.B.C. and C.B.S. were busy televising practically everything which reflected the necessary amount of radiant energy. The programme listings show that the following sports were offered to the viewing audience; baseball, basketball, football, hard-court and grass-court tennis, boxing and prize-fighting, horse racing, track and field events, wrestling (of the highly enter-

Fig. 17.—The N.B.C. mobile television vans. The microphone is mounted in a parabolic reflector to pick up the sound at a distance, while the camera is fitted with a telescopic lens. The transmitter van is at the rear.

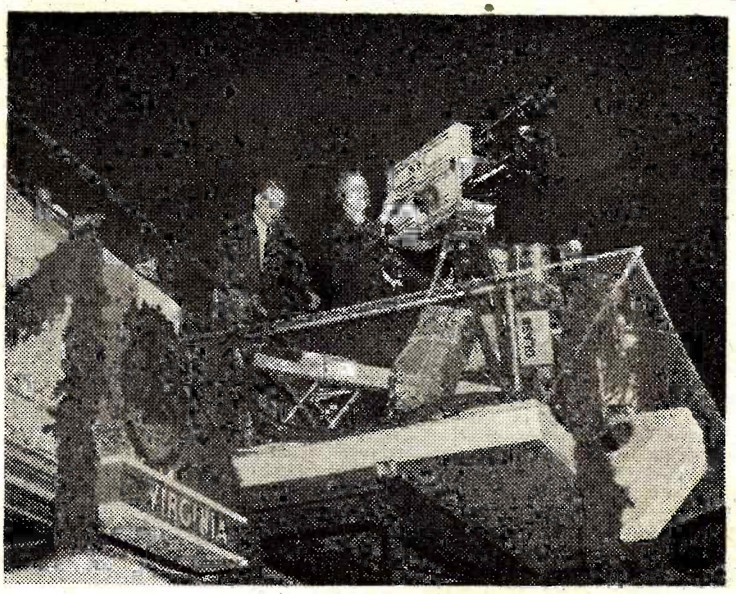


Fig. 18.—The orthicon camera in use televising the Republican National Political Convention in 1940. Note the large lenses to secure sufficient light on the long-distance shots.

taining American "professional" type), ice hockey, swimming, figure skating, bicycle racing, aeroplane racing, and rodeo contests.

In the political arena, the two major political conventions were televised in 1940, the Republican directly from Philadelphia (Fig. 18) via the coaxial cable, and the Democratic indirectly by films flown from Chicago and shown the following day. The 1944 political conventions will be televised by the second method.

From 1939 to 1942, the N.B.C. consistently polled members of its New York audience to determine the most popular type of programme material. Dramatic productions, produced in the studio, were most popular. Sports came next, followed by films. The variety show was variously received, depending on the quality of the talent.

During 1942 and 1943, consistent network linking of three stations has occurred without benefit of coaxial cable or radio repeaters. The stations involved are WNBT in New York, where the programmes originated, and WPTZ in Philadelphia and WRGB near Albany, New York, which rebroadcast them to local audiences. The air-line separations between these stations are roughly 80 and 130 miles, respectively. Despite the fact that the horizon intercepts both transmissions, regular service has been possible through the use of directive receiving arrays, mounted on the highest eminence available.

Programmes of particular interest to British viewers were broadcast in April and May, 1941, by the N.B.C. transmitter. On these occasions the programme was a transatlantic telephone conversation between British evacuee children residing in America, and their parents in England. The children were televised in the studio, and the varied expressions of delight, apprehension and nonchalance were shown to the New York audience. Fig. 6 (see April issue) is an image of one of these children, photographed from the screen of a domestic receiver in New Jersey. The happy concentration on a familiar, far-away voice is clearly evident.

More recently, in 1942 and 1943, a considerable portion of the programme activity has consisted of instruction courses for air-raid wardens and similar A.R.P. personnel (Fig. 7, see April issue). Television receivers have been distributed to precinct police stations, where they are viewed regularly by the A.R.P. workers of the local district. It has been stated that the efficiency of this method of instruction is high and the interest in it great, although it has less appeal to the general audience.

(2) PRESENT PRACTICE

Before examining the American television standards in detail, it is necessary to point out a difference between the American and British terminologies. The British terms given in B.S. 204—1943 (Section 5) agree closely with the American definitions. One difference which may lead to confusion is in the use of the term "frame frequency." The American "frame frequency" coincides with the British "picture frequency," that is, the number of complete images transmitted per second. The British "frame frequency," is equivalent to the American "field frequency," that is, the number of partial scannings per second in interlaced scanning. The term "field" relates to the alternate lines in scanning, and two fields comprise a complete picture or frame. These and other American definitions are as listed on page 180, April issue.

(2.1) The Standard Television Channel

Fig. 8 (see April issue) shows the configuration of the standard 6-mc/s channel assigned to television broadcast

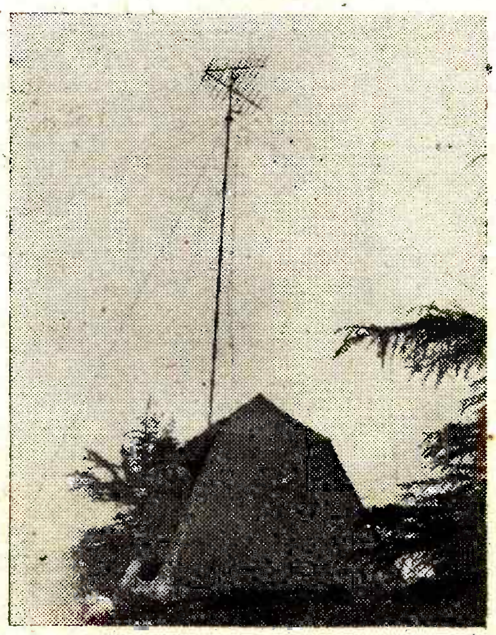


Fig. 19.—A television relay station in a tent, used by the Don Lee station in California to carry programmes back to the transmitter for rebroadcast to the public.

stations in the United States. The channel is intended for vestigial-sideband transmission. The frequency scale (abscissae) starts, at the left, at the lower frequency limit of the channel. At this point the emission is required to be substantially zero, actually no more than 0.05 per cent. of the picture-carrier amplitude. At a point 0.5 mc/s higher in frequency, the sideband emission reaches its maximum (equal to one-half the carrier amplitude). The picture carrier itself is located 1.25 mc/s above the lower channel edge, and occupies an asymmetrical position with respect to the channel limits. Thus only a portion of the low-frequency sideband is transmitted, hence the term "vestigial-sideband transmission." The higher-frequency sideband is transmitted fully over a region 4 mc/s wide, i.e., it maintains maximum amplitude to a point 5.25 mc/s above the lower channel edge. At this point the sideband energy is attenuated with increasing frequency until, at a point 5.75 mc/s above the lower channel edge, it is attenuated to 0.05 per cent. of the carrier amplitude. The carrier of the associated sound transmission is placed at this point. The remaining 0.25 mc/s of the channel is reserved as a guard band.

This arrangement of carriers and sidebands was originally devised in 1938 and has persisted substantially without change through the deliberations of the National Television System Committee and those of the more recent Radio Technical Planning Board. The vestigial-sideband principle permits a maximum unattenuated vision frequency of 4 mc/s, and permits attenuated transmission of vision signals up to a maximum of 4.5 mc/s. In comparison, the double-sideband system permits a maximum vision frequency of 2.5 mc/s. The vestigial-sideband transmission thus offers an increase in pictorial detail of 80 per cent., with substantial improvement in picture quality.

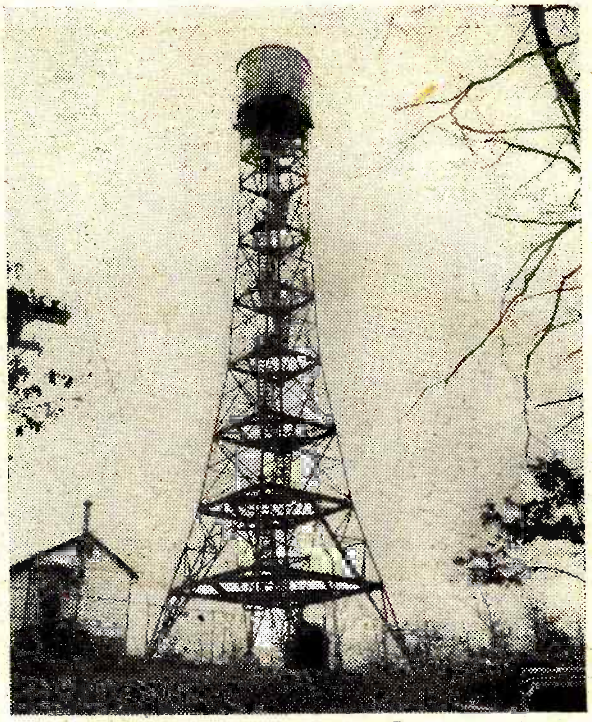


Fig. 20.—An elaborate television repeater station, constructed by R. C. A. Communications to relay programmes from Long Island to New York. The picture signal is sent by frequency modulation in this equipment.

The wide spacing between carriers (4.5 mc/s) was chosen in preference to the alternative narrow spacing (1.25 mc/s) which would be possible if the sound carrier were transferred from the right-hand edge of the diagram to the left-hand edge. In the presence of cross-modulation the wide spacing produces a high frequency beat note which is outside the limits of the vision frequency band and hence has no visible effect. The narrower spacing would produce a beat note within the vision band resulting in a visible pattern on the picture.

The vestigial-sideband system is intended to operate with a receiver whose response characteristic is that shown in Fig. 9 (see April issue). It will be noted that from 0.5 mc/s above the lower edge of the channel to a point approximately 1.5 mc/s higher, the response increases linearly with frequency. This "slope" region corresponds to the portion of the transmitter spectrum where both sidebands are transmitted. By virtue of the sloping receiver response the picture carrier is attenuated to one-half, and the sum of the two sideband voltages is constant throughout the region, and equal to the value of sideband voltage at higher frequencies outside the "slope" region. Thus the vision-frequency voltage developed at the output of the demodulator is the same for all sideband frequencies. One theoretical disadvantage of this system is the greater amount of phase distortion arising from mistuning, relative to that introduced in conventional double-sideband transmission. But in practice the effects of such additional distortion have been found to be negligibly small.

The ratio of sound-carrier power (radiated by the sound radiator) to picture-carrier power (radiated by the picture radiator) has been set within the limits 0.5 and 1.0. The tolerance has been set up to allow for inevitable variations in radiated power. The general range has been chosen to provide approximately equal areas of coverage of the sound and picture signals. The sound power is lower than the picture power because the sound transmission employs frequency modulation, with an inherent signal/noise ratio, superior to that of amplitude modulation. Account has been taken, in setting up this ratio, of the fact that interference (particularly impulsive noise) in the sound channel is usually more objectionable than interference arising from the same noise voltage in the picture channel.

The F.C.C. standards also allow the use of frequency modulation for the picture carrier, although use is not made of this type of modulation in stations currently operating. At the time the standard was written, it was not realised that frequency modulation produces very annoying image patterns in the presence of multi-path transmission (as outlined earlier), and is thus unsuitable for broadcast emissions. More recently the Television Panel of the R.T.P.B. has recommended that the standards be changed to permit only the use of amplitude modulation for picture transmissions.

(2.2) The Scanning Specifications

The standard American television picture is scanned in 525 lines from the beginning of one frame to the beginning of the next. Each frame is broken up into two fields of 262.5 lines each. The half-line portion at the end of a field causes the lines of one field to fall between the lines of the previous field (the usual odd-line interlacing sequence). Hence an odd number of lines was chosen to give this half-line relationship between fields. The value 525 consists of odd integral factors (as shown in Table 1, see April issue). This permits multivibrators or counting circuits in the synchronisation generator (used to divide from the line frequency of 15,750 c/s to the frame frequency of 30 c/s) to operate in the most stable condition.

The frame frequency (British "picture frequency") is 30 per sec. interlaced two-to-one for reasons given

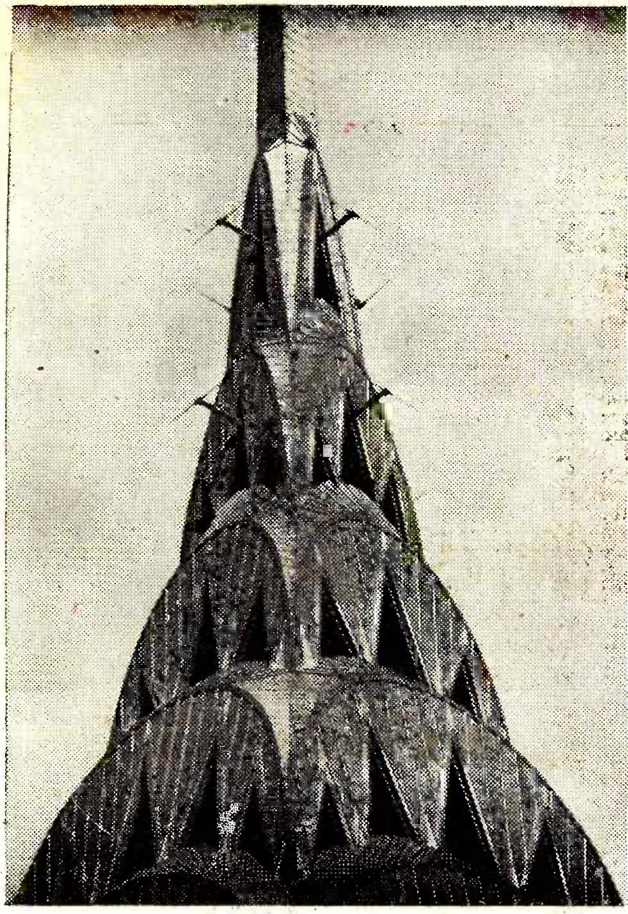


Fig. 21.—The transmitting radiators of the C.B.S. transmitter in New York, on top of the Chrysler Building (elevation 1,046 ft.).

earlier in this article. The aspect ratio of the scanning pattern (ratio of width to height) is 4/3 to agree with the ratio previously adopted as standard for motion-picture projection. The F.C.C. standards specify that the active scanning of the picture shall occur at uniform velocity from left to right horizontally and top to bottom vertically.

The choice of 525 lines was made from among several proposed values, including 441, 495 and 507 lines. Assuming 4.25 mc/s. as the maximum usable video frequency, equal vertical and horizontal resolution at 30 frames per sec. is obtained with a scanning pattern of about 500 lines, which would indicate that all the proposed values are equally suitable. The number 507 has the disadvantage of two large integral factors which require two of the frequency-dividing circuits in the synchronising signal generator to count by a factor of 13. The choice between 495 and 525 was finally made on the basis of fineness of line structure, which indicates a slight preference for the higher number of lines. The value of 441 lines was discarded as it did not make full use of the maximum available video frequency.

(2.3) The Video (Vision-Frequency) Signal

The basic form of the video signal is shown in Fig. 10 (see May issue), with a permitted alternative form of the synchronisation pulses in Fig. 11 (see May issue). Both diagrams represent the carrier envelope of the amplitude-modulated picture signal. Referring to Fig. 10 (see May issue), it will be seen that the basic level of the video signal is the so-called black level, at 75 per cent. (plus or minus 2.5 per cent.) of the maximum carrier-voltage amplitude. Negative polarity of transmission is specified, so that carrier-voltage amplitudes higher than the black level drive the signal into the intra-black region. This region is occupied by the synchronising signals. Voltage levels lower than the black level are occupied by the picture information. The maximum brightness capable of being depicted by the transmission corresponds to zero carrier, but since few transmitters can modulate to this low level it is specified that the maximum white level shall occur at a level not greater than 15 per cent. of the maximum carrier-voltage level. This assures that at least 60 per cent. of the carrier-voltage range is reserved for the contrast range of the picture.

The black level is a fixed reference level in the carrier envelope, i.e., a level which does not change with picture content. This level acts as a D.C. reference level against which the background brightness of the picture is set. This technique of D.C. transmission is now unanimously approved as providing the maximum possible carrier-amplitude range for variations in picture brightness, while at the same time offering a fixed and simply ascertained level for operating the automatic sensitivity control of the receiver.

The synchronising signals, above the black level, are of two types, the horizontal (line) pulses and the vertical (field) pulses. The line pulses are simple closely-rectangular 5-μs pulses occurring 15,750 times per sec., and occupying 25 per cent. of the maximum carrier amplitude. At the receiver these pulses may be differentiated after demodulation to provide the driving signal for the line-scanning generator.

The vertical pulses are of more complex shape. In Fig. 10 the so-called "serrated" vertical pulse is shown. It consists of six 27-μs pulses spaced 5 μs apart. This basic group in integrated in the receiver to produce the driving signal for the vertical scanning generator. The serrations between pulses are introduced to preserve the continuity of the horizontal synchronising pulses. Immediately preceding and following the serrated vertical pulse are groups of six "equalising pulses" which are half the width of the horizontal pulses and occur at intervals one-half as great. These equalising pulses are such that, when they are added to the basic vertical serrated pulse, the integrated effect is the same on each successive field. If the equalising pulses were not present, intervals of unequal length would obtain on successive fields between the last horizontal pulse and the serrated vertical pulse. Long experience with this type of synchronising signal has shown that it will provide an adequate lock of the reproduced picture if the signal strength is sufficient to provide adequate picture content. With recently developed "flywheel" scanning circuits this type of signal has been shown to be capable of holding synchronisation even when the signal level is so low that the picture is beyond recognition.

The alternative type of vertical pulse, permitted by the F.C.C. standards, is shown in Fig. 11. This pulse has been used by several transmitters, but the recently expressed opinion of the R.T.P.B. panel is that this type of pulse is not generally so satisfactory as that shown in Fig. 10, and their recommendation is that only the latter pulse be permitted in the future. Briefly, the wave form in Fig. 11 consists of a "burst" of 500-kc/s

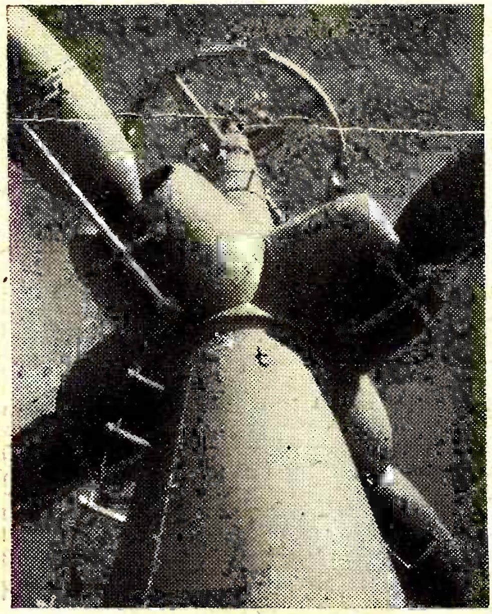


Fig. 22.—The transmitting radiators of the N.B.C. transmitter in New York, on top of the Empire State Building (elevation 1,250ft.).

sine-wave signal, lasting from six to eight lines (380 to 510 μs) and superimposed on the horizontal pulses. Limiter circuits cut off the top half sine-waves during the horizontal pulses, and the bottom half sine-waves during the intervals between horizontal pulses. The primary advantage of such a pulse is that it permits simple 500 kc/s resonant circuits to be used to distinguish between vertical and horizontal synchronising information.

Two F.C.C. standards set up tolerances on the intervals between horizontal pulses (not more than 0.5 per cent. variation from the average), and on the rate of change of the horizontal pulse frequency (not greater than 0.15 per cent. per sec.). These tolerances were intended to tighten the performance of the synchronising generators so that they would match the inertia characteristics of such mechanical methods of scanning as might be employed at the receiver.

(2.4) Sound-Signal Standards

A major difference between British and American television practice lies in the method of modulation employed for the sound transmission. The American standard specifies frequency modulation with a maximum frequency deviation, corresponding to the maximum audio level, of 75 kc/s either side of the unmodulated carrier frequency. Frequency modulation, employing a spectrum considerably wider than that required for the corresponding amplitude-modulated signal, has been shown to offer a substantially higher signal/noise ratio than that offered by amplitude modulation. This advantage obtains over all types of noise, provided only that the peak signal voltage is at least twice the peak noise voltage. Since natural atmospherics are rarely present in the v.h.f. spectrum, the principal advantage of frequency-modulated transmission is the mitigation of impulse noise such as is generated by automobile ignition systems, and noise generated in valves and circuit elements of the receiver. Tube and circuit " hiss " is important when reproduction of the full audible spectrum is contemplated, but ignition noise is important under any condition, since it usually arises from cars on a nearby highway and hence has every opportunity to maintain a r.f. voltage level comparable with that of the desired signal. The reduction of ignition noise is the principal justification for frequency-modulated transmission of the sound signal. The disadvantages are a somewhat more complex receiver, and the necessity of considerably more precise tuning to obtain maximum benefit, both relative to the corresponding amplitude-modulation system.

The maximum deviation of ± 75 kc/s was chosen to conform with the previously established standard for frequency-modulated sound broadcasting in the 44-50 mc/s band. This deviation, taken in conjunction with a maximum audio frequency of 15,000 c/s, provides a signal/noise ratio 27 db greater than that offered by an amplitude-modulated transmitter of the same peak power. This substantial improvement allows the use of less power in the frequency-modulated sound transmitter than is required in the picture transmitter.

To assist in the reproduction of the upper register of the audible spectrum, it has been customary in frequency-modulated sound transmissions to introduce audio pre-emphasis at the transmitter. The standard pre-emphasis characteristic is that of a series resistive-inductive impedance whose time-constant (resistance times inductance) is 100 μs. The converse de-emphasis is inserted in the receiver (usually by a resistive-capacitive impedance of the same time-constant). The advantage of such pre-emphasis is well understood: the sound power associated with the higher register is generally lower than that of the lower register and hence is less inefficiently transmitted with respect to the noise level. Artificial emphasis and de-emphasis thus add to the overall signal/noise ratio, by reducing the noise level in the upper register.

(To be continued.)

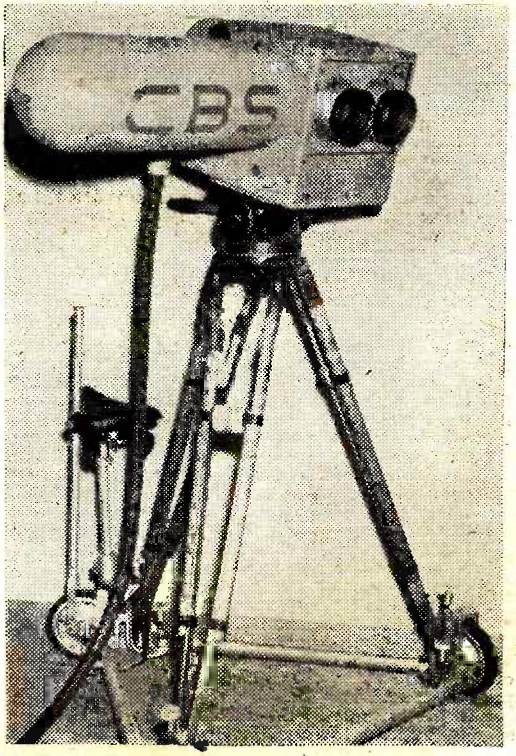


Fig. 23.—Orthicon colour-television camera developed by P. C. Goldmark, of C.N.S. The housing contains a rotating optical filter system to produce successive images in the three primary colours.

NOTES AND NEWS

First President of the Radio Industry Council

MR. ALFRED CLARK (chairman of Electric and Musical Industries, Ltd.) has been elected by the newly-established Radio Industry Council as its first president.

Mr. Clark, who has unique experience of the home entertainment industry, began his career in Edison's laboratories 50 years ago. He introduced the phonograph to Europe, and built the vast world-wide British business of "His Master's Voice." The great industrial plant at Hayes, Middlesex, which he directs, has been the leader in radio and television development, and was largely responsible for the Marconi–E.M.I. system of television adopted by the B.B.C.

Mr. Clark's election to the Presidency of the Radio Industry Council is, therefore, a logical reward for his great contribution to British industry and to British prestige.

* * *

D.C. Multi-range Test Instrument

IN the diagram on page 252 (May issue) the connection between the switch contact marked 0-1 m/A and the positive side of the meter should be omitted.

* * *

Meter Switching in Amplifiers

IN place of w. read ohms. (page 255 May issue.)

* * *

Bowen Trust—1945 Prizes

MR. W. BOWEN has presented to the Scientific Instrument Manufacturers' Association a substantial capital sum, the income of which he wishes to be devoted towards the encouragement and development of invention, design, research, processes and manufacturing technique in the scientific instrument manufacturing industry.

The Council of the S.I.M.A. have drawn up a Deed of Trust under which the income from the Trust Fund is to be devoted each year to prizes to be awarded to the employees of members submitting papers fulfilling the objects of the Trust.

For the current year the Council have decided to award five prizes to the value of £25 each for

(a) a new invention;
(b) an improvement of design;
(c) an improvement in manufacturing technique;
(d) a new development or new process arising from research.

Candidates should furnish a short description of one of the above subjects not exceeding 3,000 words with relevant sketches or diagrams.

The five prizes are offered for a paper on any one of the above subjects affecting or related to a scientific instrument covered by one of the following five sections, to each of which one prize is allocated:

Section 1.—Microscopes, binoculars and telescopes, optical elements and glass, cameras and lenses, cinema apparatus, projection and allied optical apparatus.

Section 2.—Nautical, aeronautical and survey including geophysical, meteorological and fire control (excluding optical) apparatus.

Section 3.—Industrial precision instruments.

Section 4.—Laboratory, research and medical apparatus.

Section 5.—Ophthalmic lenses.

The competition is open to every employee of members of the S.I.M.A., and any employee may compete for the prize awarded under each of the above sections.

Each paper must be the original work of the person submitting it. There is no limit to the number of papers each person may submit.

Each paper must be accompanied by a letter from the managing director of the candidate's firm confirming that it is the applicant's own work and agreeing to the paper going forward for adjudication by the judges.

Mr. Alfred Clark.

The Council will appoint a Panel of not less than two judges to adjudicate the papers. The Council reserve the right to withhold a prize where, in their opinion, the standard of work is not of sufficient merit. In cases of exceptional merit, the Council have power to increase the amount of the prize or prizes.

The decision of the Council in regard to the awarding of prizes shall be binding and final.

All papers must be submitted to the Secretaries, Messrs. Binder, Hamlyn & Co., River Plate House, 12-13, South Place, London, E.C.2, by not later than December 31st, 1945. Papers cannot be accepted after that date. It is the intention of the Council to award similar prizes for future years.

Mr. W. Bowen, M.I.E.E., M.F.S., F.Ph.S., F.Inst.P., is governing director of Bowen Instrument Co., Ltd., Cables and Plastics, Ltd., and Bowen Research.

He is a prominent member of the Scientific Instrument Manufacturers' Association of Great Britain, which comprises 74 firms and employs 50,000 people, of whom about 18,000 are skilled and 25,000 semi-skilled.

The firms belonging to the association make a great variety of scientific and precision instruments, such as nautical, aeronautical and survey—geophysical and meteorological—electrical, pyrometric and physical—microscopes, telescopes and binoculars—lenses of all kinds, including ophthalmic lenses, cameras and cinema apparatus—as also industrial precision instruments and instruments for laboratory research and medical apparatus.

Mr. Bowen studied as an "electrical engineer" in college from 16 to 19 years of age and it was then that he began to realise a defect in his tuition, namely, that he could not from experience check up on the probable accuracy of his engineering calculations.

Since those days, therefore, he has advocated, as the ideal engineering course, a contemporaneous tuition in both theory and practice and, in his opinion, this is obtained in a technical college better than in a university college. He has, in fact, largely for these reasons, taught in evening classes at Cambridge and in Leeds Technical Colleges.

(*Continued on page* 299)

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In his own works (both for making electrical instruments and electric cables), Mr. Bowen awards bonuses for good suggestions of improvements in methods of design, and he feels that this creates a remarkable sense of co-operation and good feeling amongst the staff.

Mr. Bowen is shortly leaving on a twelve months' tour on behalf of a number of concerns in the Scientific Instrument Manufacturers' Association, to establish contacts in export trade for post-war. His tour will take him to such places as South Africa, India, Australia, etc.—he will, in fact, be travelling as an Ambassador of British Trade.

* * *

Mr. G. L. Marshall

ON Saturday, March 31st, Mr. George L. Marshall, Northern Ireland director of the B.B.C., completed 21 years' service, having been appointed director at the Edinburgh station on that day, 1924. The station was officially opened by the Lord Provost of Edinburgh (Sir William Sleigh) on May 1st of that year, the principal speakers being Mr. J. C. W. Reith (now Lord Reith) and the late Sir Alfred Ewing, Principal of the University of Edinburgh.

During his period as director in Edinburgh, Mr. Marshall was responsible for bringing a number of well-known personages to the microphone for the first time, as, for instance, Earl Balfour, G. K. Chesterton, Arthur Bourchier, Owen Nares, Gerald Amos, Henry Ainley, Robert Donat, Professor Charles Sarolea, Professor Donald F. Tovey, Sir Herbert Grierson, Miss Horniman, Davy Burnaby and the Co-optimists, and Monsignor R. A. Knox. The last-named will always be associated with the early days of broadcasting because of the "spoof" News Bulletin about a Communist rising in London which Mr. Marshall invited him to give from the Edinburgh station in January, 1926. This caused a national—if not a world-wide—sensation, and gave the Press something to write about for several days and the public a scare from which it took some time to recover. The talk, in fact, demonstrated more than anything previously broadcast the widespread influence of this new form of communication. While in Edinburgh Mr. Marshall was also responsible for the first broadcast of a cabaret performance from a night club, a pantomime from the stage of a theatre, a fire brigade turn-out and other features which are now familiar.

Early in 1926 Mr. Marshall was transferred to Glasgow as director, and there he helped, among other things, to develop the musical resources of the area by arranging a series of public orchestral concerts at which many of the most eminent artists of the day appeared. These were conducted not only by the musical director, Mr. Herbert A. Carruthers, but also by such distinguished visiting conductors as Percy Pitt, Gustav Holst and Sir George Henschel. At these concerts many important new works, both choral and orchestral, were broadcast for the first time. Mr. Marshall also started an important series of broadcasts dealing with the principal industries centred on Clydeside and district.

In 1927 Mr. Marshall was appointed director of the Newcastle-on-Tyne station and there did much to reflect in the broadcast programmes the rich historic background of that portion of England. He was connected with numerous charities of the North-east coast and was chairman of the Lord Mayor's Holiday Camp Fund, which, during his régime, sent over 15,000 poor children from Newcastle for a holiday at the seaside. At that time Newcastle was fortunate in having for its Lord Mayor on two occasions the able and energetic Sir Arthur Lambert, who was responsible for organising the North-east Coast Exhibition in 1929, many features of which were conveyed to listeners through the medium of broadcasting. Sir Arthur's enthusiasm for broadcasting was infectious and the following statement from his book "Northumbria's Spacious Year" is characteristic: "I can state with the utmost gratitude and appreciation that during my two years of office as Lord Mayor of the city I found the broadcasting station of inestimable value in various directions."

In 1932 Mr. Marshall was transferred to Belfast as station director and, after the formation of the Regional scheme, became regional director of Northern Ireland. His arrival coincided with the opening of Stormont by H.R.H. the Prince of Wales, who broadcast a special message to the people of Ulster at the conclusion of his visit. The principal development in the Northern Ireland Region since that time was the erection in March, 1936, of the high-power transmitting station officially opened and named "Lisnagarvey" by His Grace the Governor, which resulted in a greatly improved service for Ulster listeners. Since then a new headquarters, in which are housed the offices and studios, has been built in Belfast which may justly be called one of the chief architectural features of the city. Mr. Marshall and his staff—greatly depleted since the outbreak of war—took over the building on May 5th, 1941, the day following the second severe enemy air attack on the city.

Mr. Marshall, in his 21 years' service, may be called one of the pioneers of broadcasting, for he has seen its development from the early days when there was only a handful of listeners up to the present time with about nine and a half million licence holders. He has seen the old Broadcasting Company—an organisation of wireless manufacturers and traders—pass to the Broadcasting Corporation under Royal Charter, the passing of the old system of "stations," the institution of the regional scheme, the advent of television and many less spectacular developments—in fact, the passing of what was sometimes called a novelty and even a luxury into an indispensable public service.

Mr. Marshall was awarded the O.B.E. in 1938.

* * *

Oliver Lodge Scholarship

IN order to commemorate the 25th jubilee of the Radio Section of the Institution of Electrical Engineers, the Council of the Institution have founded a Research Scholarship which is to be called the "Oliver Lodge Scholarship."

The scholarship will have a basic annual value of £250 and will be tenable for one year, but may be extended for a second year. The council wish to encourage scholars to travel and, after approval of a candidate's programme, may make an additional grant for this purpose. The scholar will be required to carry out research in a subject closely allied to radio engineering.

Further particulars and nomination forms may be obtained from the Secretary, the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. The closing date for receiving nominations is May 15th, 1945.

HOLIDAYS AWAY FROM HOME

Editor's Advice

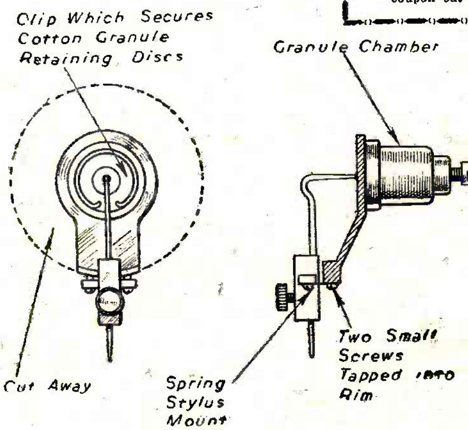
OWING to paper restrictions you would be well advised to ask your newsagent to reserve your copy of PRACTICAL WIRELESS *until you return, if you are going away for your holidays. Otherwise your copy may be allocated to the person whose name is next on the newsagent's waiting list, and this will undoubtedly lead to difficulties on your return.*

Should you so desire your newsagent would probably agree to post copies to your holiday address if you pay postage. In any case please help by letting him know in advance what you wish him to do, as it will not be possible to increase supplies to holiday resorts.

Practical Hints

Improvised Pick-up

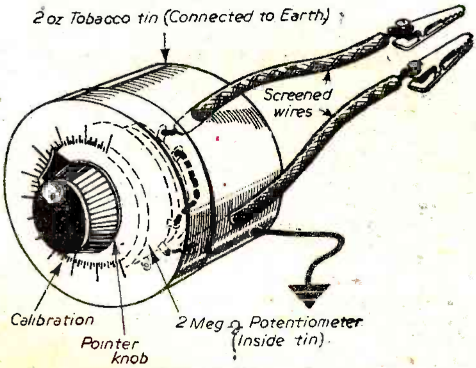
"EXPERIMENTALIST'S" article on improvised pick-ups in the March issue prompts me to describe a similar article which I constructed some time ago, but which used a different principle. I found that using an earphone as a pick-up head was prone to cause record wear through sheer weight and therefore I utilised a cheap carbon "mike" button, as described below. I cut away all but a small portion of the diaphragm holder (see sketch), removed the diaphragm itself, and fixed the stylus to the piston, in the granule chamber. This head was used on an aluminium arm, the complete assembly being very light. A transformer (to be found in the base of these microphones which are sold at about 6s. 6d. each) and battery are, of course, necessary. Background hiss was very slight indeed, and quite unnoticeable while playing.—D. C. SWAINE (Tenterden).



Details of an improvised pick-up.

Finding Resistance Values

WHEN experimenting with various values of resistance for grid leaks, grid stoppers, etc., I find the piece of apparatus shown in the accompanying sketch extremely useful. It consists of a 2 megohm potentiometer, an on/off switch wired in series as a cutting out switch and variable resistance, and enclosed (for screening purposes) in a 2 oz. tobacco tin, being fixed on to the lid by the usual one-hole fixing method. A scale is also fixed on to the lid, and the resistance calibrated by means of a bridge such as that described in the January, 1944, issue of P.W. The tin and screened leads are earthed and the two crocodile clips connected to the circuit in the appropriate place. By means of this apparatus a suitable value for the required resistance can be found by merely rotating the knob, instead of the usual process of soldering and unsoldering resistance after resistance. The correct value having been found, a resistance of the value indicated is soldered permanently in place in the circuit.—T. B. WEARDEN (Wilmslow).

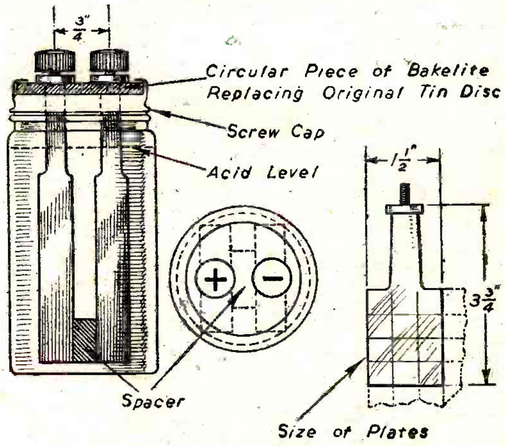


A handy unit for checking resistance values.

A Miniature Accumulator

THE following method of making a small accumulator may be of interest to other readers.

Having completed a portable short-wave set, I found that I had inadvertently not left sufficient room in the battery compartment to hold the accumulator. This is how I got over my difficulty.



Details of a small accumulator.

I found a small size Heinz sandwich-spread jar, which fortunately was the exact size of the space in the compartment; I removed the loose piece of tin from the lid and substituted a piece of circular bakelite. The plates were cut from an old pair of plates which I had. The accompanying sketch clearly shows the arrangement.

The total current taken by the set was .6 amps., and at this rate the accumulator lasted for seven continuous hours. The accumulator is charged at a steady ½ ampere, and runs the set very successfully.—J. L. HOOPER (Birmingham).

Impressions on the Wax

Review of the Latest Gramophone Records

H.M.V.

TWO records which I strongly recommend to those who are inclined to register expressions of dislike or boredom when works of the great composers are mentioned are *H.M.V. DB*6204-5. On these, the London Philharmonic Orchestra, conducted by Sir Thomas Beecham, have made a superb recording of "Serenade Eine Kleine Nachtmusic, K.525," by Mozart.

The composition is for two violins, viola, violoncello and bass, and its structure is such that it cannot truly be classified as chamber or orchestral music, but rather a delightful piece for string orchestra which places it mid-way between the two. It is for this reason, and, of course, the very composition of the work, which made me write the opening sentence of this review, as one need not be "highbrow" to appreciate to the full the great beauty of this work by Mozart. A striking little fanfare opens the first movement, and then follows a melody of contrasting structure varying between delicate shades and bold passages as it alternates between development and recapitulation. The second movement, Romanze (Andante) is rather surprising. Its gentle melodious pattern is suddenly broken by the introduction of defiant passages from the bass, but this gives way to a soothing repeat of the opening sections. The Minuetto and Trio (3rd Movement) has a slight martial opening, but its trio is delightful, and to many will appeal as the most captivating tune in the whole work. The 4th Movement (Rondo) is gay and tuneful.

The performance of the orchestra, and the interpretation by Sir Thomas Beecham, are distinctly outstanding.

When Wagner was 25 years old, he wrote "Rienzi" Overture, a work based on the novel of the same name by Bulwer Lytton. Those who have read this will remember that it deals with the last of the Roman tribunes, and it is, therefore, not surprising that Wagner's composition is impressive, even if it lacks the perfect craftsmanship of his works that followed. The Overture opens with a prolonged note on the trumpet, and then follows the quiet and solemn "Rienzi's Prayer for the People." This, with extracts from the opera, are gradually developed until the Battle Hymn forms a climax possessing great grandeur. On the fourth side of the two records, the same orchestra, namely, the Halle, conducted by John Barbirolli, have recorded that delightful fairy-like Scherzo, "A Midsummer Night's Dream," by Mendelssohn. The records are *H.M.V. C*.3425-6.

Heddle Nash—tenor—accompanied by Gerald Moore at the piano, has recorded two attractive settings of poems by Shakespeare and Constable, on one side of *H.M.V. B*9412. On the other side of this record he sings one of the few great modern art songs, the Ständchen (Serenade), Op. 17, No. 2, by Richard Strauss. The first of the poems is "Diaphenia" (Constable), and the second "The Sweet of the Year" (Shakespeare), and they form, with the Serenade, delightful material for an artist such as Heddle Nash.

"Hutch" enthusiasts will welcome his latest record, for which he has selected two film features, "I'll Remember You" (Ride 'Em, Cowboy), and "More and More" from "Can't Help Singing." These two numbers are recorded on *H.M.V. BD*1101.

Joe Loss and his Orchestra offer Nos. 15 and 16 of The Mood for Dancing Series, and these consist of "Barrel House Boogie" and "My Guy's Come Back," two lively numbers of which Joe makes the most. These are on *H.M.V. BD*5875.

Jack Payne and his Orchestra have recorded two fine slow foxtrots which I recommend to dancing enthusiasts. They are on *H.M.V. BD*5879, and their titles are "The Little Things That Mean So Much" and "The Sun Never Sets On My Dreams."

Columbia

PIANOFORTE compositions are not always improved by embellishments, but one outstanding exception is the Concert Transcription of Strauss's famous "Blue Danube," by A. Schultz-Elver. It is played, on *Columbia DX*1184, by Louis Kentner, and his performance forms a dazzling display of trills, scales and octave passages, that one can hardly credit that it is a solo performance. I can only say that it is amazing.

"The Waltz" and "Prelude" from Noel Coward's film "Blithe Spirit" have been recorded on *Columbia DX*1186 by the London Symphony Orchestra, under the conductorship of Muir Mathieson. Both compositions are by R. Addinsell, and the music is, as one would expect, blithe, gay and very enjoyable.

Harry Davidson and his Orchestra have just recorded Nos. 8 and 9 of the Old Time Dance Series, and for these they play, in their usual pleasing style, "Waltz Hesitation" (Mighty Lak' a Rose) and "Military Two Step" (Uncle Sammy). These are on *Columbia DX*1185.

"A Song to Remember" (Selection) is the title of the latest recording by Rawicz and Landauer, and also of the film dealing with the romantic side of Chopin's life. The selection recorded introduces "Polonaise in A Flat," "Fantaisie Impromptu in C Sharp Minor," "Waltz in A Flat," "Scherzo in B Flat Minor," "Study in A Flat," and "Study in E." It is a brilliant selection. The number is *Columbia DB*2166.

Albert Sandler and his Palm Court Orchestra offer two fine numbers, both in waltz time, on *Columbia DB*2165. They are "Destiny Waltz" and "Roses of the South" (J. Strauss).

A very fine vocal will be found on *Columbia DB*2167. It is recorded by that noted and talented New Zealand bass singer Oscar Natzke, now a lieutenant in the Royal Canadian Navy. Since 1936-8, when he appeared at Covent Garden while still a student, his career has been one of progressive successes, and this recent recording will give many an opportunity of hearing his remarkable voice. He sings for us "Shenandoah" and "Blow The Man Down"; and "Hullabaloo Balay," with chorus and orchestra under the conductorship of Eric Wild.

Paula Green and her Orchestra have recorded "I'm Gonna Love That Guy" and "Till All Our Prayers Are Answered" on *Columbia FB*3099. Victor Silvester and his Ballroom Orchestra play "Dancing With You," a waltz, and "More and More," a quickstep, on *Columbia FB*3101.

Turner Layton—at the piano—sings "There Goes That Song Again" and "Together," on *Columbia FB* 3100, in his usual pleasing manner.

Parlophone

GERALDO and his Orchestra, with Len Camber and the Top Hatters as vocalists, offer "Come With Me, Honey" and "Sweet Dreams, Sweetheart," both foxtrots and both enjoyable. *Parlophone F*2065.

Joe Daniels and his Hotshots in "Drumnastics" present, on *Parlophone F*2066, "If I Had You," slow foxtrot, and "Bei Mir Bist Schoen," a quickstep. In the 1945 Super Rhythm-style Series, Nos. 17 and 18 are on *Parlophone R*2967, the numbers being "Royal Flush" (Basie) and "I Got Rhythm" (I. & G. Gershwin). Both of these are played by Metronome All Star Leaders, a distinctly "hot" combination.

Regal

THE Regal choice this month is *MR*3752, on which Reginald Dixon has recorded a fine selection from "Fledermaus," by Joh. Strauss. This is a good arrangement and Reginald gives a first-class performance.

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).

AC/DC Midget Results

SIR,—I have just finished building the AC/DC midget receiver which was described in PRACTICAL WIRELESS, January, 1943, and I thought other readers might like to know the results.

The results are good and the set is very powerful combined with perfect tone. In the evenings I can log several British stations, including the A.E.F. station on 514 metres as well as several Continental stations at very good strength.

I am using a 5in. Rola P.M. speaker together with a small choke for smoothing; I am also using a pair of commercial TRF coils which are very efficient and smaller than those specified. The valves I am using are VP13c, 13SPA, Pen36c and a URIC rectifier.

I have also incorporated a small slow-motion dial of my own design with station names. I could not get aluminium for the chassis so I made it of 18 s.w.g. sheet iron, which is equally as efficient as aluminium but harder to work.

I am using an indoor aerial 40ft. long and I find an earth makes little difference to signal strength.

All I have to do now is to make the cabinet, and I will use ⅜in. plywood and when finished I will cover it with black rexine and provide it with a folding handle on the top to make it easily transportable from room to room. I might add that I am using the set on 210 volts D.C. —N. RICHARDSON (Peterborough).

P.S.—The reason I have only just built this set is because I was in the Forces until late 1944, when I was discharged as medically unfit.—N. R.

Emergency Receiver

SIR,—I have read with interest the article in the May issue of PRACTICAL WIRELESS describing the construction of the "Three Valve Emergency Receiver"; incidentally, this is one of the best constructional articles I have seen for a very long time and is so lucid that even the veriest novice should have no difficulty constructing the set. I particularly liked the paragraph dealing with circuit refinements.

Results were very good; at the moment the set is partially dismantled as I have been using some of the components for other experiments with a "Hartley" circuit.

However, I intend immediately to rebuild the "Battery Three" incorporating an L.F. transformer and other refinements described in the article.

I have recently been dealing with a number of firms who advertise regularly in "P.W." and have obtained some really useful components, among them a two-gang .0005 mfd. tuning condenser. I built the original set described in "P.W.," Jan., 1943, with two separate .0005 mfd. condensers.

May I express the hope that further constructional articles of this kind will be published in the near future. I much prefer to construct a receiver such as you have described in preference to buying a commercial article. —A. S. MORRIS (Smethwick).

Converting Battery Sets

SIR,—I have read with interest the letter by Mr J. M. T. Wood, of Enfield, and the subsequent discussion, but there is one thing that puzzles me. It is: How did Mr. Wood eliminate mains hum? If 2-volt battery valves are heated with 50 cycle A.C. there will be an unbearable (to me) hum due to the fact that the cathode will be constantly varying in voltage with reference to the H.T+ by 4 volts (twice the L.T. voltage) also partly due to the lighter construction of the filament. An A.C. valve has a comparatively massive cathode to act as a "reservoir" of heat and thus smooth out the variegation in emission which would otherwise take place.—V. WILSON (Leicester).

Absence of L.T.

SIR,—Surely S. B. (St. Albans) does not really believe that the absence of L.T. on the filament whilst the H.T. is connected will damage the valve? It is only when the L.T. is left connected and H.T. is absent that any damage will result.—F. BROOK (Maidstone).

Service Engineers

SIR,—It appears to me that Mr. Levy has confused the real issue raised by Mr. Firth (December issue), whose assertions and quotations regarding pre-war rates of pay and conditions are only too true. Surely, has not all the current controversy *re* "service engineers" (radio) had the ultimate aim of raising the "status," at the same time raising the pay to a level compatible with the high technical knowledge and skill required? Now, when Mr. Levy leaves the Forces, would he be eager to accept a post of factory radio service engineer at 1s. 6d. per hour for the amount of "trouble shooting" he is required to do, also the rate of same being governed, in the main, by mass-production requirements? It is entirely irrelevant as to how Mr. Firth would fare in Burma under conditions outlined by Mr. Levy, but it is relevant as to how Mr. Levy would fare under factory mass-production servicing requirements.

Nobody doubts the fine achievements by the "Signals" in the Forces, "because the message must get through"; but there is somewhat a difference between the bare "Signal" getting there under "field conditions" to be readable and the "highly amplified L.F. band-passed," "tone corrected," "contrast-expanded," etc., etc., etc. "signal" coming through on a high fidelity broadcast receiver tuned, say, to a Philharmonic concert.

To sum up, then, the requirements of the two cases are widely dissimilar, and no true comparison can be drawn, except to say that when peace comes the type of "signal" that will be required to be serviced will be that coming under the second category mentioned.

Consequently, Mr. Firth is undoubtedly entitled to raise doubts in the direction he has without belittling at all the fine achievements of Forces service men. I would mention that throughout the letter, in referring to Forces service men I am citing those men who have had no "civilian" experience at all, but who have been trained in, and whose experience has been entirely confined to, Forces personnel and equipment. To the thousands of Forces radio service men who were radio service men in civilian life, of course, the remarks in this letter do not apply, except as to improvement in "status" and rates of pay.—R. SKELTON (London, E.11).

2-valve All-dry Receiver

SIR,—With reference to Mr. Wells's letter in your April issue on the subject of my article, "A Two-valve All-dry Receiver," I must point out that the receiver worked quite well when constructed exactly as described. Possibly there may be some confusion due to the numbering of the grids of the 1A7 valve, which are as follows, starting from the grid nearest the filament:

G1—Oscillator grid.
G2—Oscillator-anode grid.
G3 and G5—Screen grids, internally connected.
G4—Control or injector grid (top cap).

The idea, as described in the article, was to use the

(Continued on page 304)

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350-0-350; 150 ma.; L.T.s, 6.3 v. 5 a.; 4 v. 4 a.; Rec. 5 v. 2 a.; 4 v. 2½ a.; can be used with International or English valves. Colour coded. Mains Input tapped 200/220/240 A.C. 50/-, post 1/1. 400-0-400; 120 ma.; L.T.S. 4 v. 2½ a.; 4 v. 4 a.; 4 v. 2 a.; 4 v. 2 a.; long Colour Coded Leads, with high insulation. (200/220/240) Mains Input Tappings. 45/-, post 1/-. 350-0-350, 80 ma.; 4 v. 4 a.; 4 v. 2 a.; A.C. Mains Input 230, 30/-, post 8d. 300-0-300; 80 ma.; 4 v. 4 a.; 4 v. 2 a. A.C. Mains Input 230, 30/-, post 8d.
350-0-350, Chassis Mounting, Shrouded, 4 v. 4 a.; 4 v. 2 a; Input 200/220/240. 35/-, post 9d. 300-0-300, 75 ma., Chassis Mounting, Shrouded, 4 v. 4 a.; 4 v. 2 a.; Input 200/230/250. 37/6, Mains Transformers, wound to specification.

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oscillator section of the valve as a triode detector, and apply the detected signal to the usual control grid G4, so that the rest of the valve functioned as a pentode amplifier. The value of the resistor R2 is quite critical, and should be adhered to. Lack of signals may be the result of an incorrect value for this resistor. If the wiring is connected as shown on the diagram, with the oscillator grid and top-cap connected by a 100,000 ohms resistor, I see no reason why the circuit should not work in a satisfactory manner. I cannot comment on the modified wiring proposed, connecting G1 to G5 by a 100,000 ohms resistor, as I have not tried out this arrangement myself.—G. ELLIOTT (Gosport).

Reception on the Lower Bands

SIR,—I should be glad if any of your readers could explain the following mystery:

Before the war there used to be several American stations in the 13, 11, 9 m. bands, and below. Those in the 13 m. band were intended for long-distance reception, whereas those in the lower bands relayed medium- and long-wave stations for local reception. All these were frequently heard over here at good strength, and were reported in PRACTICAL WIRELESS.

Nowadays, however, not a thing can be heard in the lower bands, and in the 13 m. band only GSH (13.97 m.), Algiers and Moscow are audible, the latter two being, presumably, harmonics. Why?

Some of the more interesting stations I have heard are:

KGEI, San Francisco (15.34 mc/s, 19.56 m.), directed to South America. A poor signal, fluttering considerably. Also used is KNBX, possibly on 21.765 mc/s. which I have not heard. A programme summary is given at 11.10 p.m. D.B.S.T., in which reference is made to stations KWID, KNBO, and others. HCJB Quito (Ecuador), heard on 19.8, 24.09, 30.1 m., although it claims to operate in the 19, 24 and 31 m. bands. MTCY, Hsingking (Manchuria), on 19.58 m., not heard since last September. Information wanted about its transmissions.

All-India radio on 19.54, 19.62, 25.27, 25.36, 25.45, 31.28, 31.36, 41.15, 41.24, 48.47, 60.48 m. New service in English from Paris on 463 m. from 7.30 p.m. daily to 9 p.m. Also transmitted from 8 to 9 p.m. on 31.58 and 31.98 m.

South America, at excellent strength on 60–64 m. and 75 m. after midnight. All announcements in Spanish. PZC, Paramaribo (Dutch Guiana), on 19.4 m. PRE, Fortaleza, 19.78 m., good signal. Emisora Sociale, Rio de Janeiro, 31.2 m. (could this be PRF5, 31.25 m. ?). LRA and LRI, Radio Belgrano, Buenos Aires, on 31.06 m. around 10.30 p.m. D.B.S.T.

Lahti, Finland, broadcasts daily to America at 2.15 p.m. D.B.S.T. from stations OFD, 31.58 m.; OIE, 25.47 m.; OIX4, 19.75 m. VONH, St. John's (Newfoundland), works on 50.25 m. Also used is VONF. What is its wavelength?—A. H. B. BOWER (Hull).

Short-wave Stations

SIR,—There would appear to be a general lack of accurate data on a number of broadcasting stations at present operating and also on wireless telegraphy stations. The information given below may be of interest to your readers.

The station variously reported as Radio "Jakarta," "Jojakarta," etc., is, we believe, the old PMC transmitter operating on 18,135 kc/s, i.e., 16.54 m. It is located at Bandoeng.

Radio Shonan, Singapore, operates on 9,555 kc/s and 11,850 kc/s.

APH, Italy, Rome, uses calls ICF and ICD. ICF is using the old IQA2 channel on 14,736 kc/s, ICF2 is on 11,695 kc/s, ICF3 on 5,905 kc/s, and ICF4 seems to be using the old ICB channel on 12,025 kc/s. ICD on 13,102 kc/s may be the old IRJ transmitter.

AFHQ Algiers uses THA5 on 16,025 kc/s when calling Press in New York and London appears to use JDJD for photo transmissions. Algiers is also to be heard via: THD, 15,820 kc/s; THC, 14,895 kc/s; THC2, 10,195 kc/s; THC3, 5,315 kc/s; THA, 12,120 kc/s; THA2, 8,960 kc/s; THA4, 5,115 kc/s; THB, 19,890 kc/s; THB2, 13,055 kc/s; THB3, 7,688 kc/s; THB4, 14,285 kc/s.

GBB2 Rugby is on 13,590 kc/s, and is used to contact the Middle East area. The transmitter near 43.5 m. is probably GDS on 6,905 kc/s.

WBC and WCP are two Press wireless stations, the former on 15,825 kc/s and the latter on 15,565 kc/s.

Amongst the Swedish stations now well heard on telegraphy are: SDL, 5,845 kc/s; SDL2, 8,177.5 kc/s; SDL3, 9,210 kc/s; SDL4, 12,212.5 kc/s; SDL5, 13,577.5 kc/s; SDL6, 14,645 kc/s; SDO, 3,700 kc/s; SDO2, 4,295 kc/s; SDO3, 4,575 kc/s; SDO4, 5,225 kc/s; SDO5, 5,780 kc/s; SDO6, 7,682.5 kc/s; SDO7, 7,920 kc/s; SDO8, 9,302.5 kc/s; SDM, 5,714 kc/s; SDM2, 6,747.5 kc/s; SDM3, 7,422.5 kc/s; SDM4, 9,397 kc/s; SDM5, 10,857.5 kc/s; SDM6, 12,028 kc/s.

Recent reception tests have shown that ZHV2, Freetown, on 12,915 kc/s, is a strong reliable signal and excellent reception has been had from ZB13, 9,805 kc/s, and ZB14, 10,135 kc/s, on Ascension Island. Other strong telegraphy signals at the moment are: VLN9 Sydney, on 10,420 kc/s; VWF8 Bombay, on 17,320 kc/s; PSP Rio de Janeiro, on 10,330 kc/s; CWG Cerritos, Uraguay, on 11,365 kc/s; FZF2 Martinique, on 8,185 kc/s, and KPV Palo Alto, California, on 14,755 kc/s.—JEFFERY E. TOMLINSON (Manchester).

Stations Logged

SIR,—I give here a log of my recent receptions on the s.w. band of a commercial superhet (H.M.V.). On very weak signals I use 'phones connected via a "mike", transformer across the Ext. L.S. sockets. I have not yet been able to construct a s.w. D.X. set, but I hope to do so soon. WCRC, WCBX, WCBN, 23, 21, 16 m.b's (U.S.A.); JJKR (A.F.H.Q.), 23.3 m. (Italy); VL4G, 31.32, 31.2 m. (Australia); Shonan, 31 m. (Japan). This last station is used for pro-Japanese propaganda. In "Practical Hints" of "P.W.," January, 1944, a cycle dynamo is used as a motor by current supplied by a bell transformer. I have tried this scheme out and find that the dynamo pulley wheel merely "judders" and shows no tendency whatever to rotate. For any information on this I should be grateful. Thermion's remarks regarding Bing Crosby I very much appreciate. —K. PAINTER (Staffs).

"Refresher Course in Mathematics"

SIR,—I feel I should be lacking if I did not take this opportunity of expressing appreciation for your most useful publication, F. J. Camm's "Refresher Course in Maths." Never had this subject attracted me until this book made the whole thing child's play!

Many wonderful and startling advances have been made in the art of wireless communication since I made my first loose-couplet inductance and silicon detector and wound my own earphone (one!) in 1913, and I am sure the innovations yet to come will be lucidly and comprehensively explained by the foremost wireless publication of all—PRACTICAL WIRELESS. Good luck to you.—E. A. PORTER (Leicester).

Half-wave Dipoles

SIR,—After reading the article on "Half-wave Dipole Aerials" in February's PRACTICAL WIRELESS, I feel that for people with little knowledge of the subject, for whom the article is presumably intended, it contains much that is badly expressed.

For instance, it is only possible to tell by inference that the dipole in Fig. 1 is horizontal. The Fig. 8 polar diagram mentioned is thus the horizontal polar diagram, while that worked out by analysis is the vertical one. A clearer distinction throughout between horizontal and vertical polar diagrams would have made the article much more lucid. Similarly, for the benefit of the uninitiated it might have been pointed out that Figs. 3 and 4 are cartesian and polar diagrams, both representing the same thing.

In the paragraph on phase displacement the second sentence is a bad example of loose thinking. Under no circumstances can the distance AA be expressed as $\frac{2h}{\lambda}$, since this is merely a number. Presumably the author intends to express the distance 2h as some multiple of λ, in which case it becomes $\left(\frac{2h}{\lambda}\right).\ \lambda$, or nλ where $n=\frac{2h}{\lambda}$. Phase displacement, A, B, or more correctly, path difference, should either be left as 2h sin θ, or if preferred $\left(\frac{2h}{\lambda}\right).\ \lambda \sin\theta$, though this seems an unnecessary complication at this stage of the argument.

This expression for path difference is certainly not ϕ as stated; ϕ has already been defined as an angle, so that obviously it cannot be equated to a length. To determine ϕ in radians we must multiply the path difference by $\frac{2\pi}{\lambda}$.

We then have:

$\phi=\frac{2\pi}{\lambda}\cdot 2h \sin\theta+\pi$ (allowing for phase change on reflection)

$$=\frac{4\pi h}{\lambda}.\sin\theta+\pi.$$

This differs from the result obtained by the author by the factor π in the first half of the expression, but this may be a printer's error, as it is included in the expression for R in the penultimate line of P. 124 (L.H.S.).

In the vector diagram for determining R, F and Fr are shown as equal in amplitude, i.e., it is assumed that there is no loss on reflection. It is also assumed throughout that the earth acts as a plane reflector. Whether or not these assumptions are justified depends to a great extent on local conditions, but it is necessary in many cases to go to extreme lengths before such perfect reflection is achieved in practice, e.g., the erection of a horizontal, perfectly flat wire net over a considerable area surrounding the dipole.

Further mathematical errors which occur are:

(1) Last line, L.H.S., p. 124, should be

$$2F\cos\left(2\pi\frac{h}{\lambda}\sin\theta+\frac{\pi}{2}\right)$$

the brackets having been omitted.

(2) Similarly, first line R.H.S., p. 124, should be $\cos(\theta+90°) = -\sin\theta$ (it is rather unfortunate that θ should have been used generally here, when it has already been used for the reflected angle).

(3) Following from (2), the next line should be

$$R=-2F\sin\left(2\frac{\pi h}{\lambda}\sin\theta\right)$$

instead of $R=-2F\sin\left(2\pi\frac{h}{\lambda}\sin\theta+\frac{\pi}{2}\right)$

(4) The last column of the table at the end of the article is headed—

$$R=-2F\sin\left(\frac{\pi}{2}\sin\theta\right)$$

The values given for this column are however for $\sin\left(\frac{\pi}{2}\sin\theta\right)$, and in order to obtain R each figure must be multiplied by −2F. It then becomes apparent that the maximum value of R is twice either the direct or reflected signal considered separately—a result one would expect.

From the expression

$$R=-2F\sin\left(\frac{2\pi h}{\lambda}\sin\theta\right)$$

a rather interesting result can be derived, namely that for every $\frac{\lambda}{2}$ in the height h there is one lobe in the vertical polar diagram from 0° to 90°, e.g., half a lobe in the case of $h=\frac{\lambda}{4}$ as shown in the article.

Take the case when h=λ.

$R=-2F\sin(2\pi\sin\theta)$.

For R=0, $\sin(2\pi\sin\theta)=0$.

i.e., $2\pi\sin\theta=0, \pi, 2\pi, 3\pi$, etc.

and $\sin\theta=0, \frac{1}{2}, 1$ (larger values impossible).,

$\therefore \theta=0, 30°, 90°$.

For R max, $\sin(2\pi\sin\theta)=\pm1$, i.e., $2\pi\sin\theta=\frac{\pi}{2},\frac{3\pi}{2},\frac{5\pi}{2}$, etc.

$\sin\theta=\frac{1}{4},\frac{3}{4}$ (larger values impossible),

$\theta=\sin^{-1}\frac{1}{4}, \sin^{-1}\frac{3}{4}$.

Thus between θ=0 and θ=90° there are 3 points of minimum pick-up or radiation, and 2 points of maximum pick-up, or in other words two lobes.

Similar reasoning for $h=\frac{3\lambda}{2}$ gives three lobes and so on.

I trust that in the foregoing I do not appear to be labouring a few minor points. Most aerial theory is after all merely an exercise in elementary trigonometry, but in my experience wireless amateurs (not to mention professionals) are lamentably equipped in this direction. All the more reason, therefore, why any mathematical analysis should be impeccably correct—J. TOMLINSON (Berwick).

Service Engineers

SIR,—Re the controversy concerning dealers and private man service engineers, may I say that I am wholly in agreement for an examination for service engineers. It would, however, be a curtailment of private enterprise to allow a dealer to monopolise a particular district. Surely the real solution is to make it compulsory for any man, dealer or private, to hold a service engineer's licence. Examinations should be set for same, and any person operating without a licence will be liable to prosecution. I greatly miss the usual problem and exam. questions feature. Why not a problem (no prizes) in each issue with the answer on another page? Such a feature is knowledge in itself, especially when one can't solve it. Should be pleased to see more useful servicing hints, so dominant in your pre-war issues. Apart from my suggestion may I say the paper is very informative and sign off with thanks for a very interesting paper.—M. C. BLUNDELL (Edgware).

Thermion Acclaimed

SIR,—In your issue of PRACTICAL WIRELESS of March last, I read with interest a letter written by Mr. C. G. Williams, and I endorse what he says about the various articles he mentions that have appeared in your paper in the past few months. They also happened to be items of particular interest to me, particularly the "Radio Examination Papers" by Experimenters, which helped me out of many a troublesome case in servicing receivers for my friends. I believe many a reader of your journal will appreciate more articles of that nature.

I agree wholeheartedly that all that Mr. Williams has said is a fact, but I am afraid there is one point on which I totally disagree, and that is his views on Thermion. I am inclined to agree with the Editor here, who has very appropriately put in a note in Mr. Williams's letter, that the B.B.C. asks for criticism and gets it. I agree with Thermion's views that there is too much crooning, dance bands and swing coming from the B.B.C., and worse still is wailing howls of a singer singing the so-called "Hits of Tin Pan Alley," or some other equally qualifying name. Believe me, sometimes they really do hit me on the head when I accidentally tune into one. Surely public taste in Britain is not of that standard, for if the B.B.C. truly strives to please the majority by swing and dance bands, it rather leads me to think that the standard of musical education is undoubtedly low, or, alternatively, the classical music lovers have no voice in the matter of programme choice whatsoever. On the other hand, do European broadcasting stations strive to please the majority of their listeners, because if they do, it only endorses what I have just said. One seldom comes across swing and crooning from the Continental stations of as low a standard as that sometimes sent out into the ether by the B.B.C. They no doubt have their news bulletins and topical talks, and occasionally light music, but never sink to the level of "song hits" and fowl noises. Surely then I begin to believe that the Continental peoples are more musically minded, taking the majority. I have had the opportunity to be present in many a famous concert hall throughout Europe, and heard on all these occasions some of the most notable symphony orchestras under the most distinguished conductors, and in view of this, I must pay tribute to the orchestras of the B.B.C., for I believe they surpass most of the Continental ones. No doubt, therefore, the B.B.C. have fine orchestras, and many a talented conductor who can direct them, but they seldom make use of them to propagate the beautiful creations of art that composers have toiled for, and left for us to appreciate and enjoy. Perhaps the worst bogy of the B.B.C. is the fact that when they use their fine symphony orchestras in a programme designed to please the few music lovers, they normally have to apologise for interrupting the concert because it is time somebody's dance band began to croon down the microphone. Why can't they finish a concert once they start one?

Finally, to conclude, I change the subject and wish your splendid paper every success. It is a good journal, and it is the one I look forward to receiving every month.—J. A. ANASTASI (Malta).

All-wave Five

SIR,—I have just read in the May issue of "P.W." a letter from a reader S. B. (St. Alban's). He states that in my All-wave Five receiver in the March issue there is no provision for switching off the H.T. to the valve anodes, and that this will damage the valves in time. I should like to point out to anyone who has built this set, that it is standard practice to leave the H.T. applied to the valve anodes, and that this does not harm the valves in any way. Where the H.T. is switched off in a battery set this is generally because a resistor-network is in circuit across the H.T. supply, which would exhaust the battery were it not disconnected.

Again, I have followed this practice in the 4-valve S.W. receiver in the May issue, and should not like any reader to hesitate to build the set because of this point, raised by Mr. S. B.—F. G. RAYER (London).

Voltage-dropping Calculations

SIR,—*Re* C. E. Hedley's letter in the Practical Hints in the May issue of "P.W." I think a more scientific approach can be made to the finding of the capacity to be used than the method advocated. Maybe some of your readers will be interested

Suppose the set in question uses four 6.3 v 0.3A valves and one 40 v. 0.3A valve.

Then total heater voltage $=4\times 6.3+40=65.2$ v.

The voltage across condenser being in quadrature with the voltage across the heaters we have,

V_c (voltage across condenser) $=\sqrt{230^2-65.2^2}$ (assuming, of course, 230 v. 50 cycles mains).

Then $V_c=220.5$ v.

The required capacity $C\mu F$ is given by $C=\dfrac{10^6\times I}{2\pi F\times V}$

For our case this gives $C=\dfrac{10^6\times .3}{2\pi\times 50\times 220.5}=4.33\ \mu F$ (approx).

Thus we can start with 4 μF which is close to the right value and then add, say, 0.1 μF condensers until 0.3A flows. Another beauty of this arrangement is that, if the heater voltage is only a small fraction of the mains voltage, say about a ¼ to ⅓, the condenser voltage is almost constant, and so the heater current is almost constant. This means that we could add, say, another 6.3 v. 0.3A valve with no alteration. This is a decided advantage in experimental work.

Next, I find myself in disagreement with C. E. Hedley's statement regarding pilot lights. When the set is first switched on the current through the condenser is abnormal for the first few cycles and transients are produced. The current which flows can be as much as 20 times the normal. Now the heating time of valve heaters is much longer than the transient period so no harm is done, but the same cannot be said of the pilot light. The warming up time is comparable to the transient period and I fear that lamps of the 0.3A variety would not last very long.

This can be overcome by leaving the condenser in circuit all the time and operate the set by shorting out the heaters.

The electricity suppliers should be pleased at this because it helps to improve the power factor of their system.

One of the disadvantages to this series condenser method of voltage dropping is the longer warming up time or the valves due to the constant current.

Again, Hedley's letter states that no heat is produced in the condenser at all. This is quite wrong. True it is not much, only a few milliwatts, but nevertheless heat is produced. If the condenser was perfect, which it is not, then no heat will be produced.—T. E. MILLWARD (Portchester.)

Short-wave Log

SIR,—Herbert Brooks's letter in the May issue prompts me to join in his plea for a list of S.W. stations. I can't get hold of any of the American lists, and I am relying on old pre-war lists and a meagre knowledge of Spanish for the identification of Latin American DX. Apart from the regulars, HCJB and the PRLs the Cubans on 32 metres and the Dominicans on 46 metres are coming over quite well now before midnight.

K. Dobeson asks for information. From a letter very recently received from the official Montevideo Service I see that the following calls and frequencies are in use: CXA4 (6,125 kc/s), CXA6 (9,620 kc/s), CXA10 (11,895 kc/s), CXA18 (15,300 kc/s). These stations seem to relay medium-wave transmitters in Buenos Aires quite a lot, and this may cause confusion. I have heard the station he mentions as being LRX, and agree with his reading of the call. I do not think that this station was on the same wavelength as CXA6 was when I last received the latter.

He may also be interested in a few random jottings from my log. TGWA often heard very well on 19 metres just after the Ws close down evenings. Havana station on 32 metres, "La voz del pueblo," around 23.00 hrs. G.M.T.—call letters missed. YV5RC at 23.30 hrs. on 50.26 frequently—call "Radio Caracas." On 50 metres R8 at 03.30 hrs. "La voz de Columbia en Bogota"—call letters missed. On 19.48 metres at 11.25 hrs. "Radio Paramaribo"—no call sign given. Regularly at R6-9 from 22.30 hrs. approximately "Transmite Broadcasting Nacional" Ciudad Trujillo, call letters missed, as usual, but frequency given as 6,420 mc/s. HH2S in French that does not at first sound like French, on 50 metres. A very good regular high-up on the 49 metre band during the night is "Radiodifusora Sao Paulo," Brazil, but this station does not seem to have a call sign. On 48 metres "Radiodifusora Nacional de Columbia en Bogota" with a programme of songs in Welsh.

Can any reader throw any light on a station heard last summer on 47.8 metres with a "Test Transmission" at R6-9 evenings with programmes of a South African flavour, giving the call between records JJFH in English and Afrikaans?—B. P. CEALLAIGH (Dublin).

Multi-range Tester

SIR,—In the article on page 252 of the May issue of PRACTICAL WIRELESS the resistance of the 100 mA shunt should have been .181 ohms not 181 ohms as printed. Also, in the diagram to this article, when the switch is at the 0-1 mA range the meter is completely shorted out, which is obviously wrong; in this switch position there should be an open circuit.—J. LING (West Hartlepool).

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(Continued in next column)

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

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

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

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...ould unjustifiable to proceed wit... rapid extension of the old ... vision system to the provinc... the intention was to discard it a... a very few years. It is tho... that the old system will cont... to appeal to many people ... after a new system has ... introduced.

(*Continued in next column*)

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