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Vol. 26. No. 529
AUGUST, 1950

PRACTICAL WIRELESS

EDITOR:
F. J. CAMM

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CHIEF CONTENTS

BUILD YOUR OWN

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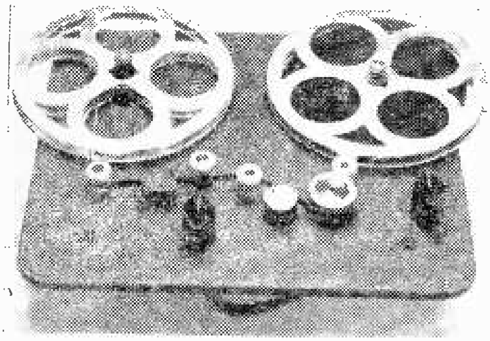

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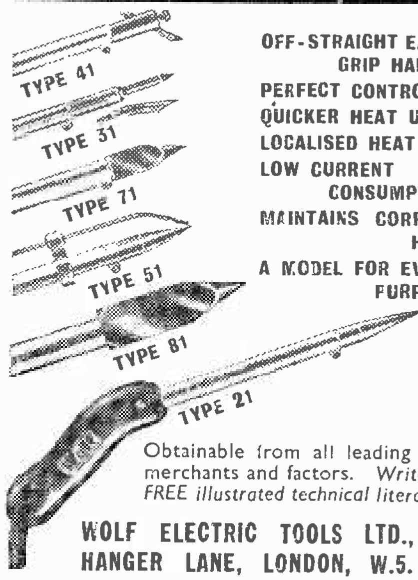

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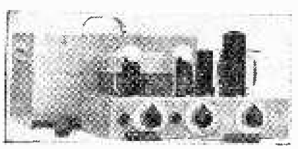

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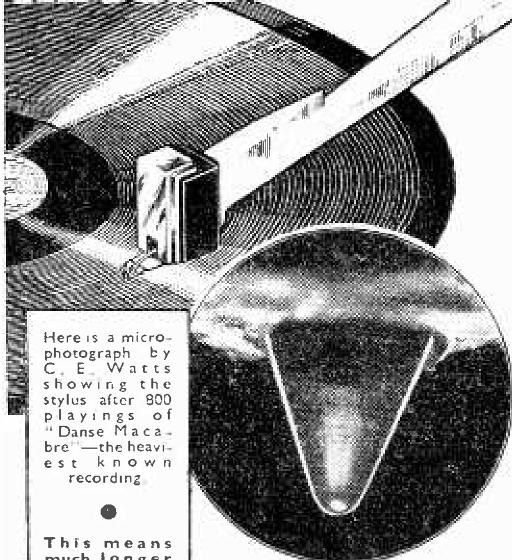

Here is a microphotograph by C. E. Watts showing the stylus after 800 playings of "Danse Macabre"—the heaviest known recording

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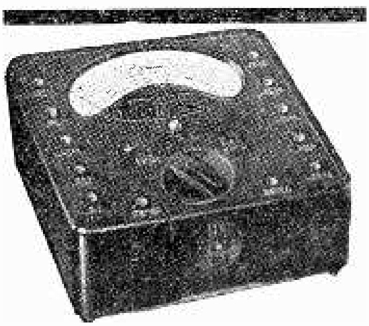

A dependably accurate instrument for testing and fault location is indispensable to the amateur who builds or services his own set. Stocks are now available of these two famous "Avo" Instruments. If you have any difficulty in obtaining one locally, please send us the name and address of your nearest Radio Dealer.

The UNIVERSAL AVOMINOR

(as illustrated) is a highly accurate moving-coil instrument, conveniently compact, for measuring A.C. and D.C. voltage, D.C. current, and also resistance; 22 ranges of readings on a 3-inch scale. Total resistance 200,000 ohms.

Size: 4⅝ins. x 3¾ins. x 1⅝ins.
Nett weight: 18 ozs.

Complete with leads, interchangeable prods and crocodile clips, and instruction book.

Price: **£8 : 10 : 0**

D.C. Voltage	A.C. Voltage
0—75 millivolts	0—5 volts
0—5 volts	0—25 ,,
0—25 ,,	0—100 ,,
0—100 ,,	0—250 ,,
0—250 ,,	0—500 ,,
0—500 ,,	

D.C. Current	Resistance
0—2.5 milliamps	0—20,000 ohms
0—5 ,,	0—100,000 ,,
0—25 ,,	0—500,000 ,,
0—100 ,,	0—2 megohms
0—500 ,,	0—5 ,,
	0—10 ,,

The D.C. AVOMINOR

is a 2¼-inch moving coil meter providing 14 ranges of readings of D.C. voltage, current and resistance up to 600 volts, 120 milliamps, and 3 megohms respectively. Total resistance 100,000 ohms.

Size: 4⅛ins. x 3⅞ins. x 1⅛ins.
Nett weight: 12½ ozs.

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Practical Wireless

18th YEAR OF ISSUE

EVERY MONTH.
VOL. XXVI. No. 529 AUGUST, 1950

Editor F. J. CAMM

COMMENTS OF THE MONTH — BY THE EDITOR

Suppressors—No Compulsion

THE Postmaster-General, in a written reply to a parliamentary question, states that he does not propose to take legislative action to make suppressors compulsory in motor vehicles. This problem has become more acute as television has developed, and it will not be disposed of by a parliamentary reply. Sooner or later the weight of public opinion will force the Government to take action, now that there is a visual reproduction of the interference as well as an audible one.

The suppression of the ignition system of motor cars can be carried out for a few shillings. It is argued on behalf of motorists that it is unfair to expect them to go to the small expense of fitting suppressors, and that the problem should be tackled at the manufacturing end. This presumably could be done, but it would be far more costly.

In any case, it is not only motor cars which offend, but many other forms of high-frequency electrical apparatus. The industry has been pressing for legislation to make suppression compulsory for a number of years, and it is a pity that the Postmaster-General in his reply did not give reasons why he proposes to continue to allow it to be voluntary. It is of little use expressing pious hopes that motorists and others will fit suppressors. They will only do so when they find that the interference affects their own receivers.

The problem is by no means shelved, and complaints which at present are confined to two areas will gradually become nation wide. The time to make suppression compulsory is now.

As part of a campaign to overcome the trouble an unusual film has been prepared by the B.B.C., by arrangement with the radio industry, showing how easy it is to fit any car with an interference suppressor.

The film, which is now being televised at intervals, incorporates the sort of interference familiar to most viewers—the "snowstorm" effect on the picture and the "machine-gun rattle" on the sound—when an unsuppressed motor car travels near a television receiving aerial. After the film's opening announcement has been submitted to this form of interference, the picture steadies for a straightforward demonstration of two kinds of suppressor and how to fit them. One is a simple type, costing between 1s. 6d. and 2s., which is fitted on the car distributor head and will stop most forms of interference. With the other type, also shown in the film, the ignition cable is cut and the ends screwed into the suppressor, which cannot be shaken adrift by the vibration of the engine. The fitting of a suppressor in no way impairs the efficiency of the engine.

The film ends, as it began, with a burst of interference and a reminder from the announcer that sparks from your car spoil people's pleasure.

TV AERIAL BAN

LOCAL authorities in some areas are banning the erection of TV aerials, and the industry through the R.E.C.M.F. and B.R.E.M.A. have issued a booklet which gives expert advice on the subject of television aerials. It has been circulated to the surveyors of local authorities throughout Great Britain and Northern Ireland. Although the booklet is intended for private property owners, it is also on sale to the public. The letter to the surveyors expresses the hope that the booklet may be useful not only in advising the council but in dealing with enquiries from tenants who may have their own opinions as to the type of installation most suitable.

The booklet shows the factors which must be considered before an aerial suitable for a particular building or district can be selected. It emphasizes that tests must be carried out on the site before such decision can be made. A list is given of firms who are providing testing facilities and who will advise local authorities and property owners on aerial installation. Eight types of aerial are classified and illustrated. It is only fair to state, however, that owners of radio receiving sets are complaining of the interference caused by adjacent television receivers. Owners of the latter, therefore, should make quite certain that they are not themselves offending in this respect before complaining about interference with their own reception.

F. J. C.

ROUND the WORLD of WIRELESS

Broadcast Receiving Licences

THE following statement shows the approximate numbers of licences issued during the year ended April 30th, 1950:

Region	*Number*
London Postal	2,309,000
Home Counties	1,627,000
Midland	1,715,000
North Eastern	1,878,000
North Western	1,587,000
South Western	1,048,000
Welsh and Border Counties	722,000
Total England and Wales	10,886,000
Scotland	1,115,000
Northern Ireland	203,000
Grand Total	12,204,000

The above total includes 363,950 television licences, of which 221,115 were in the London Region.

New Third Programme Transmitting Station for Sheffield

ON June 6th the B.B.C.'s Third Programme transmitter at Manor Lane School closed down, and the service was taken over by a more powerful transmitter which has been installed in a building adjoining the Heeley Baths. The new transmitter has a power of 1 kilowatt and is connected to a "T" aerial, one end of which is suspended from a chimney on the Heeley Baths. The increased power and more efficient aerial will give listeners in the Sheffield district better reception of the Third Programme. The wavelength will remain unchanged at 194 metres.

Amateur Saves 37 Men

AN amateur, listening to the trawler band at 4 a.m. recently heard a call for help.

The message said that two unknown ships had been in collision and one was sinking.

The listener gave the alarm among the Dungeness fishing colony and men and women rushed to the lifeboat house. Within 15 minutes, the James Cooper Henderson was at sea.

By six o'clock the crew of 37 of the 3,712-ton Spanish steamer *Cabo Espartel*, who had taken to their boats, were rescued by the Dungeness lifeboat.

Appointment of Head of Engineering Secretariat

FOLLOWING Mr. F. Williams's appointment as B.B.C. Superintendent Engineer, Studios, Mr. J. H. D. Ridley has become Head of the Engineering Secretariat, a department that deals mainly with the control of expenditure within the Engineering Division.

Mr. Ridley has been engaged on radio work since the earliest days of broadcasting. From 1920 to 1922 he was with the Marconi Company, and from 1922 to 1932 with Burndept Wireless, Ltd. After that he joined the Edison Swan Electric Company, remaining there until 1938 when he came to the B.B.C. In 1945 he became Assistant Head of the Engineering Secretariat.

Mr. Ridley is well known for his cinematograph films of nature subjects. Last year he accompanied Dr. Julian Huxley, F.R.S., and Mr. James Fisher on an expedition to Iceland to make films of bird life for the Television Service.

Customs Use V.H.F.

CUSTOMS and Excise, in stepping up their war against smuggling have ordered new V.H.F. R./T. equipment which will enable them to operate in much the same way as police patrol cars.

This equipment was fitted as an experiment on the *Vigilant*. It proved a great success.

Now it will be installed in the *Valiant* and the *Vincent*.

The *Vigilant* carries two fast launches—one for fine weather, and another for rough seas.

A section of the new Ekco showrooms recently opened in Glasgow.

Danish Radio Exhibition

THE Danish State Radio and Denmark's Radio Industry are arranging an exhibition in Copenhagen, from August 11th to 20th, to mark the twenty-fifth anniversary of the State Radio.

The exhibition, which will be under the patronage of H.M. King Frederik, will include radio and electrical measuring equipment, radio components, radio and television apparatus and will demonstrate working television and music studios. Most of the products on show will be of Danish manufacture.

The Danish Radio plans to illustrate its progress over the past quarter-century and, at the same time, to give visitors an idea of what its future services will be like. The television studio and the music studio will be built round an auditorium capable of holding 1,000; during the afternoons and evenings, performances will be broadcast from these studios.

On the Skyline

THE B.B.C. Outside Broadcasting Department arranged an ambitious coverage of the first post-war R.A.F. Pageant at Farnborough.

There were two major operations in the pageant. The first, which was broadcast in the Light Programme on July 7th, reconstructed an attack, based on the Amiens Prison raid, in which a squadron of low-level Mosquitoes breach the prison wall. Arms are dropped to the escaping prisoners who are then evacuated by helicopter and glider. Raymond Baxter was in the glider to give listeners his impression of the scene as his aircraft was towed in and, later, snatched off the ground by a Dakota. John Ellison was reporting from one of the Mosquitoes and Wynford Vaughan Thomas was on the ground to describe, amongst other things, the aerial combat when the fighter cover to this operation was engaged by "enemy" fighters.

The pageant's second feature, broadcast in the Light Programme on July 8th, consisted of a mock attack on the airfield by Mosquito aircraft bombing from 5,000ft. Charles Gardner was in one of the Mosquitoes, which was later intercepted by a squadron of Meteors taking off at high speed from the airfield. Raymond Baxter was in a Meteor and Wynford Vaughan Thomas again reported from the ground.

All three airborne commentators have served in the R.A.F. John Ellison was a pilot before the war; Charles Gardner flew with Coastal Command and Raymond Baxter was a fighter pilot. Wynford Vaughan Thomas of Anzio fame has been co-opted into this ex-service team.

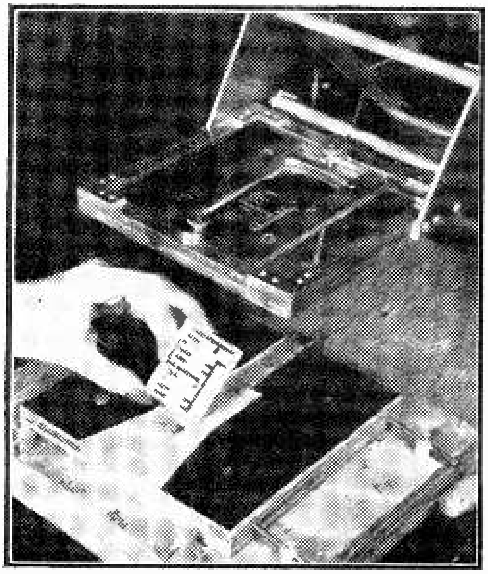
New Radio Control

A NEW form of radio control was recently demonstrated at Portsmouth. A high-speed sea-going launch, designed as a bombing target for the R.A.F., was put through complicated evolutions up to a distance of eight miles by means of a control which operates by musical tones. It is claimed by the inventor, Mr. F. Parfitt, that this type of equipment which has only five buttons can give complete control and cannot be jammed. The launch, incidentally, is armour plated and unsinkable.

Suppression of E.H.T. Radiation Interference

WITH the extension of television transmission to the Midlands area last December, the problem of interference to normal radio reception by television receivers reached major proportions.

Although the trouble originates in the line time base circuit, the associated circuits also radiate, including in a number of cases the wall coating of the C.R.T. itself. It soon became apparent that screens around individual components were not effective, and the only satisfactory method found was a screen around the whole receiver.



A "wired" chassis. The main part of the American miniature receiver in which wiring, resistors, etc., are all chemically printed with oxide silver paint on ceramic.

In the course of the investigation into this problem Messrs. Acheson Colloids Limited were approached and a special product was developed for the purpose.

The product in question, "dag" Dispersion 479, is a quick-drying water-based paint designed to be brushed on the inside of the cabinet. Tests show that a radio receiver will operate satisfactorily, even on the long-wave band, only a few feet away from a treated television set.

Those interested are asked to write for further technical information regarding the use of Dispersion 479 to Messrs. Acheson Colloids Limited, 18, Pall Mall, London, S.W.1.

Grounds for Divorce

LISTENING on his own frequency on his car radio receiver whilst travelling home recently, an American heard his wife talking over his transmitter to another amateur. As a result of what he overheard he has filed a petition for divorce, citing the other amateur.

Phase-shift Audio Oscillator

A Useful Wide-range Instrument Built from "Junk-box" Spares

By J. C. FLIND

THIS simple oscillator covers, in three steps, frequencies from about 40 cycles per second right up to and beyond the limits of audibility. It gives a generous output, in the region of three volts peak, and this remains remarkably high over the full range of frequencies.

The stability of frequency is excellent, and over the range quoted the wave-form produced is good enough for most purposes, but if some measure of distortion can be tolerated a little adjustment of the preset controls (VR3 and VR4) will further extend the lower limit down to about 20 c/s.

The instrument works entirely from batteries, so that the bugbear of mains hum is avoided, and as radio-frequencies are not employed and the circuit includes no inductors, there is no need for screening. Nearly all the components comprised in the brief list of parts are standard items, and, together with the two valves, which are general-purpose two-volt triodes, they will be found in almost every amateur's collection of discarded spare parts.

From the circuit diagram, Fig. 1, it will be seen that V2 is driven by V1 through a conventional R/C coupling, and that negative feedback is applied from the anode of V2, via the blocking capacitor C3 and the potentiometer formed by VR3 and VR4 (VR4 is the cathode bias resistor, common to both valves) to the point marked (B), the cathode of V1. Simultaneously, positive feedback is applied to the point marked (C), the grid of V1, this time through the potential dividing network VR1-C1 and VR2-C2.

The conditions required for the maintenance of oscillation are (a) that the positive feedback at (C) should exceed the negative feedback at (B), and (b) that the voltages which appear at these two points should be in phase with one another. As regards the first requirement (a), it will have been noted that VR3 and VR4 are variable, and once the optimum setting for VR4, which sets the grid bias voltage, has been determined, VR3 can be adjusted in its turn to decrease the negative feedback to the point where oscillation commences. When we consider (b), however, the position becomes more complicated. Both the points (B) and (C) are fed from the point marked (A), which is common to both positive and negative feedback circuits: (B) is in a purely resistive arm, so that at all frequencies of oscillation it will be exactly in step with the point (A). The positive feedback point (C), however, lies on an arm containing both resistance and capacity, which in the "upper" part are in series, while in the "lower" section they are arranged in parallel. It can be shown mathematically that for any given set of values for VR1, VR2, C1 and C2 the points (A) and (C) will be in phase at only one frequency. Accordingly, by making these values variable, the frequency at which the circuit as a whole will oscillate can be fixed.

Obviously, if the degree of positive feedback obtaining at the point (C) is not to be unduly disturbed, the upper and lower sections of the potentiometer VR1-C1—VR2-C2 must be varied simultaneously: the most economical and convenient way of arranging this, while giving adequate range coverage, is to provide for C1 and C2 each to consist of three capacitors, selected by means of a two-pole

LIST OF COMPONENTS

Resistors:
- 2 x 5,000 ohms.
- 2 x 50,000 ohms.
- 1 x 25,000 ohms.
- 1 x 500,000 ohms.

Capacitors:
- 2 x .0001 μF.
- 2 x .001 μF.
- 2 x .01 μF.
- 2 x .1 μF.
- 1 x .5 μF.

Variables:
- 1 x double—1 megohm.
- 1 x 2,000 ohms.
- 1 x 100,000 ohms.

Switches:
- One 3-way 2-pole Yaxley.
- One single-pole on-off.

Valves:
- Two general-purpose two-volt triodes.
- Terminals, control knobs, resistance wire, systoflex, etc.

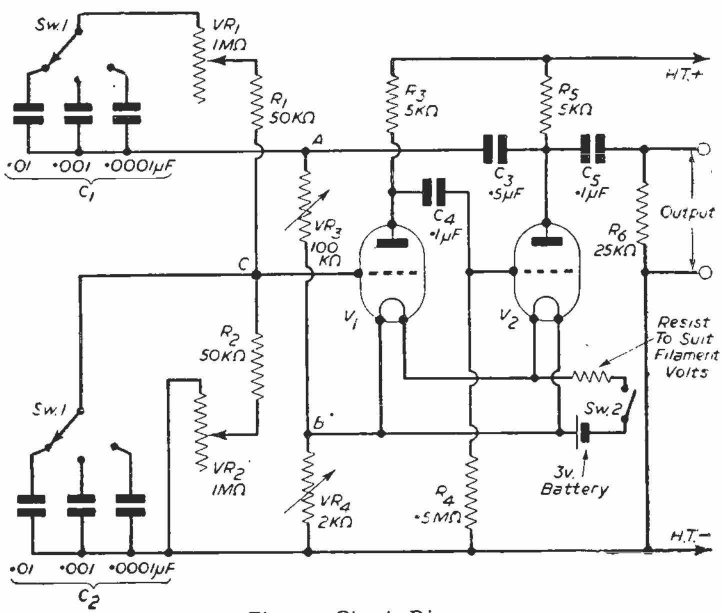


Fig. 1.—Circuit Diagram.

three-way Yaxley switch, while VR1 and VR2 are continuously variable resistors, ganged or geared together. (It so happens that at the time of writing a very suitable component, consisting of a pair of 1-megohm carbon potentiometers, mounted on a common spindle, is offered at 2s. 6d. by Radio Clearance, Ltd., of Tottenham Court Road, London, W.1.)

Ranges

The values chosen for C1 and C2 will depend to some extent on the characteristics and condition of the valves employed: in the author's instrument values of .01, .001 and .0001 μF provided ranges running respectively from 40-300, 200-2,000 and 1,500-25,000 cycles per second.

The oscillator is intended to feed into a relatively high impedance, such as the grid circuit of an amplifier, and the purpose of the 25,000 ohms resistor placed across the output terminals is to minimise the effect which the varying input impedances of different amplifiers might have on the calibration. If required, however, the instrument will give a good account of itself in conjunction with an ordinary pair of headphones, preferably in series with a resistor of, say, 50,000 ohms. The oscillator described could, of course, easily be combined with an amplifier and built-in speaker to provide a complete unit, but to ensure freedom from back-coupling the amplifier should have two stages, the first giving low gain but acting as a "buffer."

In the prototype instrument as described space has been found for a No. 800 cycle lamp battery which supplies current for the valve filaments—of course, through a short length of resistance wire which takes care of the surplus 0.8 volts given by the battery. This self-contained L.T. battery is doubly convenient, as besides saving one pair of external leads it makes it a simple matter to keep the L.T. and H.T. supplies separate—it will have been noted from the circuit diagram that H.T. and L.T. negative poles are not directly connected to one another.

If a pair of 1.4 volt miniature valves should be to hand, a very neat self-contained instrument could be made up, with both batteries inside the case: the modern small layer-type H.T. batteries would be suitable, as even with the older 2-volt valves the anode current consumption does not exceed 3 milliamperes.

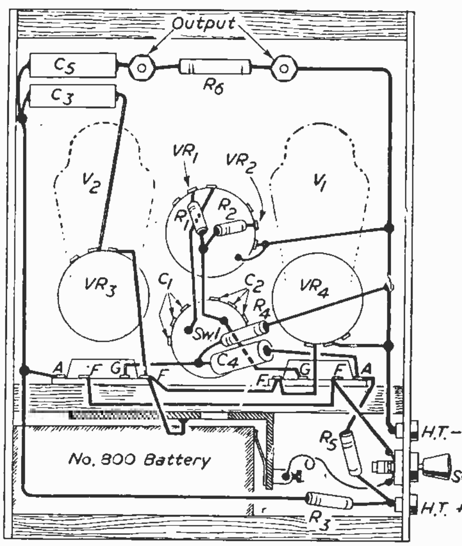


Fig. 3.—Wiring Diagram.

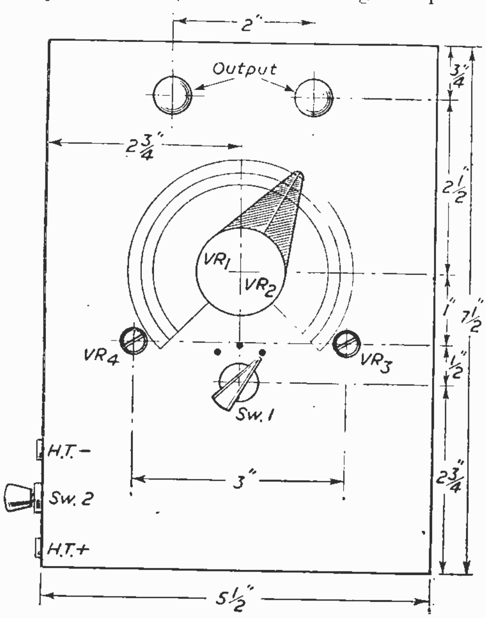


Fig. 2.—Panel Layout.

Constructional Notes

Layout is not at all critical, but as high values of resistance are employed in the control circuits some care should be taken to maintain a high standard of insulation and to avoid leakages. It will be found advantageous to bond the metal cases of VR1 and VR2 to the "earth" line.

The original model was built up in a wooden box, 7½in. × 5½in. × 2¾in. deep, whose plywood bottom provided the panel. A partition of ⅜in. thick wood makes one wall of the battery compartment and serves, at the same time, to carry the valves mounted in old-fashioned baseboard-type holders: it will be found that if the valves are positioned well away from the panel, there will be room underneath them for the two variable resistors VR3 and VR4. The scale fixed to the panel can consist of a piece of thin, white card or ivorine, and should be marked to show the three positions of the selector switch SW1. The scale traversed by the cursor fitted to the fine-frequency control knob operating VR1 and VR2 can conveniently take the form of three concentric circles, and the cursor itself can be a piece of thick celluloid fastened with cement to the underside of a skirted-type knob and scribed with a hairline. This ensures that the whole of each of the three scales is always visible. There are no scale markings for the controls VR3 and VR4, as these will not often need to be touched: the spindles, which protrude through the panel, are cut off short and slotted for adjustment with a screwdriver.

Brass contact pieces for the battery are bent to shape and screwed to the partition. It will be found that with the battery in position there is a spare space of about 2in. × 1½in., and this is used to house the on-off switch and the resistance wire in circuit with the valve filaments, which is threaded through a short length of "systoflex." The sockets for the two leads to the H.T. battery are also brought in here, and in the original model, in order to leave more room for the "control" components, the anode resistors and the components forming the coupling between the valves have all been kept on the battery side of the partition. The anode resistors, by the way, have been kept to the low figure of 5,000 ohms in order to minimise the risk of distortion; even so, the output is quite high enough for most requirements.

Now with regard to the two sets of capacitors forming C1 and C2. These should, of course, be good quality components, preferably mica types, and it is suggested that for convenience the switch-and-capacitor assembly should be "prefabricated." That is to say, the six capacitors should be soldered to the appropriate tags of the switch and finished off with four flying leads, for connection to VR1, R1/R2, VR3 and H.T. negative respectively, and that only then should the switch be fixed in position on the panel. The six capacitors have been omitted from the wiring diagram (Fig. 3) in order to avoid confusion.

Operation

When the instrument has been completed, connect the output terminals to an oscilloscope or a suitable amplifier, plug in to an H.T. battery giving about 100 volts, and switch on. Set SW1 to the middle range and the control of VR1 and VR2 to about the centre of the scale. A little manipulation of VR3 and VR4 should very soon produce a strong "signal" at about 400 c/s.; the fine-frequency control should then be operated to make sure that connections have been made the right way round; it may be necessary to reverse some of the leads.

VR4 should next be adjusted for maximum output and, following this, VR3 should be turned back until oscillation ceases, after which it should again be advanced until the noto is heard again. It will be found that if this setting is kept to the minimum, the wave-form is improved. Before deciding on the final setting for V3, make sure that oscillation is maintained on all ranges, as inadequate feedback will cause the oscillations to collapse at the lowest frequencies.

Accurate calibration really demands the use of an oscilloscope but, with care, a good deal can be done by aural comparison with another calibrated source (or even a piano), relying on the ear to detect the unwanted harmonics which indicate a marked departure from the basic sinusoidal wave-form.

This little oscillator will be found invaluable in checking the performance of amplifiers and speakers, and the effect of insertion of various forms of filters and tone-controls. It will also provide a means of tracking down those mysterious buzzes and reverberations which so often spoil the performance of powerful high-fidelity equipment when used in ordinary living-rooms.

V.H.F. Constant Impedance Attenuators

THE problems of variable attenuator design for accurate V.H.F. measurements have been a subject of scientific research since the beginning of the high-frequency era in communications. The familiar techniques employed in designing constant impedance attenuators for use in voice-frequency and carrier-frequency ranges have so far failed to afford the same degree of precision when applied to the V.H.F. range. In this range, unavoidable wiring and resistor reactances coupled with mutual impedances within the attenuator become significant and cause a marked deterioration in performance.

First in the field to meet what has in some quarters become an urgent need for a medium-priced, constant impedance, variable, V.H.F. attenuator in the range up to 50 Mc/s. is Standard Telephones and Cables, Limited. These attenuators set a new standard of performance in the V.H.F range. Two models for use in 75-ohm circuits are available. One model, variable in 1 db. steps, gives a maximum insertion loss of 9 db. The other, variable in 10 db. steps, provides a maximum insertion loss of 90 db. Both models can be used in tandem and will handle up to ¼ watt input. They are ready for building into customers' own equipment.

Of practical importance and interest to laboratory engineers and others engaged in making accurate measurements, is the information that the maximum deviation from nominal loss at D.C. does not exceed ± 0.05 db. for any setting on the 0-9 db. model. On the 0-90 db. model, the insertion loss error does not exceed ± 0.06 db. for the 10 db. setting, rising linearly to a value not exceeding ±0.3 db. for the 90 db. setting.

In keeping with this accuracy of adjustment, the high-frequency performance is quite remarkable. The total insertion loss error at 50 Mc/s. (inclusive of D.C. errors as above) will not exceed ± 0.05 db. for the 1 db. setting, rising linearly to a value not exceeding 0.15 db. for the 9 db. setting. On the 0-90 db. model, the total insertion loss error at 50 Mc/s. (inclusive of D.C. errors) does not exceed ± 0.1 db. per step. The above insertion loss errors are, in all instances, relative to zero db. setting.

Individual calibration charts for the frequencies up to 100 Mc/s. for the 0-9 db. model and 60 Mc/s for the 0-9 db. model can be supplied.

Negative Feed-back

Some More Details of a Modern Circuit Arrangement

By ERIC LOWDON

TO many amateurs there is something slightly sinister about negative feed-back—an air of mystery that savours more of the black arts than the down-to-earth business of radio circuitry. For instance, the valve manual may give the A.C. resistance of a valve as being X ohms, but put it in a circuit with negative feed-back and, as the amateur has read, the Ra may appear to be much higher, say Y ohms; or to add to his bewilderment he may have read somewhere that negative feed-back makes the Ra much lower, say Z ohms.

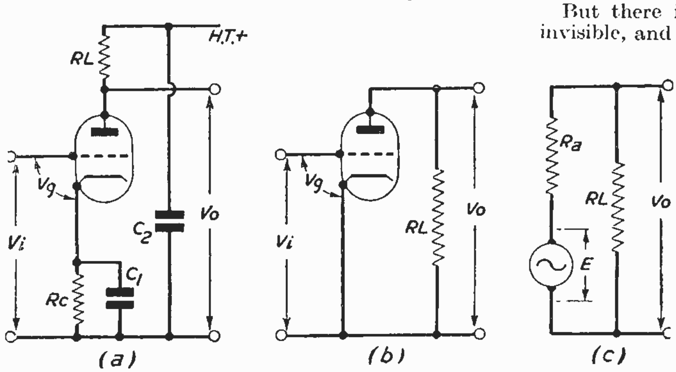


Fig. 1.—Diagrams illustrating the evolution of the equivalent circuit.

It seems that the valve manuals can't be believed any more; the Ra of a valve with negative feed-back may be X ohms, Y ohms, Z ohms or anything you like; in fact, it can be X, Y, and Z ohms at the same time.

Does the Ra really jump about in this mysterious fashion? If so how does negative feed-back operate on the valve? Before we go further, here is a clue; there are two kinds of feed-back (negative is understood from now on), current feed-back and voltage feed-back. One causes the Ra to increase—or so it seems—and the other causes an apparent decrease; perhaps this makes things seem a little more reasonable. Incidentally, neither of these two types feed back current, they both feed back voltage—here we go again!

In actual fact, this question of variable Ra and its effect on the circuit is not difficult provided you look at it in the right way. To answer it we have to consider the relationship between the load resistance RL and Ra.

Amplifier without Feed-back

To begin, then, let us consider a simple amplifier circuit without feed-back as shown in *Fig.* 1*a*, where RL is the anode load resistance, Rc the cathode bias resistance, C1 the cathode bypass capacitance, and C2 all the capacitance that usually appears between the HT end of RL and earth—decoupling, smoothing, and stray capacitance, etc.; Vi is the input signal volts, Vg the signal volts appearing between grid and cathode, and Vo the volts output.

In this article the D.C. components in the circuit are ignored, and we are dealing only with A.C., signal currents and voltages. Since C1 and C2 will form short circuits to A.C. (assuming negligible reactance) the circuit can be redrawn as shown in Fig. 1*b*. It will now be seen that so far as the output is concerned, RL is effectively in parallel with the valve, and the effective grid-cathode signal input is the same as Vi.

But there is still one component that is quite invisible, and that is Ra, the A.C. resistance of the valve. In order to complete the picture, then, we can replace the valve with a generator and series resistance Ra; this is shown in Fig. 1c. Thus we have evolved a circuit that is equivalent in every way to that in Fig. 1a, *so far as signal voltages and currents are concerned.* Note: it is usual when employing this artifice to label the generator output-voltage as μVg, that is, the amplification factor of the valve multiplied by the grid-cathode input volts; for the purpose of this article it will be more convenient to call it E as has been done in the diagram.

We have, then, a generator supplying E volts and driving a current of E/Ra+R amps (ohms law) round the circuit. It will be immediately obvious that if Ra and E are constant, then a given variation of RL will cause the current in the circuit to vary by an amount dependent on the relative values of Ra and RL. If Ra is very large compared with RL then even a large variation of RL will have only a small effect on the current: on the other hand, if Ra is small relative to RL then a large variation in RL will cause a big variation in current.

The effect on the voltage developed across RL is

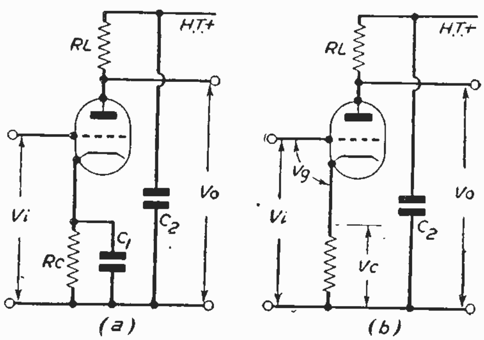


Fig. 2.—Simple amplifier and modification to introduce N.F.B.

no less obvious. In the first case, that of the high Ra, the current variation is small and therefore the change in voltage across RL will be nearly proportional to the change in its resistance; if, for instance, the resistance of RL is halved so also will the voltage across it be nearly halved. In the second case, where Ra is very low compared with RL, change in the resistance of RL will result in a *current* variation very nearly proportional to the change in resistance; that is to say, if RL is halved the current will be nearly doubled and the voltage across the resistance will be maintained more closely to its original value.

A few figures will illustrate this: Suppose that E is 100, 20,000 ohms for Ra, and 5,000 ohms for RL then,

$I = E/Ra + R$
$= 100/20{,}000 + 5{,}000 = 100/25{,}000 = .004$ *amp.*

and the volts developed across RL, call it Vo, will be,

$Vo = I \times R = .004 \times 5{,}000 = 20$ *volts.*

If RL is now halved the circuit current becomes .0044 amp. and the volts drop across the new value of RL is 11 volts.

Now suppose Ra to be small compared with RL, thus: E equals 100 volts, Ra equals 1,000 ohms, and RL equals 5,000 ohms. Calculating in the same way as above we have .0167 for the current and 83 volts across RL. When RL is halved, the current becomes .0285 amp. and the volts drop across RL is 71 volts.

It is seen, then, that the effect of a comparatively high Ra is to cause a large variation in output volts with change in RL, and a comparatively low Ra tends to maintain the output volts with change in RL. Armed with this knowledge we can now give our attention to negative feed-back.

Current Feed-back

In Fig. 2*a*, we again have our simple amplifier circuit in which the input volts are applied between grid and earth, but since CI presents a short circuit to A.C. the input is effectively between grid and cathode. Now look at Fig. 2*b*.

Here the bypass condenser has been removed, and this simple alteration makes a remarkable difference to the working of the circuit. The input signal Vi is no longer applied directly between grid and cathode, but is in series with the cathode voltage Vc and in opposition to it. The effective grid-cathode voltage is therefore Vi—Vc. (Don't forget that we are concerned only with signal voltages; D.C. voltage conditions are being ignored.)

A little thought will show that this is so, for if the grid is moving in a positive direction with respect to earth, then the current through the valve must be increasing and the cathode must also be moving positively. If we assume that the grid has moved 5 volts positive and the cathode 2 volts positive, then the grid has moved 3 volts more positive than has the cathode.

Since the valve is only interested in the volts which appear directly between its grid and cathode, it will be obvious that only three volts of the five volts input are effective in producing an output. The other two volts are employed in neutralising the two volts increase across Rc.

This is negative feed-back and since Vc depends on the current through RL it is called current feed-back.

The first most noticeable effect of current feed-back, then, is to reduce the output for a given input, but as this can hardly be classed as an advantage there must be some other reason for its adoption in amplifiers. In actual fact, it not only reduces the gain of the circuit but also reduces the harmonic distortion generated within the valve in the same ratio, and this is, of course, a decided asset.

However, don't let this fact encourage you to nip the bypass capacitor out of your amplifier output stage, for as we shall see in a moment, current feed-back is particularly unsuitable for this part of the circuit.

Current Feed-back and Ra

Turning again to Fig. 2b, let us suppose that the valve has a fairly low Ra compared with RL. If RL is now reduced to, say, half it's original value, then the signal current in the valve and therefore through RL and Rc will increase, and the feed-back voltage Vc must also increase because the voltage drop across Rc will be greater. The effective grid cathode volts Vi—Vc will thus decrease giving rise to a decrease in output current which tends to balance out the original current rise due to the smaller value of RL. The current is therefore maintained at somewhere near it's original value, but since RL has been reduced by half so then will the output volts be reduced proportionately. This as we saw earlier in the article (Fig. 1c), is exactly what happens in a non-feed-back circuit where the valve has a very high Ra compared to RL.

In this case then current feed-back has effectively converted our low Ra into a high Ra so far as change in anode load is concerned. As any high-quality enthusiast will tell you, this is far from the ideal state of affairs required in an output stage where the load is a loudspeaker whose impedance varies with frequency. If the Ra of the output valve is high then the output will vary with frequency and result in distortion. Another important reason why the Ra should be low is that since the reproducer is effectively in parallel with the valve, a low Ra will assist in damping out unwanted natural resonances in the speaker.

For these reasons current feed-back is never used in the output stage of an amplifier, though it may find important uses in other parts of the circuit.

Voltage Feed-back and Ra

Turn now to Fig. 3. This will be recognised as the simple amplifier of Fig. 2a with the addition of a potential divider consisting of R1 and R2 connected between anode and earth—for the moment assume that the reactance of C1 is negligible—and the portion of the output voltage Va developed across R2, is connected in series with the input voltage Vi.

This is an example of voltage feed-back, so called because Va is proportional to the output voltage across RL and not, as in the case of current feed-back, to the output current flowing in RL.

As before, the effective grid-cathode input voltage is the difference between the input volts and the feed-back volts—that is Vi—Va. In this case, however, change in RL has an entirely different effect on the apparent Ra of the valve.

(To be continued)

On your Wavelength

by THERMION

The Saucepan Special

I CERTAINLY rubbed my eyes the other day when there dropped on to my desk a booklet issued by the Director of Information of Lusaka, Northern Rhodesia entitled "Report on the Saucepan Special," which is described as the Poor Man's Radio for Rural Populations. The report has been written at the request of the Director of Information Services of the Colonial Office because the success of the cheap wireless set for Africans in Central Africa will be an important factor in decisions which have yet to be made in other colonies on the establishment of broadcasting organisations.

The Saucepan Special, a receiver of British manufacture, has been enormously successful in Africa. It has been bought in considerable numbers and it is already having the effect upon Africans that it was meant to have, as an instrument of mass education. The Saucepan Radio is a simple, but efficient, short-wave receiver operated by an external dry battery of 90 volts H.T. and 1½ volt L.T., giving 300 hours' service.

The "Saucepan" Special.

The cabinet of the receiver is in effect a large aluminium saucepan (without handle) of 9in. diameter with a back plate attached by screws and sealed, and a gauze-covered opening at the front of 4in. diameter. At this opening is the combined on-off switch and volume control and below it the two-speed tuning control and tuning dial. There is no tone control or other refinement. The set stands on black bakelite knobs, the tuning dial is white; the appearance of the receiver is more attractive than one would imagine. It is painted blue since research in the various colonies in Africa revealed the fact that one tribe or another had some kind of superstition about almost every other colour. The back plate is tight fitting and the three holes in it are gauze-covered, so that the set is entirely insect proof. It is also tropically finished throughout. The receiver is a formal (though simplified) four-valve superhet type. Its range is from 25 to 90 metres. The aerial and earth wires are attached to the set, and it is important that the earth sytem should be used with this receiver. Before the sets are distributed a small copper plate is soldered on to the earth wire which should be buried about 9in. in the ground.

The receiver and the battery, which is about 8in. by 3in. by 5¼in., each weigh just over 7lbs.

The aerial wire supplied could with advantage be lengthened.

I understand that the manufacturer is working on a very low margin of profit, relying upon large sales. The government had agreed to suspend customs on all radios of not more than £4 f.o.b. U.K. value. At present there is no system of wireless licences in Africa! I must examine one of these receivers.

Radio Book Reviews

WHY is it that the B.B.C. seldom, if ever, review technical books? There are as many, if not more, readers of technical books to-day than there are of fiction and biography. Five years of war compelled most people to acquire technical knowledge in a wide range of subjects, and the technical book industry in this country has expanded enormously in consequence. One would imagine from the radio book review feature that no one in this country read anything of a technical nature. The newspapers are also remiss in this respect. The B.B.C. and the newspapers are ignoring a feature which would have a very popular appeal. Technical books are expensive to produce, and at a time when the spread of technical education is a matter of national concern, I should have thought the B.B.C. would have been the first to draw attention to important technical works. I know that the B.B.C. boys read this feature, so perhaps I am making a suggestion which they will adopt. Obviously the books would have to be reviewed by a person with technical and scientific, as distinct from literary qualifications. The view seems to be at present that unless the book is a simple one, telling you how to ride a bicycle or paper a wall without dabbing it here and dabbing it there it is of no interest to the public.

For the Experimenter–2

More Experiments in Electromagnetic Induction

By "MICRON"

AT first, when the signal-amplitude is small, rectification will take place around the bend of the characteristic—where the curvature is large, and *varying*. In this region, it will be far from true to say, "Io is directly proportional to Eg." The rectification will be "out of proportion," or *non-linear*, causing much distortion in the shape of each half-wave of anode current.

If the experiment is carefully carried out, the effect at the bend will be shown by slow, and *unequal* increments in the meter readings for given changes in volume control settings. When the amplitude of Eg is sufficient to take the peak considerably into the straight part of the characteristic, i.e., much above the bend, Io will become nearly directly proportional to the signal input: an important requirement of distortionless detection.

Valve Voltmeters ; "Radio Controls"

The fact that we do get a D.C. component from a rectifier suggests construction of numerous useful pieces of apparatus.

The milliammeter will be an accurate tuning-indicator if the received signal is strong enough to give a readable indication—or previous H.F. stages make it strong enough. Thus a tuning condenser may be calibrated in wavelengths or frequencies, making a "wavemeter."

Plotting calibration curves for condensers (when used with various coils) will be a useful series of experiments in themselves. Broadcast frequencies are exact within very close limits for this purpose. The actual shape of graph connecting wavelengths (or frequencies) with dial settings will depend on the "law" of a given condenser—which provides another line for investigation.

One important advantage of the "lower anode bend" type of detector over all others is the extremely high impedance of the valve grid cathode circuit—equivalent to an open-circuit or "infinite impedance" at low frequencies. This is especially advantageous in valve voltmeters which may be used to show high-frequency voltages existing across other high-impedance R.F. circuits where any appreciable shunting effects would be serious.

Our anode-bend rectifier is in effect a "valve voltmeter." An "Eg," of 50 c/s or even 5 Mc/s. frequency is made to give a readable indication on a D.C. moving coil instrument. If we have accurate means of measuring the R.M.S. voltages applied at 50 c/s., a calibration curve may be drawn connecting milliamp readings with R.M.S. volts, and this will remain reasonably correct up to fairly high radio-frequencies.

The "law" of a valve voltmeter (as shown in the calibration curve) will depend whether it is worked over a linear or non-linear part of the characteristic. Once calibrated, of course, the same valve, the same bias, H.T., and filament voltages must be employed as in calibrating.

If a fairly sensitive relay is substituted for the milliammeter, we have possibilities for fascinating experiments in "radio control." Extremely weak signals from a transmitter thousands of miles away (or stronger ones from a local oscillator) could first be amplified by the H.F. stages of a receiver, and applied to grid-cathode of the detector stage. The relay would close under the action of the resulting "Io," and could be arranged to initiate all sorts of things—switch-on lights, ring bells or buzzers, control models, etc. etc.

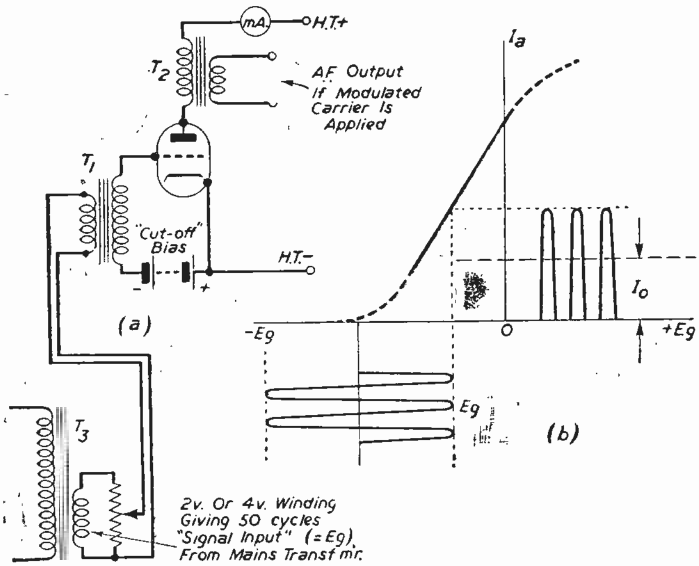


Fig. 5.—Demonstrating "Anode Bend" Detection with a Milliammeter.

Signal Detection

A next step should be to study what is taking place in the detector when receiving a modulated H.F. carrier.

The emphasis we have put on the "D.C. component" (Io) should make the matter perfectly clear. Instead of remaining at a fixed value, Io will start "swinging" up and down at audio-frequency as illustrated in Fig. 6. This is because the amplitude of each rectified "pulse" of anode current is different, Fig. 6b, hence so will the successive average values.

Yet, if the rectification is "linear," a milliammeter will continue to register the *steady* Io.

A moving coil D.C. instrument cannot follow A.C. changes: it always stops at the "mean value," and if the current swings equally on both sides of Io. the latter remains a constant "mean."

But if there is any non-linearity, it is possible—to mention one case—that Io will increase more at the crest of the modulation than it decreases at the trough, in which case there will be an *average increase* in Io—the D.C. component rises from Io to Io', say, the effect being to give a sharp upward "kick." in the milliammeter at modulation peaks.

With linear detection another fact may be gleaned from this. If we make sure of the D.C. component for any purpose—A.V.C. let us say—we shall have a current (or the resulting voltage

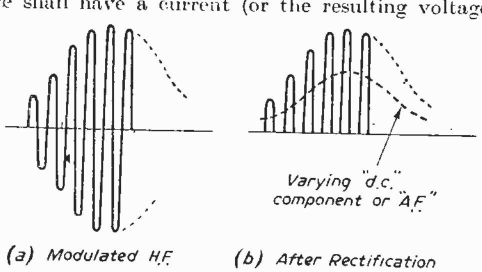


Fig. 6.—Rectification of a modulated signal. The D.C. component will now be varying *at the frequency of the amplitude modulation.*

developed across resistances) which depends only on the *carrier* amplitude, i.e., is *independent of the modulation*—a fact, of course, which can be observed in ordinary tuning indicators, or in A.V.C. (it would be a poor thing if A.V.C. bias varied with modulation).

Studying Mathematical "Laws"

We have already touched upon experimental studies of "quantities," with reference to valves, detection, valve voltmeters, and simple calibrations.

One difficulty here will be measuring equipment, though much can be done in improvising or making up permanently items such as valve voltmeters, rectifier instruments, frequency-measuring devices, low-frequency bridges, etc. The hobby will tend to become costly when developed along these lines, but many may think it well worth while.

Let us start with a job which calls for nothing more than a few coils, a condenser, and an ordinary or improvised receiver, a study of some of the "laws" connecting frequencies or wavelengths with inductance and capacitance values.

The "tuning-point" or *resonant* wavelength of an LC-circuit is given by:

$$\text{Wavelength } (Metres) = 1885\sqrt{LC},$$

where, $L = \mu H.$
$C = \mu F.,$

or,

$$\text{Frequency, } f(kc/s) = \frac{160}{\sqrt{LC}}, \text{ approx.}$$

If we omit the constants we may write:

$$\text{Wavelength } \lambda \propto \sqrt{LC}.$$

$$\text{Frequency } f \propto 1/\sqrt{LC}.$$

the sign "$\propto$" signifying "is proportional to," or "varies as."

The important thing to note is that Wavelength (or Wavelength range) varies as the *square root* of the tuning capacitance; the Frequency varies *inversely* as the square root. The same is true of L if C is kept constant.

Note: It is *not* correct to say, varies as the "square" of the tuning capacitance. Transposing the expression gives

$$C \propto \lambda^2,$$

or $\propto 1/f^2$, or $(1/f)^2$.

Take a practical question. What range of wavelengths can be tuned by a variable condenser of 500 $\mu\mu$F. minimum capacitance?

You will know, of course, from the tuning dial of a M.W. receiver that the range is, roughly, 200m.-600m.—a ratio of about 3/1.

But the ratio, 500$\mu\mu$F./50 $\mu\mu$F. is 10/1, or, as a more convenient figure, let us say 9/1. When the condenser vanes are "all in," the capacitance is *nine times* the minimum with the vanes "all out." Yet the wavelength range is only 3/1. In other words,

$$\text{Tuning range in metres} = \sqrt{\text{Capacitance Range.}}$$
$$= \sqrt{9/1} = 3/1.$$

Consider another question. If with a given coil, 200 $\mu\mu$F is required to tune to 1,000 kc/s, what value condenser will be necessary to tune to 1,200 k/cs?

The frequency ratio $= 1{,}200/1{,}000 = 1.2/1$.

Capacitance $\propto (1/f)^2$, or inversely as $(1.2/1)^2 = 1.44/1$. Therefore, since a *smaller* C is required for tuning to 1,200 kc/s.,

$C = 200\ \mu\mu F/1.44$, or $200\ \mu\mu F \div 1.44 = 139\ \mu\mu F$.

As a preliminary experiment to check these fundamental proportions, suppose you have chosen a coil which should tune from 200m. to 600m. with a variable condenser of about 9/1 capacitance ratio. You make up some sort of receiver or insert this LC-circuit across aerial and earth of an existing receiver.

You find the tuning range is not 3/1, but something like 2/1. Perhaps you can tune-down to 200m. (depending on the coil used), but you cannot go higher than 400m. What accounts for this? Knowing the condenser values, how could you calculate the approximate value of the quantity involved? What is the remedy?

Book Received

"WILLIAMSON AMPLIFIER." Collection of articles on "Design for a High-quality Amplifier," by D. T. N. Williamson, formerly of the M. O. Valve Company, now with Ferranti Research Laboratories. Published April 20th, 1950, at 3s. 6d. (postage 2d.), for "Wireless World," by Iliffe and Sons, Ltd. Size 9¾in. x 7¼in. Thirty-six pages and 31 illustrations.

This 15-watt amplifier has gained world-wide recognition among quality-reproduction enthusiasts for its remarkably low harmonic and intermodulation distortion. The response curve is flat within 1 db. up to 10 kc/s. Direct coupling in the first stage helps to reduce phase shift, which is negligible over the range 10 c/s-20 kc/s.

Input for the main amplifier is 1.9 v. peak. With a simple record-compensated pre-amplifier it is 18 mV.; 1.3 mV for use with microphones and under 1 mV with a high-gain pre-amplifier.

The booklet gives full details not only of the basic circuit, but also of ancillary equipment recommended by the designer for high-quality reproduction of records and radio programmes. Circuits for correcting recording characteristics are included and also high- and low-pass filters, the latter variable. There is a fading control for reducing gain to zero when changing records; the rate of fading is automatically controlled.

Contents include: Introduction. Basic Requirements: alternative specification. Details of chosen circuit and its performance. Design data of new version. Design of tone controls and auxiliary gramophone circuits. Design for a radio feeder unit. Replies to queries raised by constructors.

Equivalent Circuits

An Important Aspect of the Set Designer's Work is Described Here

By E. N. C.

THIS article is intended to give the reader an insight into the methods used by designers in nearly all aspects of design work. With the aid of an equivalent circuit the designer's job is somewhat eased, partly because it removes a lot of circuitry which is not necessary in the process of designing, and also because an equivalent circuit often presents to him a clearer picture of what is happening. Let us take as a first example the

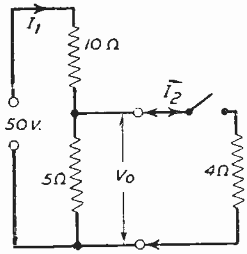


Fig. 1.—Simple potential divider circuit.

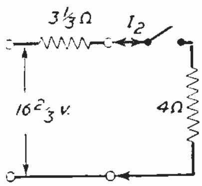


Fig. 2.—Equivalent circuit of Fig. 1.

simple potential divider, the circuit of which is shown in Fig. 1.

If we wish to know the output voltage a few simple calculations will show us as follows:

$$I_1 = \frac{50}{15} = \frac{10}{3} \text{ amps.} \therefore Vo = 5 \times \frac{10}{3} = \frac{50}{3} = 16\tfrac{2}{3} \text{ volts.}$$

Now if we connect the 4Ω load to the output Vo and we wish to know the circuit that will flow, how are we going to do it? It is no good saying that the current flowing is equal to $\frac{Vo}{4}$, because as soon as we connect up the 4Ω load the output Vo will fall to a new level because of the extra volts drop on the 10Ω top arm. The only way we can see so far is to go right back to the beginning and start all over again as follows:

$$I_1 = \frac{50}{10+\frac{5\times 4}{5+4}} = \frac{50}{10+\frac{20}{9}} = \frac{50\times 9}{110} = 4^1/_{11} \text{ amps.}$$

The output voltage Vo is equal to the current I_1 multiplied by the 5 and 4Ω in parallel, and is, therefore, $Vo = \frac{45}{11} \times \frac{20}{9} = 9^1/_{11}$ volts, instead of the previous $16\frac{2}{3}$ volts. We can now calculate the current flowing through the load, which is

$$\frac{9^1/_{11}}{4} = \frac{100}{44} = 2^3/_{11} \text{ amps.}$$

Varying Loads

Now if we want to connect up different loads and calculate the load current in each case we would be letting ourselves in for a lot of unnecessary work. What we want here is an equivalent circuit of the potential divider. Now consider the circuit of the potential divider. On the assumption that the 50 v. supply is being delivered by a generator having no internal resistance, if we switch off the generator without disconnecting it the terminal voltage would fall to zero and the generator or 50 v. supply has effectively been replaced by a short circuit. If we were now to look into the Vo terminals we would see 5Ω in parallel with 10Ω that is $3\frac{1}{3}$Ω, and if we switched the generator on we would look into $16\frac{2}{3}$ volts as previously calculated. Therefore as far as we are concerned we are looking into a generator of $16\frac{2}{3}$ volts output and having an internal resistance of $3\frac{1}{3}$Ω, and we can therefore draw an equivalent circuit of the potential divider, as shown in Fig. 2.

If we now want to connect up the 4Ω load and calculate the current that will flow, all we do is divide the generator volts by the load + series resistance as follows:

$$I_2 = \frac{16\frac{2}{3}}{3\frac{1}{3}+4} = \frac{\frac{50}{3}}{\frac{22}{3}} = \frac{25}{11} \text{ or } 2^3/_{11} \text{ amps.}$$

which is exactly the same answer as we arrived at before when we calculated it by the round-about method. We can see now that for any value of load resistance, which we will call R, the current that it will draw is given straight away by the formula $I = \frac{16\frac{2}{3}}{3\frac{1}{3}+R}$ for that particular potential divider. You can prove this for yourself by trying several examples and working out the results by each method.

Simple Formula

The output voltage delivered by any potential divider can instantly be obtained by the use of a simple formula. We will derive the formula first, then we can see how easily it is applied. Consider the simple potential divider shown in Fig. 3, where actual values have been replaced by symbols.

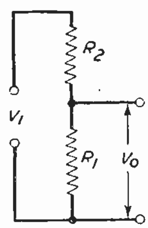


Fig. 3.—Potential divider circuit without values.

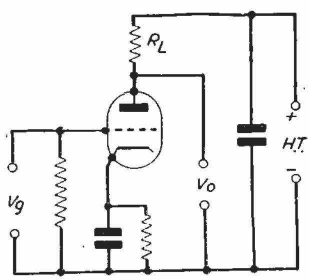


Fig. 4.—Single-stage voltage amplifier.

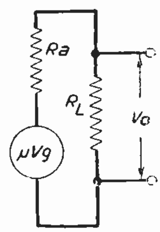


Fig. 5.—Equivalent circuit of Fig. 4.

The current flowing into the divider as a result of the applied voltage V_1 is $I = \frac{V_1}{R_1 + R_2}$ and the output voltage Vo is equal to the current multiplied by the resistance R_1. so

$$Vo = I\ R_1 = \frac{V^1}{R_1 + R_2} \times R_1 \therefore\ Vo = V_1 \frac{R_1}{R_1 + R_2}.$$

We can see how this applies to our first potential divider merely by replacing the symbols by their true values as follows:

$$Vo = 50 \times \frac{5}{10+5} = \frac{250}{15} = 16\tfrac{2}{3} \text{ volts.}$$

The effective output resistance, or internal resistance as it is often called, is straightway got by the formula $Ro = \frac{R_1 \times R_2}{R_1 + R_2}$ and substituting real values $Ro = \frac{5 \times 10}{5+10} = 3\tfrac{1}{3}\Omega$.

These formulæ and the equivalent circuit then show us, in the shortest time, the capabilities of any potential divider whose arms are composed of components where voltage and current bear a linear relationship.

Valve Equivalent Circuits

Let us now consider another type of equivalent circuit which is much used. that of the thermionic valve. Fig. 4 shows the circuit of a triode valve connected up as a voltage amplifier. Now before we look at the equivalent circuit of Fig. 4, let us consider one of the fundamental properties of the valve. its amplification factor. or μ. μ is defined as the change in anode volts divided by the change in grid volts. the anode current being maintained constant. This, therefore, means that if an alternating potential is applied to the grid such that it does not overload the valve, an alternating potential would be developed between anode and cathode which would be μ times as great; and as the valve has an A.C. anode cathode impedance designated Ra, this impedance can be reckoned as being in series with the alternating potential μ Vg.

It is quite logical then to draw the equivalent circuit as shown in Fig. 5. Here all the irrelevant things such as H.T. supply. cathode biassing. valve symbol, have been removed.

When I say irrelevant. I mean irrelevant as far as design procedure is concerned, because we already assume that the valve is operating under correct conditions.

The equivalent circuit (Fig. 5) shows the valve and its circuitry as being equivalent to a generator delivering an A.C. output voltage μ Vg and having an internal impedance equal to Ra of the valve. This generator is feeding the anode load RL across which the output voltage Vo is developed. The usefulness of the equivalent circuit can readily be appreciated when we calculate one of the most important things. the stage gain. Now considering it as a potential divider we saw from a previous formula that the output voltage from a potential divider composed of two arms and being fed with a voltage V was $Vo = V \frac{R_1}{R_1 + R_2}$ and substituting μVg for V and Ra and R_L for R_2 and R_1 we have $Vo = \mu Vg \frac{R_L}{R_a + R_L}$. Now the stage gain is equal to the output voltage divided by the input voltage, therefore the stage gain which we will represent by the letter $A = \frac{V_o}{V_g} = \frac{\mu R_L}{R_a + R_L}$, a very well-known formula.

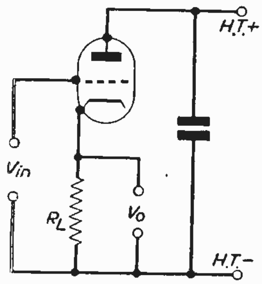


Fig. 6.—Basic cathode follower stage.

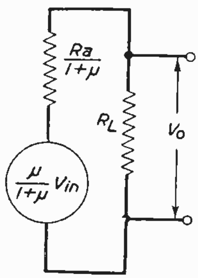


Fig. 7.—Equivalent circuit of Fig. 6.

Cathode Follower

The cathode follower has an equivalent circuit which is often used in analysing its performance. Fig. 6 shows the basic circuit of a cathode follower stage.

The only fundamental difference between the cathode follower and the normal amplifier as far as circuitry is concerned is that the load R_L has been moved from the anode circuit and placed in the cathode circuit; but this simple change considerably modifies the performance of the stage so far as concerns gain, output impedance and input impedance. Fig. 7 shows the equivalent circuit of the cathode follower stage, and one can readily see the difference between it and the normal triode amplifier by merely comparing their equivalent circuits.

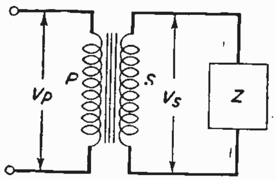


Fig. 8.—Standard transformer circuit.

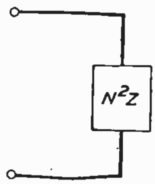


Fig. 9.—Equivalent circuit of Fig. 8.

Here the valve and its circuitry have been replaced by a generator delivering a voltage $\frac{\mu}{1+\mu}$ V_{in} and having an internal impedance of value $\frac{R_a}{1+\mu}$. One can see that the effective generator voltage for the same value of input volts is considerably less than that of the normal amplier (Fig. 5), but we also see that it has a much lower internal impedance, and this is an advantage because it means that the cathode follower will feed into circuits of low input impedance. The cathode follower also has a very high input impedance, and these two factors make it very suitable for such applications as a buffer stage in oscillators or an output stage in pulse generators, etc. Now with the aid of the equivalent circuit and our previous potential divider formula we will calculate the stage gain of the cathode follower as follows:

$$V_o = \frac{\mu}{1+\mu}V_{in} \times \frac{R_L}{\frac{R_a}{1+\mu}+R_L}.$$

Multiplying top and bottom by $(1+\mu)$ we get $V_o = \frac{\mu V_{in} R_L}{R_a + R_L(1+\mu)}$ and the stage gain which equals $\frac{V_o}{V_{in}} = \frac{\mu R}{R_a + R_L(1+\mu)}$. Another well-known formula.

Transform

Let us take as a last example the transformer. In order to ease the calculation and make the subject more easy to grasp we will consider the transformer to be perfect, which means that unlike practical transformers this transformer will have no magnetising current, no leakage inductance, no D.C. resistance, etc., and will therefore be 100 per cent efficient. These assumptions are often made when dealing with the transformer simply. Fig. 8 shows our transformer, which in this case is a step-down transformer, such as a speaker transformer.

The secondary has connected across it an impedance Z which could well be the speech coil of a loudspeaker.

We will calculate the effective impedance one would see looking into the primary terminals as a result of the load Z being placed on the secondary. Now calling this imaginary reflected impedance Zp and remembering that in a 100 per cent. efficient transformer the primary watts will equal the secondary watts the following formula is obtained

$$\frac{V_p^2}{Z_p} = \frac{V_s^2}{Z}$$ where V_p = primary volts and V_s = secondary volts. Rearranging we get

$$\frac{Z_p}{Z} = \frac{V_p^2}{V_s^2} \therefore Z_p = \frac{V_p^2}{V_s^2}Z \text{ and as } \frac{V_p^2}{V_s^2} = N^2$$

where N is the transformer ratio we have $Z_p = N^2Z$. We could therefore represent the transformer by the equivalent circuit of Fig. 9, which shows an impedance of value N^2Z, and that is the effective impedance the output valve in a radio set would see if the transformer were placed in the anode circuit. Incidentally, the transformer ratio necessary to match an output stage to a speech coil can be calculated from the last formula because as one can see, if $Z_p = N^2Z$ then $N^2 = \frac{Z_p}{Z} \therefore N = \sqrt{\frac{Z_p}{Z}}$ where Zp equals the anode impedance of the valve and Z equals the speech coil impedance.

Marine Radar

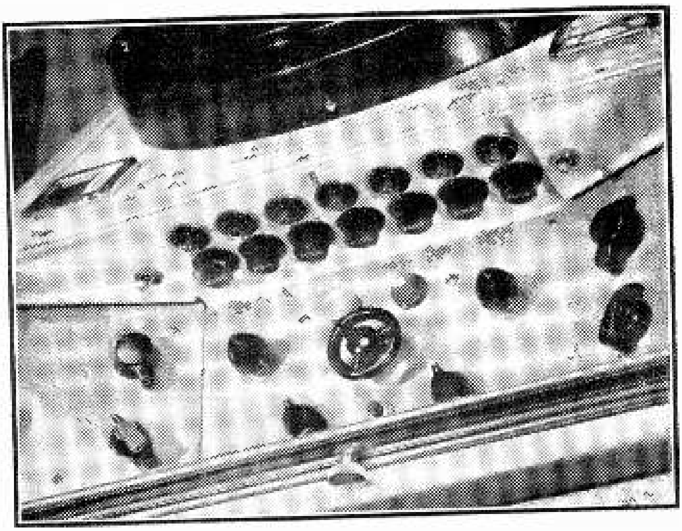
THE Kelvin Hughes Marine Radar Type 2 is a further development of P.P.I. type radar equipment as used for navigational purposes. While this design includes many of the successful features of earlier types, recent advances in the technique of design and construction enable a simplified, more compact and more efficient equipment to be produced.

The principal features of the Type 2 design are the reduced dimensions and weights of the various units and the larger and improved display; the power consumption has also been reduced. Simplification of the equipment and a substantial reduction in the number of expendable items (particularly valves) contribute to increased reliability, while servicing is greatly simplified by new methods of construction.

Dimensions and power consumption. The reduction in dimensions will be particularly noticeable in the case of the two main units (transmitter and display units), which are usually installed in the wheelhouse. This reduction, together with the low power consumption (1 kW.), extends the possibility of fitting radar to the smallest class of vessel.

The P.P.I. Display. A 12-in. diameter cathode-ray tube is used, and a very high standard of definition has been achieved. The larger diameter of C.R.T. increases the scale of the display—expanding, in effect, the display as seen on smaller tubes, and it will be appreciated that the presentation of a one-mile picture on a tube of this size greatly facilitates pilotage in estuaries or other similar narrow and congested areas.

Four range scales, 25 m., 15 m., 10 m. and 1–5 m., are provided, the 1–5 m. range being continuously adjustable between these limits. Accurate range is measured by an adjustable range marker ring superimposed on the display, and immediate approximate range by superimposed calibration patterns. The values of range interval between the rings of the calibration pattern are 4 m., 4 m., 2 m., and ½ m., respectively, for the four ranges.



A close-up of the display unit showing fuses and tell-tale neon indicators.

Radio Valve Review–5

Voltage Amplifying Triodes are Dealt with This Month

IT was Lee de Forrest's epoch-making invention —the insertion of a "grid" between the cathode and anode of a simple thermionic diode, thus converting the valve into a triode—which made possible radio telephony and broadcasting as they are known to-day. In theory—and also in practice—the triode can perform each of the three essential processes for tele-communications: it can be used as an *oscillator* for generating alternating voltages; it can be used as an *amplifier* to magnify radio or audio-frequency signals; and it can be used as a *rectifier* for detecting or demodulating signals intercepted by the receiving aerial.

This is clearly indicated by the fact that early broadcasting receivers were equipped with anything up to six identical triodes.

In practice, however, many of the functions formerly fulfilled by triodes can be performed more efficiently by more complex or special purpose valves, and triodes are not to-day used to the same extent as in the past. There are, however, a number of purposes for which this type of valve is quite adequate.

The Triode as an Oscillator

The local oscillator in a superheterodyne receiver is usually a triode. In most cases this triode comprises a small electrode system mounted in the same envelope as a pentode, hexode or heptode which serves as the mixer. This application has already been covered earlier in this series of articles. Triodes for use as power oscillators in transmitting equipment are rather outside the scope of the present article and will be dealt with in a later instalment.

The Triode as R.F. Amplifier

The conventional R.F. amplifier is, of course, the pentode, but there are a few highly-specialised types of triode designed for use as R.F. amplifiers in very-high-frequency communications equipment. Even so, the stage gains obtained are comparatively small, and the valve serves mainly as a buffer to prevent oscillations from the frequency-changer reaching the aerial.

The Triode as Detector

In present day receiver practice the detector is almost invariably a diode, and a diode is merely a rectifier and has no amplifying power. Early receivers commonly employed a triode as detector, and this form of detector was held in esteem because of its great "sensitivity." A little consideration of the basic circuit of the "leaky grid" triode detector shows, however, that this arrangement is really a combination of a diode detector and an A.F. amplifier. The grid and cathode form, in effect, a diode detector, producing an audio-frequency voltage across the diode load (i.e., the grid leak), and the audio-frequency variations of grid potential produce corresponding variations in the anode current whereby an amplified audio-frequency voltage can be obtained.

The vaunted "sensitivity" of the triode detector, therefore, is merely the normal amplification obtained from the valve in its role of A.F. amplifier. This amplification was, in the past, enhanced by the barbaric practice of applying regenerative feed-back whereby part of the A.F. output was returned to the grid circuit and re-amplified. Blessed were they of the listening fraternity who so handled this "reaction" that the valve did not revert to its third possible function and burst into uncontrolled oscillation!

The Triode as an A.F. Voltage Amplifier

If a diode detector is fed with a really strong signal, a matter of several volts, and is followed by a very sensitive output pentode, voltage amplification between the detector and output stage may not be necessary. Generally speaking, however, the signal available at the detector stage of a broadcast receiver will range from several volts for the local stations down to a small fraction of a volt for the weaker or more distant stations—quite insufficient to load a normal output valve.

A stage of audio-frequency voltage amplification is therefore provided, and this is very commonly a triode. As most modern receivers incorporate A.G.C., the double diode required for this purpose is frequently built into the same envelope as the triode amplifier, and the valve is termed a double-diode-triode.

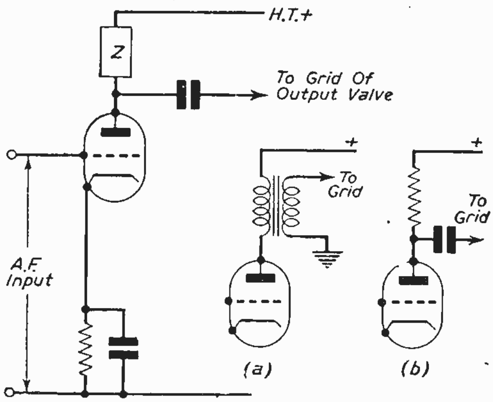


Fig. 1.—Basic circuit of triode amplifier, together with (a)—Transformer coupling, and (b)—Resistance-capacity coupling.

The basic circuit of a triode A.F. voltage amplifier is given in Fig. 1. The amplified A.F. voltage appearing across the load "Z" is transferred to the grid of the following valve, which is usually the output valve. Early triodes for this purpose were of medium impedance, and the "load" in the anode circuit was usually the primary of an iron-cored transformer, the secondary circuit of which was included in the grid circuit of the following valve. The turns ratio of this transformer gave a voltage step-up of from 2½ to 6 times, and thus augmented the somewhat modest gain of the valve itself.

An audio-frequency transformer, however, is

VOLTAGE AMPLIFYING TRIODES

Type	Description or Application	Construction and Base	V_f (V)	I_f (A)	V_a (V)	$-V_{g1}$ (V)	I_a (mA)	g_m (mA/V)	r_a (KΩ)	μ
	Mullard									
	(1) BATTERY TYPES									
	Equipment Types									
DAC32 ..	Diode triode	Octal	1.4	0.05	90	0	0.15	.275	240	65
KBC32 ..	Double diode triode ..	Octal	2.0	0.05	100	0	2.4	1.2	21	25
	Replacement Types									
PM2HL ..	Medium impedance triode	4-pin	2.0	0.1	135	1.5	2.2	1.4	21.5	30
TDD2A ..	Double diode triode ..	5-pin	2.0	0.12	135	1.5	1.95	1.2	25	30
Type	**Description or Application**	**Construction and Base**	**V_h (V)**	**I_h (A)**	**V_a (V)**	**$-V_{g1}$ (V)**	**I_a (mA)**	**g_m (mA/V)**	**r_a (KΩ)**	**μ**
	(2) A.C. MAINS TYPES									
	Equipment Types									
EBC33 ..	Double diode triode ..	Octal	6.3	0.2	250	5.5	5.0	2.0	15	30
EBC41 ..	Double diode triode ..	B8A	6.3	0.225	250	3.0	1.0	1.3	54	70
EC31 ..	Low impedance triode	Octal	6.3	0.65	250	16	20.0	3.2	3.3	10.5
ECC33 ..	Double triode	Octal	6.3	0.4	250	4.0	9.0	3.6	9.7	35
ECC34 ..	Double triode	Octal	6.3	0.95	250	16.0	10.0	2.2	5.2	11.5
ECC35 ..	Double triode	Octal	6.3	0.4	250	2.5	2.3	2.0	34	68
ECC40 ..	Double triode	B8A	6.3	0.6	250	5.2	6.0	2.7	11	30
ECC91 ..	Double triode	B7G	6.3	0.45	100	0.85	8.5	5.3	7.1	38
	Maintenance Types									
ECC31 ..	Double triode	Octal	6.3	0.95	250	4.6	6.0	2.3	14	32
TDD4 ..	Double diode triode ..	7-pin	4.0	0.65	250	7.0	4.0	2.0	13.5	27
354V ..	Medium impedance triode	5-pin	4.0	0.65	250	4.5	6.5	3.5	11.5	40
EBC3 ..	Double diode triode ..	P base	6.3	0.2	250	5.5	5.0	2.0	15	30
Type	**Description or Application**	**Construction and Base**	**V_h (V)**	**I_h (A)**	**V_a (V)**	**$-V_{g1}$ (V)**	**I_a (mA)**	**g_m (mA/V)**	**r_a (KΩ)**	**μ**
	(3) D.C./A.C. TYPES									
	Equipment Types									
UBC41 ..	Double diode triode ..	B8A	14	0.1	170	1.6	1.5	1.65	42	70
	Replacement Types									
HL13 ..	Medium impedance triode	P base	13	0.2	200	3.7	5.0	3.3	12	40
HL13C ..	Medium impedance triode	7-pin	13	0.2	200	3.7	5.0	3.3	12	40
TDD13C ..	Double diode triode ..	7-pin	13	0.2	200	5.0	4.0	2.0	13.5	27

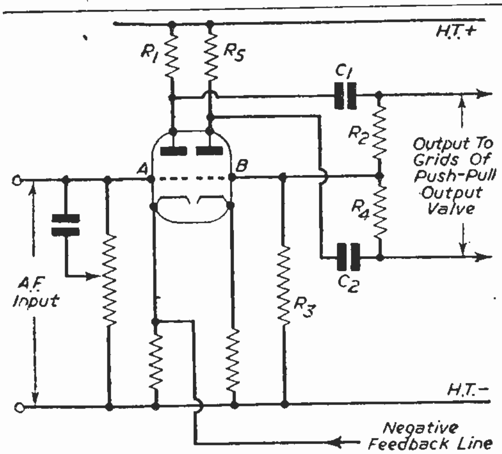


Fig. 2.—Basic circuit for phase inverter using a double triode.

a fairly expensive piece of apparatus, and this arrangement is now seldom used, being replaced by a triode of greater internal resistance operated with a resistive load, a coupling capacitor being employed to transfer the amplified A.F. signal to the grid of the next valve.

The Triode as Phase Splitter or Inverter

In amplifiers employing two output valves in push-pull it is necessary to supply two signals of equal magnitude, but of opposite phase to the grids of the two output valves. This was at one time achieved by using an A.F. intervalve transformer with centre-tapped secondary winding, but with transformer coupling becoming somewhat outmoded, a form of resistance capacity coupling employing a double triode is the more usual arrangement.

Of the many suitable circuits, a typical example is shown in basic form in Fig. 2. The A.F. input is applied to the grid circuit of Section A of the double triode and is amplified in the usual way.

(To be continued.)


SEE THE WORLD

Two-valve S.W. Receiver

A Long Range Simple Receiver for the Beginner

By A. W. MANN

THE receiver to be described, is of simple design, but is nevertheless one of proved efficiency. It should be of interest to those who like to build experimental receivers in which they can incorporate suitable spare components which are to hand. The use of doubtful and junk components should however be avoided.

The Circuit

Fig. 1 shows the theoretical circuit, in which will be seen a regenerative triode detector, six-pin plug-in type coils, and a simple yet efficient form of band spreading. The extra expense of a band-spread condenser and slow-motion dial will prove in terms of results to be fully justified.

Components Values

The grid leak and grid condenser values specified are, in the writer's opinion, the most suitable for use with triode detectors, and enable the operator to obtain smooth regeneration throughout the full tuning range, providing of course that too high a voltage is not applied to the plate of the detector valve. That, however, is a matter for experiment.

The H.F. Choke and Coils

If you have a set of plug-in coils which cover all ranges between ten and one hundred metres, the H.F. choke should be of the type which will function efficiently throughout the full range with entire freedom from resonance peaks. The Eddystone type No. 1010 or one of the old Graham Farrish screened all-wave type meet these requirements.

Should you have suitable tuning condensers and slow-motion dials to hand, by all means use them. There are various makes of coils available and the theoretical diagram shows how the aperiodic or primary winding may be cut out of circuit.

Thus you can use only the grid and reaction winding of the six-pin coil, or four-pin coils if these are to hand. The .00005 μF pre-set, aerial series condenser should be used on all bands apart from the trawler and 160 metres amateur band, and in these circumstances true aperiodic coupling should be used.

If however you are using four-pin plug-in coils, the above trawler and amateur bands are best received using a .0001 μF pre-set condenser in series with the aerial

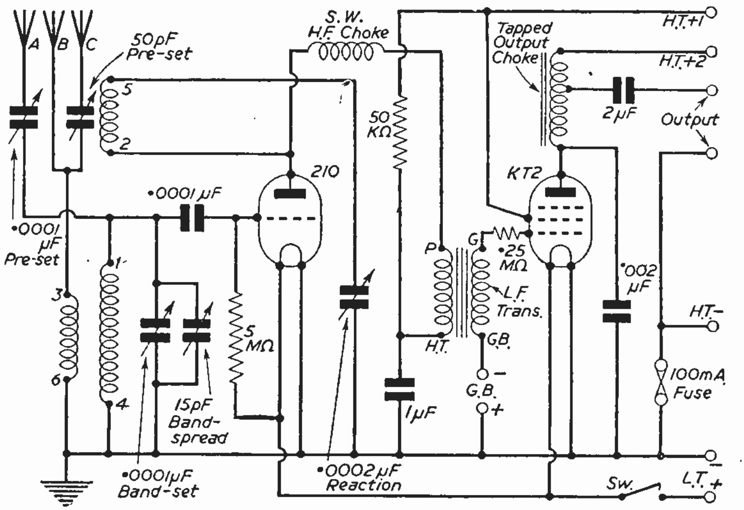


Fig. 1.—Circuit of the Regenerative Detector and Pentode Output receiver.

L.F. Coupling

Transformer coupling is used between the detector and output stage, and decoupling is also included. A suitable pentode L.F. transformer can be used if loud-speaker reception of the more powerful Europeans is desired, and is to hand.

As the original model was required for headphone reception only, a Lissen Hypermu Nickel-iron core type was used. The Ferranti AF4 is also suitable. A pentode output choke, however, should be used.

Depending on the form of H.T. supply used, some modification of the decoupling resistance might be found necessary. If an H.T. battery eliminator is used and the detector plate voltage on the lowest tapping is found to be excessive, the value of this resistance should be increased to 50,000 ohms or higher.

If when tuning on the higher range coils, the regeneration starts with what may be aptly termed a bump, the detector voltage is definitely too high. Some experiment is necessary on each aerial coupling. Note the following. A cuts out aperiodic winding, B is for use on 160 metre bands. C for use on all other bands.

Layout

Fig. 2 shows the component layout. The valve holders and coil holder as shown, are of the base-board type, as used in the original model. If however you have none of these on hand, I would strongly advise the purchase and use of the more modern chassis mounting type.

The layout diagram conveys the relative positions of the components at a glance. The coil holder and the detector valve holder should be as close together as the grid condenser coupled between them will allow. The leads from the band-setting condenser should go to the coil holder connections. The band-spread condenser being wired in parallel with the band-setting condenser.

The Wiring

All leads should be short and as direct as possible, but the tuning condensers should not come within the magnetic field of the coil winding. Do not use old wire. Push-back insulated wire is now available and is very handy to use. My own method when using this is to remove the insulation from one end, and push back the other end. This avoids the piling up of the insulation, and certainly looks neater.

Chassis and Panel

Chassis and panel dimensions will depend upon the relative size of the larger components. An aluminium chassis and panel should be used. Alternatively a plywood chassis with two side runners, and a plywood top face with aluminium sheet could be made at low cost.

It should be understood, therefore, that the chassis and panel dimensions are given only as a guide, and some slight modification may be found necessary.

When building this receiver, do not make the chassis and panel first and then lay out the components. Take a sheet of drawing paper, mark out a plan of the 12in. by 10in. chassis to full size. Follow this by arranging the components in their relative positions as shown at Fig. 2.

This method will enable you to avoid cramped layout, and on the other hand excessive spacing between components, which would result in long leads.

Apply this method to the panel layout but in this instance use cardboard. The relative position of the tuning condenser and dials can be determined at a glance and mistakes avoided.

One point which should be understood is that unless the chassis and panel assembly of this, or for that matter, any short-wave receiver built as a rigid assembly, tuning operations will be accompanied by a series of crackles.

The panel should therefore be of stout gauge material, and the brackets used should have at least a 2½in. base. (See Fig. 3.)

It is also a sound idea to bend over about half an inch at the top of the panel at right angles. This, together with the support provided by the chassis, will guard against panel whip when tuning.

Another point is that the panel should not be depended upon to provide effective earthing of the tuning and reaction condenser moving vanes, or rotors. Wire up to both sides of these condensers: it may save trouble later.

Tuning Dials

The writer is strongly in favour of panel-mounted slow-motion dials (where direct calibration is not desired): the Utility and Muirhead are good examples.

These could be used in conjunction with Raymart tuning condensers. A reaction condenser with integral s.m. drive was used in the original model.

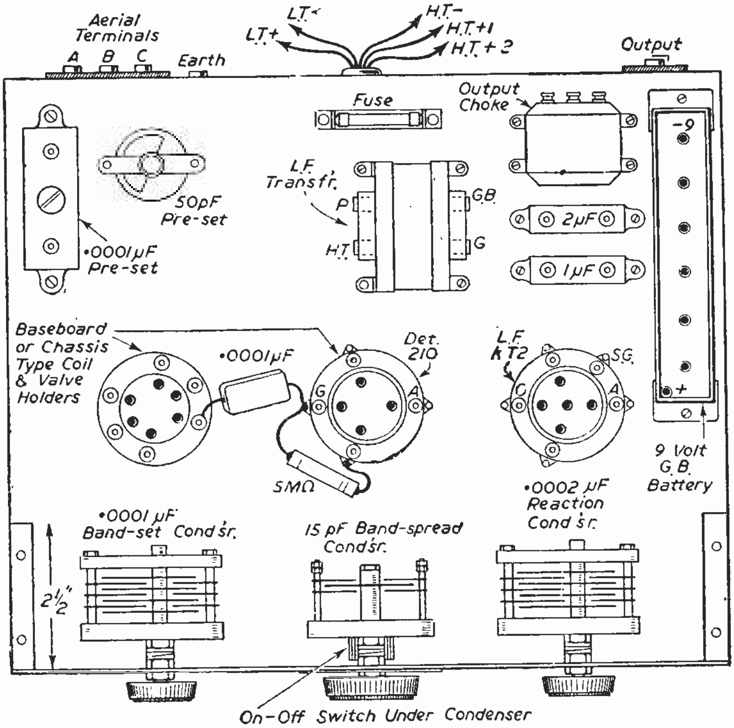


Fig. 2.—Chassis and Component layout.

Safety First

Beginners and others are sometimes worried when about to try out a new home-constructed receiver in case a wiring mistake has passed undetected, with the possibility of burnt-out filaments. Two components should be common to all battery receivers—a fuse and fuseholder. Fuses are cheaper than valves.

Two versions of this receiver were built, the second one now being under test. So far as performance is concerned, there is little to choose between them. This version, however, is far simpler to build and wire.

Experimental Designs

This is an experimental design, as distinct from a sponsored, complete kit receiver. It is intended solely for the experimenter who wishes to use spare components and build his receivers with the minimum of extra outlay.

It is therefore only suitable for those who have previous constructional and trouble-tracking experience. I stress these points because every single model built will include in it different components from those used by the author. In fact, no two versions will be alike. Such differences may result in instability or other trouble being experienced, or, on the other hand, a receiver better than the original model.

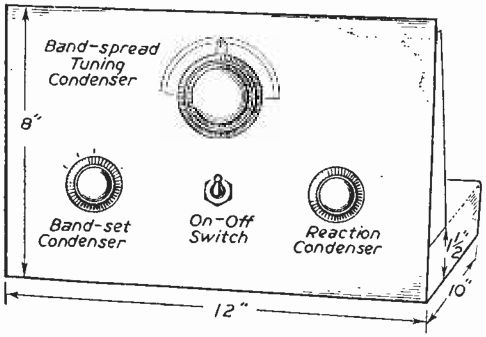


Fig. 3.—Panel and chassis panel mounting.

Point-to-Point Wiring

The true experimenter, given a suitable circuit and layout, should be able to go ahead with the construction, trace the cause of any trouble and effect a cure.

If not, with practice, and by following the methods outlined, he should eventually find it possible to do so. Those are the reasons why point-to-point wiring diagrams are not given.

The original model used by the writer has proved to be a good DX receiver. Those who are interested in all continents, all zones, and set listening period reception should find that it will meet their requirements if carefully built.

It is a good performer on the world broadcast bands, and equally good on the amateur bands. The New Zealand 20 metre amateur phone station ZL4HP has been heard with this receiver, and later verified by QSL card. (Incidentally, this report was sent because no other station came back to his repeated CQ and QRM was bad.)

There is much activity on 160 metres at the time of writing. The low noise level of this receiver makes it ideal for reception on this band.

In conclusion, the writer will be interested to hear of the results obtained with a receiver built on these lines, especially in the case where the aerial is the indoor one described in the April issue of this journal.

Television on Tap

SIX months from the date of the Postmaster-General's licence, the first resident of the City of Gloucester will be able to have trouble-free TV laid on to his home by wire for 7s. 6d. a week. This charge will include four ordinary radio programmes (3 B.B.C. and 1 special) as well as the TV programme whenever there is one on the air. Seventy miles from Sutton Coldfield, he will get reception, free from all interference, as brilliant as though he were only a mile or so from Alexandra Palace. And there will be no aerial to bother with, and only one selector knob to adjust.

Before deciding to go ahead with this progressive scheme, the first of its kind to exist, the Gloucester County Borough Council made a close study of various systems, especially the experimental installation that has been operating on test for a year at Northampton in conjunction with the Northampton Wireless Relay Company, Ltd.

Equipment

This equipment, designed and installed by Link Sound & Vision, Ltd., a firm owned jointly by Pye, Ltd., of Cambridge, and Murphy Radio, Ltd., was finally approved, and work is now going ahead on the Gloucester installation.

Basically, the system comprises a master receiving station picking up programmes from Sutton Coldfield and redistributing them by wire throughout the Gloucester area. Sets similar to ordinary TV sets in appearance are installed in subscribers' homes, and ease of installation is a great advantage of the system. This is the first time that an entire town or area (as distinct from blocks of flats) has been equipped in this way, and town-planning authorities throughout the country are taking a keen interest in Gloucester's pioneer lead.

Our Cover Subject

MRS. CLEMENT ATTLEE, the wife of the Prime Minister, opened the first of the new B.B.C. television studios at Lime Grove, Shepherd's Bush, London, recently. Titled "Studio D," the premises form the B.B.C.'s biggest studio now in operation—5,400 square feet, or more than twice the area of the two studios of Alexandra Palace. Studio D is to be the first "Television Nursery" in the world. Devoted mainly to children's programmes, it will eventually extend the range of children's broadcasts. The first hour additional to the normal Sunday "Hour" was broadcast on Wednesday, May 31st. To cope with the increase in programmes, the B.B.C. has appointed three men and four women as "Children's Hour" producers. Programmes produced in Studio D are fed by special cable to Alexandra Palace for broadcasting.

Our cover this month shows a general view of the new studio as the first programme was being broadcast from the premises.

Our companion paper, *Practical Television*, gives up-to-the-minute news on all topics relative to both the programme and the technical side of this new art.

A SIMPLE TI

An Effective One-watter for the QRP Enthusiast an

"WHAT is QRP?" is fast becoming as perennial and vexed a question as "What is DX?" To the American ham, able as he is to use as much as one kilowatt input legally, QRP is undoubtedly something in the region of 100 watts or under. Transmitters of 250 watts are termed "medium power." And in this country it is not uncommon to hear hams talk of their 25-watters as QRP. Of course, it is all a matter of opinion, but for real QRP the basis should probably be 5 watts or under, possibly even lower. The dyed-in-the-wool low-power fan also considers that for QRP work the valves should be directly heated types—any form of mains supply (even for heaters) being definitely *de trop*.

On this basis, and using a normal H.T. block, it would be difficult indeed to produce an input in excess of a couple of watts. But experience has shown that the increase from 1 to 5 watts makes very little difference at the receiving end. So the QRP fan normally contents himself with anything up to 2 watts, and even this is considered to be QRO by some diehards who go on the air with commendable faith using a fraction of a watt! The line must, however, be drawn at some point and so we will consider that one single solitary watt will meet our requirements. And if anyone doubts what can be done on this power (if it can be called such!) the exploits of such QRP giants (excuse the metaphor) as G3XT, G6ZN, *et al*, should prove to be an eye-opener.

It is no great achievement to work DX using 150 watts input, 100 watts or even 50. Given an average aerial and location WAC is child's play on even 25 watts; before the war we used to do it with 10. But when one gets down to real QRP then contacts of what normally are considered to be "local" become feats. By this, it is not implied that QSO's will become few and far between, but that contacts assume some sense of achievement in proportion to the power used.

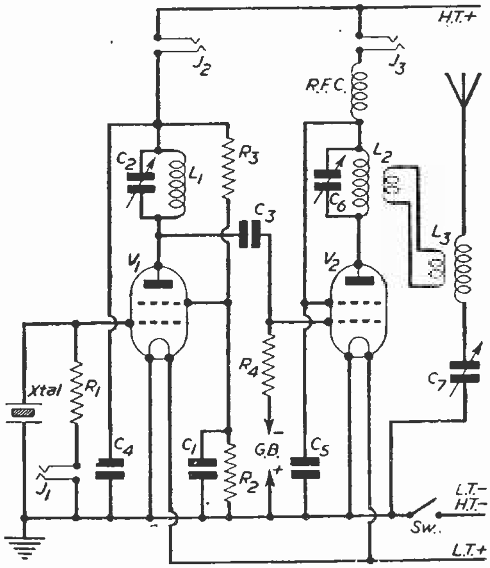


Fig. 1.—Theoretical circuit of the complete unit.

So for the ham who wishes to tread new pastures, probably due to finding the chasing of super-DX a little tedious, and to the newcomer to transmitting, maybe a little QRP work would prove to be not only diverting but fascinating and instructive. At any rate, in both instances, it is certainly worth a trial.

The simple transmitter to be described was originally constructed to meet the requirements of a "hunt-the-transmitter" outing, but it operates very successfully in the shack. The original requirements were that it should put out a strong enough signal to be picked up easily by the marauding bands of receiver teams using simple one- and two-valvers. This on a hastily slung-out aerial.

It was used for its field day activities on top band and this is probably the best frequency to operate it on when used in the shack. But by suitably changing the coils, other bands can be covered. Eighty metres is the next best bet, with 7 Mc/s following as a further choice. It has not been tried on 14 and 28 Mc/s, simply because the writer has no 14 Mc/s crystals; in any case, unless one has 28 Mc/s crystals it means using the PA as a power doubler which would hardly be a practical proposition in this case! So the prospective QRP operator is advised to tackle the low frequency bands, with a special emphasis on 1.7 Mc/s, where surprising results can often be obtained using this type of very low-powered gear.

The Circuit

The one-watter is more or less the same on paper as its larger cousins, though, of course, in a rather diminutive fashion. It is a two-stage transmitter—CO/PA—using the 2-volt KT2 tetrodes in both stages. With 120 volts H.T. the PA should draw around 10 mA., perhaps a little under, which with a little mental calculation works out at

LIST OF C

Resistors
R1—47,000 ohms.
R2—100,000 ohms.
R3—10,000 ohms.
R4—10,000 ohms.

Capacitors
C1—0.002 μF.
C2—160 μμF. variable.
C3—100 μμF.
C4—0.002 μF.
C5—0.002 μF.
C6—160 μμF. variabl
C7—250 μμF. variabl

Valves
V1—KT2.
V2—KT2.

Jack sockets
J1—Keying jack.
J2—CO anode curre jack.
J3—PA anode curre jack.

ANSMITTER

Transmitting Beginner By "ELECTRON"

1.2 watts input. If the H.T. is increased to, say, 150 volts then it is possible to squeeze about 2 watts from this little transmitter. But believe me, the difference in results between the two inputs will be negligible, so it is advisable in the interests of economy to use but 120 volts, or even 100.

The crystal oscillator stage follows convention. The key is inserted in the earthy end of the grid resistor return and this was found to be the most favourable position. Some may prefer keying the screened-grid line, or even the H.T. On no account key the filament circuit—if you do the results will be no oscillation, for the valves must "warm up"!

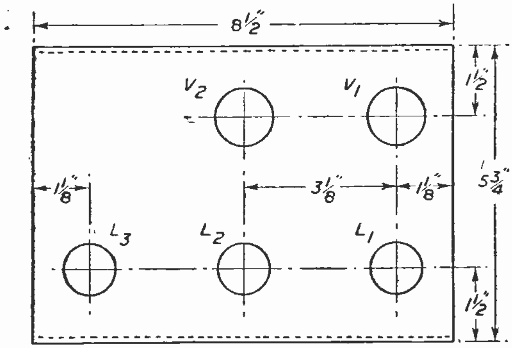


Fig. 2.—Chassis drilling data.

The anode circuit consists of the usual tuned circuit made to resonate with the grid circuit frequency (that of the crystal). The screened-grid feed is of the potential divider type, as this tends to give better stability, a factor that is of utmost importance when QRP is used.

The CO is coupled to the PA stage through the capacitor C3. Battery bias is applied to the PA valve. The output of the PA valve comprises a tuned circuit of the same frequency coverage as that in the anode circuit of the CO stage. Since the transmitter was designed for a throw-out Marconi-type aerial, a tuning circuit for this aerial is an integral part of the transmitter. This aerial tuner is link-coupled to the PA tuned tank circuit and is built into the unit.

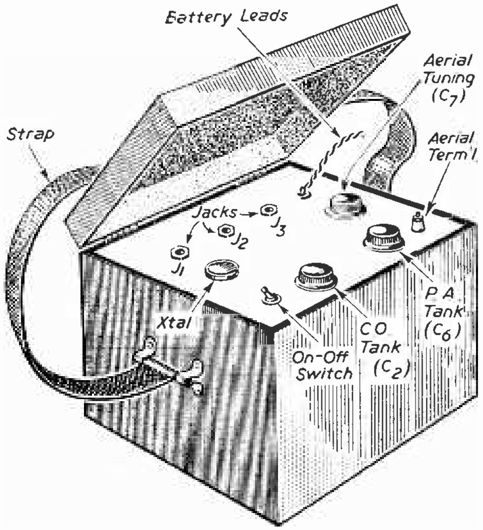


Fig. 3.—Appearance of finished unit.

The two jacks shown in the circuit, J2 and J3, are respectively for checking the anode currents of the CO and PA stages and are used when the transmitter is tuned up. Details will be given in a later paragraph.

Choice of Components

When dealing with medium- and high-power transmitters it is most important to take the utmost precautions against RF leakages and losses. But on QRP work it is vital—for there is so little power to spare that losses must be reduced to the barest minimum. First of all, use ceramic or other low-loss holders for the valves and the coils. Use air dielectric variables and preferably those with ceramic insulation. The crystal holder, which is actually an 807 base, must be of low-loss construction, also.

Regarding resistors, there are but four in the complete unit. These can be of very low ratings—say, $\frac{1}{4}$ watt. Capacitors required number three, apart from the variables in the tuned circuits. Make sure the capacitors are efficient.

As to coils, the prospective builder of the one-watter has several choices. In the original model standard five-pin coil formers were used and the actual coils home-wound. Details of these coils will be given in the next instalment. If the transmitter is to be used on the higher-frequency bands it would be an advantage to use self supporting horizontally mounted inductors; this contingency was not visualised in the original transmitter, but each constructor will have his own

MPONENTS

Other components

- One crystal holder.
- Two British 5-pin ceramic valveholders.
- Three sets of coils and holders (see table for coil data).
- On/Off switch.
- Aerial feed-through terminal.
- Two extension rods and couplers.
- Three control knobs.
- One RF choke.
- Two condenser brackets (insulated).
- N.B.—For measuring anode currents a milli-ammeter of 15-50 mA. FSD is required.

ideas on matters like this as it is purely one of personal choice.

The remainder of the components leave little to be commented upon and so we can now proceed to discuss the details of construction.

Housing the Transmitter

A somewhat unusual form of housing is used, due to the requisites of the original model. The chassis is mounted in a hinged carrying case in a vertical position—the opposite to normal chassis position. The case was purchased at one of the local surplus radio stores and it may be easily possible to find a similar one fairly rapidly. For those desirous of using an identical case it will be of

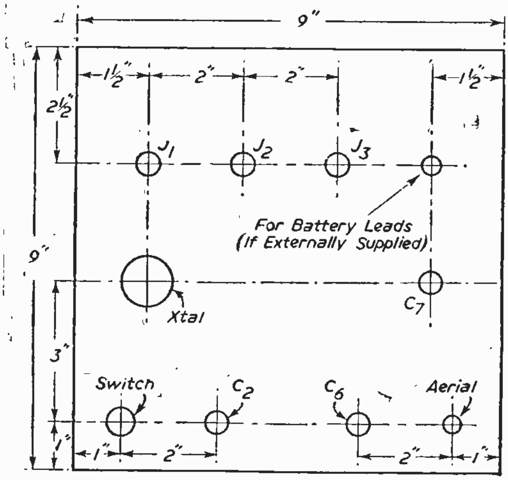


Fig. 4.—Details for panel drilling.

interest to note that it was originally used for an aerial coupling unit and it has these words stencilled on the outside of the lid—" Aerial Coupling Equipment. Aerial Unit F. ZA0841." If one of these cases cannot be unearthed and the constructor wishes to build his one-watter the same as the original one, the sizes of the case, chassis and panel will be found in the panel above.

With the chassis mounted in the way described all one has to do to tune up the transmitter is to lift up the lid of the case and the controls will be exposed for simple adjustment. The sketch will show this quite clearly. And the final touch was the webbing strap. This was taken from a Class D wavemeter and forms an ideal carrying strap when using the transmitter on field days.

Regarding batteries, it is possible to fit these into the carrying case itself providing that midget accumulator and H.T. blocks are used. A couple of simple metal clips could be made up for securing the batteries in position to avoid their moving around inside the case. Arrangements were made, however, in the model described to use external batteries. It was agreed at the time that a self-contained unit would have been better, but the club committee decided that as we already had standard 2-volt accumulators and 120-volt H.T. blocks, it would not be in keeping with the club's current financial status to invest in entirely new batteries! But, if the prospective builder *has* midget batteries or is prepared to purchase them, it is by far the better policy to adopt. For instance, the Ever Ready number 67 battery is very suitable. It will supply 103½ volts and has a grid bias tapping of −4.5 volts. The dimensions of the battery are

Dimensions of Metalwork

Chassis: 8½in. wide × 5¾in. long × 2½in. deep.
Panel: 9in. wide × 9in. deep.
Cabinet (inside measurements): 9⅛in. × 9⅛in. × 6¼in. (with ¼in. flange around the top for bolting chassis and panel). Cabinet hinged lid measures 2in. deep.

2⅞in. x 6¼in. x 5¾in. and this can easily be accommodated in the main case. Other small batteries could, of course, be used, and the grid bias block could be fitted to the inside of the hinged lid with a simple metal clip.

Construction

The layout drawings will show how the whole unit is constructed and it is hoped that the following notes will clear up any odd points that may occur. As it is assumed that many of the readers of this article are beginners in the field of transmitters the notes are designed primarily for their benefit.

The first task, of course, is to drill the necessary holes. The panel and chassis fixing holes are the preliminary drillings and then the holes common to both, such as for the spindles of the variables, the switch and the aerial terminal. As the variables are mounted on brackets set back from the face of the chassis (about which more later) the holes should be a good clearance for the extension spindles (say about ⅜in. diameter). The switch and aerial feed-through holes will naturally depend upon the type of components used. The remainder

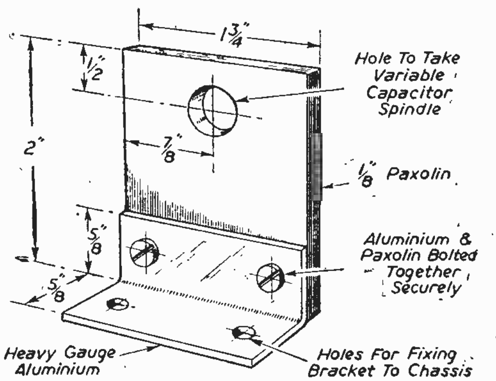


Fig. 5.—Bracket for condenser.

of the panel holes are perfectly straightforward; a valveholder must be fixed for the crystal, three jacks inserted and the aerial tuning variable mounted. Since this component's rotor is earthed the capacitor can be mounted direct on to the panel without any extension rod. The only other panel holes are minor ones—the two small holes to accommodate the anchor tags.

(To be continued.)

Radio Valve Faults—2

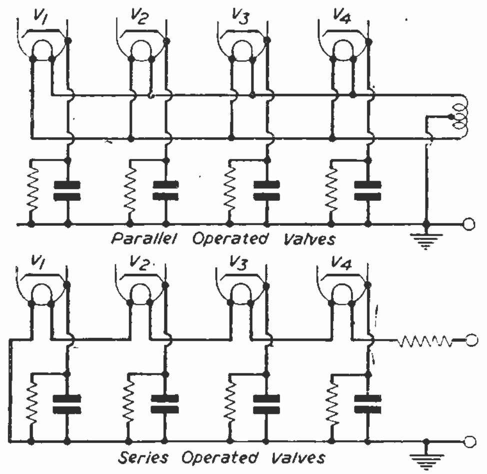
Types of Fault and the Process of Fault Finding in the Modern Radio Valve

By H. GARDNER

FUNDAMENTALLY any valve consists of a cathode which when heated will emit electrons, an anode to which these electrons finally flow, and one or more grids to control the flow or act as screens.

The cathode must be of such design that it is capable of emitting the required number of electrons to constitute the maximum anode current when it has reached some chosen temperature.

The earliest valves had cathodes made from plain tungsten wire which had to be heated to bright incandescence in order to obtain the necessary emission, but these were soon replaced by



Figs. 1 and 2.—Note the possible difference of potential between heater and cathode of V4 in each case.

valves in which the cathode contained a percentage of thorium oxide which enabled them to be run at a lower temperature. In these cases the cathode was directly heated by means of an electric current being passed through it, but the necessity for heating the cathode from an A.C. mains supply required a construction which would allow of the retention of heat so the temperature fluctuations caused by the rising and falling values of the A.C. mains should not be reflected in the operation of the valve.

Consequently, it was necessary to provide a cathode of such physical dimensions that temperature fluctuations of this nature could not occur. In the case of output valves, the filament itself was of sufficient thickness to cause no appreciable trouble, but in valves used in early stages further precautions were necessary.

The emission material or cathode proper, was therefore separated from the heating filament, the cathode being made of suitable dimensions to allow of it retaining a constant temperature.

Cathode Insulation

It thus became necessary to insulate the cathode from the heater and as insulators of electricity are also good insulators of heat, it became desirable to construct the cathode with no more insulation than was necessary to be effective.

A glance at the circuit diagram of various forms of mains receivers will show that the requirements of the insulation between the heater and the cathode will vary according to the type of circuit in use.

In a straightforward A.C. mains set there will rarely be a potential of more than a few volts between heater and cathode, but in the case of series operated valves and valves used in some types of special applications, the potential may amount to a considerable figure.

Consequently, the manufacturer will vary the insulation between heater and cathode in accordance with the normal requirements of the circuits for which the valves were designed.

Breakdown of the heater-cathode insulation is not a usual fault in modern valves operated in accordance with the makers' specified conditions, but if hum in a receiver is believed to be caused by such a condition a straightforward test can be applied to the insulation between the cathode and heater of the valve.

There are, however, several important precautions to take in making this test. The use of a test voltage higher in value than that specified as the maximum to be applied between the heater and the cathode of the type of valve under test, may easily result in breakdown of the insulation of a good valve, so reference should be made to published characteristics before undertaking the test.

It is also worthy of note that expansion and

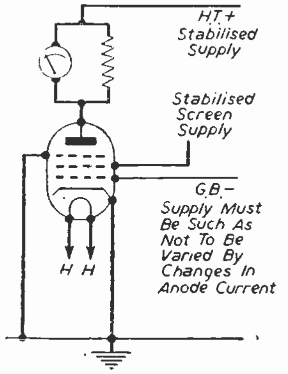


Fig. 3.—Heater supply must apply accurate potential across heater. This supply must give correct voltage for any current drawn. Care must be taken to prevent oscillation through arrangement of leads to electrodes.

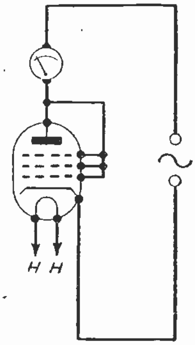


Fig. 4.—A not uncommon method of checking emission. Pitfalls concerning this test are discussed in the text. One of the most serious is the possibility of breakdown due to excessive current.

contraction of the parts comprising the heater and cathode may cause the fault to appear only under certain temperature conditions and it is therefore important to test the valve not only with a cold cathode, but also with the cathode at normal operating temperature.

Cathode Tests

The purpose of the cathode being to provide electrons for the current flow of the valve, it follows that a drop in its emissive properties will throw the valve off characteristic.

The emissive properties of the cathode are reduced with use. If the valve has been severely over-run, or the heater under-run, such properties may be damaged in a short space of time. Testing the condition of the cathode in this respect is not the simple matter that it appears at first sight. In the first place it is necessary to have some sort of a "yardstick" against which to make the measurement, and the only one usually available is the data given by the manufacturer for new valves in good condition operated under certain stated conditions. Testing a valve under these conditions it is possible to see how far it may fall short of the performance to be expected from it when new. This still leaves the tester in the position of having to use his judgment as to whether the trouble is serious enough to affect the working of the particular apparatus in which it is used.

There are numerous pitfalls to be avoided in making this test. Unless the cathode is put fully to work, in other words unless the valve is operated under the conditions specified by the maker, the true drop in emission will not be shown although some drop will be indicated. The ideal test, therefore, is to put the valve under its normal operating conditions as stated by the manufacturers and check the anode current against that given as correct under those particular conditions.

Unfortunately, it is possible for a valve to show up well under such a test when in fact this is far from being the true state of affairs. for unless all the other electrodes and vacuum are in order the anode current may actually be in excess of that given for the conditions of test.

Care must also be taken to ensure that self-oscillation is not present. Capacity between the wiring leading to the electrodes may easily provide a circuit which in the case of high slope valves will cause this trouble. Such self-oscillation will, of course, give an entirely fictitious reading of the anode current.

A not uncommon method of testing the condition of the cathode is to strap together all other electrodes in the valve, apply an alternating current, use the valve as a rectifier and measure the rectified current. Manufacturers' published data does not usually provide useful information for this test. There is also a word of warning to be given concerning it insomuch as an unsuitable value of A.C. supply to the valve may seriously damage it either by causing too much current to be drawn from the cathode or overheating of the control grid or other electrodes to a temperature which may cause gas to be driven from them.

No mention has so far been made of the first and most obvious test which should be carried out on a valve. That is, to ensure that the filament or heater circuit is intact. This may sound exceedingly simple, but there are two points worth watching. In the older types of valves it is not uncommon for the heater or filament wire to become intermittent or disconnected by reason of faulty soldering to the pins in the base. In the case of the old split types of pin, this sometimes was the result of an endeavour to open out the splits in order to obtain better contact between the pin and the socket. Examination of valves of this type with a view to checking this fault may result in a few minutes' job with a soldering iron saving an otherwise good valve from the scrap heap. As nearly all types of valves fitted with these pins are now obsolete, an irreplaceable valve may be saved from destruction by watching this point.

Even a straightforward filament or a simple heater can occasionally develop a fault worth checking, and it can be of interest to make a test as to whether the filament or heater still retains the resistance value that it was designed to have. This test must, of course, be made by measuring the necessary voltage required to pass the stipulated current through the filament or heater under test. as otherwise variation of the resistance of the filament or heater due to temperature change will provide a fictitious result.

Technical Literature Received

A USEFUL range of photo-electric and electronic equipment is described in the new series of leaflets received from Radiovisor Parent, Ltd., of 1, Stanhope St., London, N.W.1, founded 21 years ago. These include the firm's new photo-electric press guard and the recently developed type FR49 Flamestat flame control device for the protection of industrial gas-fired ovens, etc.

Other leaflets deal with units for indicating the density of smoke emission from chimney stacks, counting moving articles on conveyors, automatically controlling the switching of street lights, and the protection of premises by infra-red beams. Other applications of the firm's products include automatic fire detection, the control of hopper filling. the detection of turbidity in liquids, as well as countless specialised applications for almost every trade.

"Mermaid" R/T Equipment

A leaflet has recently been issued by the communications department of Philips Electrical, Ltd., and is now ready for mailing to the trade.

The leaflet concerns a compact "Mermaid" radio-telephone equipment specially designed for small vessels. It conforms with G.P.O. requirements.

New Aid to Valve Dealers

A comprehensive price list of all current radio and television valves at present manufactured in this country, together with their Mullard equivalents where applicable, is now being distributed to the trade by the valve sales department of Mullard Electronic Products, Ltd.

This list, which is in the form of a chart measuring 26in. wide by 22in. high, is intended for wall-mounting. It has been designed for quick and easy reference, and should prove of great value to all radio and television dealers.

MAGNETIC RECORDING

Hints and Tips for Experimenters

By F. C. BLAKE

FROM the number of letters received in the past six months, the construction of magnetic recorders, both wire and tape varieties, has become very popular. Recording by magnetic means is not a new invention, Poulsen having used it at the beginning of the century for recording telegraphic messages, before the advent of the thermionic valve.

The discovery in recent years of the use of high-frequency current, as distinct from the earlier D.C. biasing, has helped considerably in improving the reproduction, giving a greater dynamic range, and great reduction, if not elimination, of background noise.

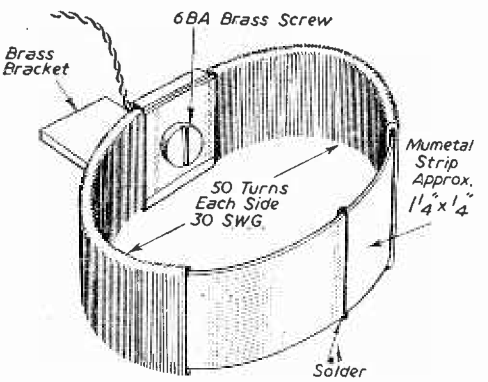


Fig. 1.—A simple record-playback head.

To obtain the best results, the wave-form of the H.F. bias frequency must be sinusoidal, or at least symmetrical, otherwise a noisy background will be produced on playback, equivalent to a small direct current bias, the amount depending on the proportion of "unbalance" of the wave-form. The use of a buffer stage will help to keep the wave-form correct, especially if there is a considerable load to supply, as when erasure current is also being taken from the same source.

Difficulty is often experienced in getting sufficient current to erase, and I find the best scheme is to feed the erase head through a series condenser of suitable capacity to act as a resonant circuit. The precise capacity can easily be found by placing a small lamp, such as a 6.3v. .3 amp. pilot light in series with head and condenser, and changing the capacity until optimum brilliance of bulb is found. The actual frequency of the oscillator is not critical, and is usually in the neighbourhood of 30-50 kc/s.

Although heads may now be obtained ready-made, a simple yet quite efficient head may be made from a strip of mumetal as shown in Fig. 1, which is suitable for both tape and wire.

The strip is best obtained from a discarded para-feed or similar inter-stage transformer, and it should not be cut or bent more than absolutely necessary, as this will tend to harden it and destroy its particular properties. Mumetal is recognisable by its silvery appearance—but unless you are certain of the core material you will be using, it is best to get several samples from different sources. Radio metal is also silver in colour and, although this is not suitable for record-playback heads, it will be useful for making erase heads. If you have some silicon iron stampings these will be ideal for erase heads, which can be made in the same way as the record-playback heads but with a 2 thou. brass shim inserted in the gap instead of the aluminium foil.

A brass bracket is made to secure the lamination which is drilled in the centre to clear a 6 B.A. screw, the tips of the "lam" if previously cut must be perfectly square and clean edged, the inside butting edges should be tinned.

After covering each side with a layer of medical plaster, two windings of fifty turns are carefully put on. Next, the ends of the "lam" are carefully bent with a small pair of pliers so that the tips touch each other squarely. This is most important, and demands just a little patience.

When satisfied that all is correct, carefully insert a small shim of aluminium foil such as is used for wrapping chocolates. The foil is usually in the neighbourhood of 1 thou. thick.

A little solder is now run on to the ready tinned undersides of the tips to lock the gap at its set width. Finally, the face of the gap is carefully filed dead level with a magneto or other very fine file, and then polished with a well-worn strip of emery cloth. If care has been taken in correctly aligning the gap and pole pieces very little filing

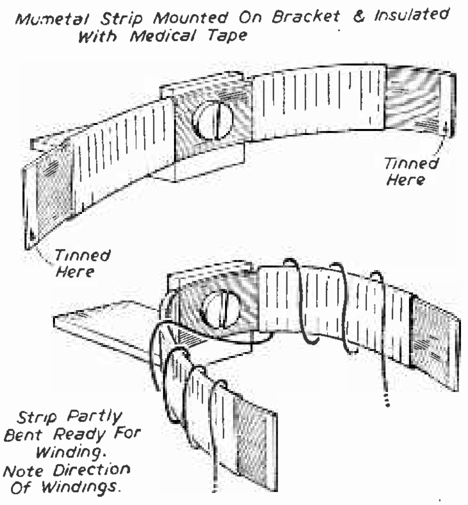


Fig. 2.—Details of construction of the head.

should be necessary. Too much filing is detrimental.

The lead ends should be covered with silk sleeving taken from an odd piece of flex and twisted together to reduce hum pickup.

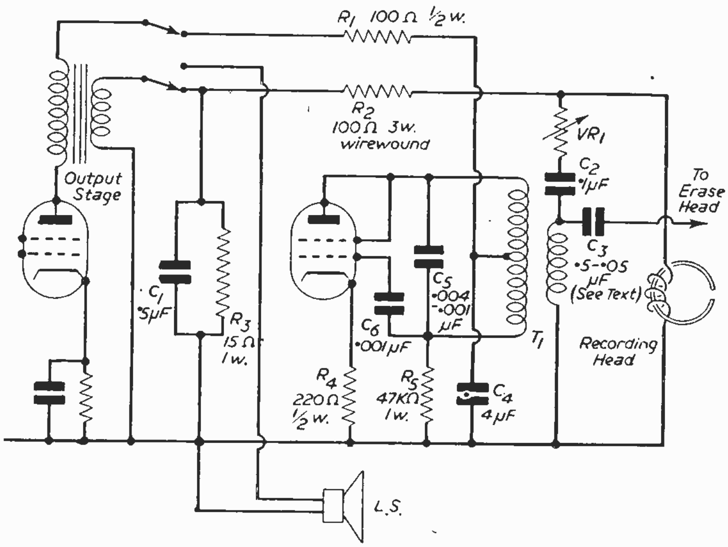


Fig. 3.—Oscillator and head circuit. The oscillator coil may be obtained from Wright and Weare, Judge Industries, etc.

It is a good plan to make several heads at the same time, selecting the best after testing each one individually. The D.C. resistance of the head is about .5 ohms.

Impedance Counts

Several readers thought that the head should have a D.C. resistance of 15 ohms when connecting it to a "15 ohm" transformer. This, of course, is not necessarily so, as it is the *impedance* of the head that matters, which is governed by the number of turns, the core, and the gap width, whilst the D.C. resistance is due to the size of wire used. In the head described 30 s.w.g. silk and enamelled wire was used; any gauge, however, around this figure will be quite satisfactory.

High-impedance heads are rather difficult to make as the large number of turns necessitates the use of thin gauge wire, but as already stated, they may be purchased ready-made, should the constructor wish to record at high impedance direct from the anode circuit of the output valve, and to dispense with the input transformer.

In either case, whether high- or low-impedance heads are used, the recording head should be fed through a resistor. A suitable circuit for the head described is shown in Fig. 3. The resistor R2 keeps the audio recording current reasonably constant at all frequencies, and without it there would be a preponderance of bass, and serious overloading. This is due to the fact that the head acts almost as a pure inductance. At high frequencies, the head impedance would be high, with consequently a low current flow through its windings; as the recording frequency is decreased more and more current would flow, until saturation with attendant distortion commenced.

The most satisfactory way of finding correct level of audio current is to use a "loop tester," Fig. 4. An endless wire or band of tape is made up, and either fitted to the recorder mechanism with a spring-loaded pulley to hold it taut, or to a gramophone motor, on the spindle of which is mounted a suitable pulley. By fitting two heads, one for recording, the other for playback, instantaneous checks can be made with different bias and recording current levels. It is most important to see that the heads are aligned correctly with one another, otherwise there will be a serious loss of top response.

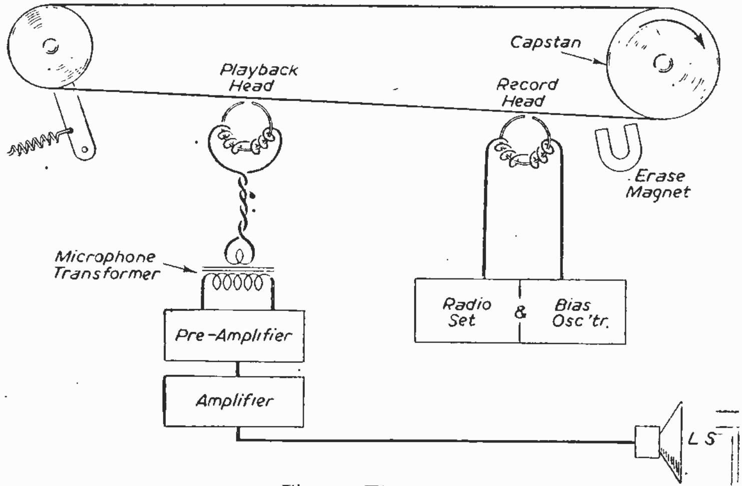


Fig. 4.—The Loop Tester.

ADDRESS CORRECTION

WITH reference to the article on Tape Recording in our July issue, will readers please note the new address of Audigraph, Ltd.: 74, Gt. Hampton Street, Hockley, Birmingham, 18.

Designing your own Receiver

Advice and Guidance for the Beginner

By STANLEY BRASIER

THERE are always beginners in radio and there always will be, but the subject cannot be learned quickly, and a start is usually made by building one or two simple receivers to strict design—such as those found in this journal. This is all very well, but before long the time comes when the student wants to try his hand at building a receiver to his *own* design, but the desire is thwarted by the fact that he does not know how to start. To this one may answer that if the student has not that knowledge he is not in a position to start designing. The argument to offset this, however, is that by such designing he will absorb far more in the matter of knowledge and in a quicker period. For it is an undisputed fact that a little practical experience is worth a whole lot of theory. For instance, if one wants to know something of the workings of a certain test instrument, one may wade through pages of literature on the subject and still not find the exact information desired, but make the thing up—be it only on the breadboard principle—and after a little experiment, this knowledge, plus a lot more, will soon be acquired.

Similarly, in receiver design, the same benefits are conferred. With a published design, one takes it for granted, knowing that it *will* work and that is the end of it. With a receiver of one's own design, however, there is always the stimulus of pride in one's own efforts, and the added interest spurs one on to get the utmost out of the set. Quite probably the finished result will be little or no better than a published design, but what a lot of knowledge has been gained.

Having started the ball rolling, so to speak, the thirst for knowledge increases and is supplemented by theoretical and technical learning from the many books on the subject. By this means, practise helps theory and vice versa.

It is the experience of the writer that these would-be designers have a reasonably good idea of the requirements of the radio section of the receiver and in this respect need only a little guidance in the method of procedure. It is usually the calculation of values of the various components in the power section which cause the most worry.

Symbols

The beginner will naturally have studied the design of various receivers, and should be familiar with the numerous diagrammatical symbols used to denote components, types of valves, etc. The ability to draw theoretical circuit diagrams is essential before anything is attempted and in this connection most textbooks include a page or two

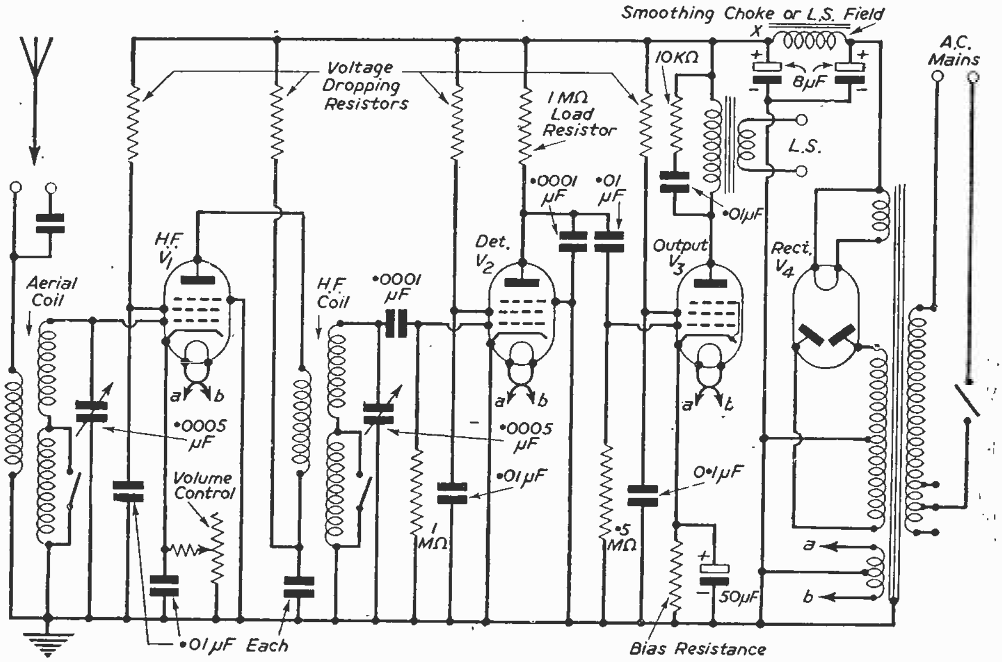


Fig. 1.—A suggested circuit for a simple 3-valve plus rectifier A.C. Mains Receiver. Details of design and the principles involved will be described in this series.

devoted to symbolic diagrams. Similarly, valve data books provide lots of information on the various types of valves. All this should be studied earnestly.

With a beginner having a natural and keen interest in radio, certain factors are easily or automatically absorbed and are implanted upon his memory for good and all. It is the theory, after a certain point, that is so difficult to master. The enthusiast knows, from constant reference to these pages, that one must observe various rules of thumb. He knows, for instance, that a condenser will pass A.C. and will block D.C. but does not know why; and that A.C. has to be rectified before it can be used for H.T. at the valve electrodes, but has no notion of A.C. theory.

Given a certain standard of intelligence, such things, and many others, are readily absorbed, and usually provide all the bare information to start on the venture of receiver design.

Naturally, a certain amount of elementary knowledge on the subject of radio is necessary. We have already discussed the question of circuit diagrams but to emphasise the ease with which such a diagram may be read—as compared with a wiring or block diagram—refer to any typical receiver design. Most novices tend to avoid the theoretical counterpart, until it is realised that a block diagram is quite tedious to unravel, and that once mastered, the essential details of a theoretical diagram can be appreciated in a few moments. In this respect it is interesting to see how long it takes to decipher a block diagram into its theoretical equivalent.

Ohms Law

A thorough knowledge of Ohms Law is also essential because it is the key to many calculations necessary even to simple design. This is also available in most text books, but for ease of reference it is given here. It denotes the relationship between voltage, current and resistance, and is the law by which, if two quantities are known, the third may be assessed. Where E=voltage (electro-motive force) I=current in amps., and R=resistance in ohms, the various formulæ are:

$$I=\frac{E}{R} \qquad R=\frac{E}{I} \qquad E=I\times R$$

Note that in all cases I is in amps., not milliamps., so that the result must be multiplied or divided by 1,000 if milliamps. are used.

And since wattage (or power) is dependent upon the quantities used in Ohms Law it can be assessed as follows:

$$\text{WATTS (or W)}=\frac{E^2}{R} \text{ or } W=E\times I \text{ or } W=I^2\times R.$$

Resistances

Whilst on the subject of simple mathematics it would be as well to consider resistances and condensers in series and parallel, for such calculations are always useful during receiver adjustments. Resistances in series are merely added together thus, $R=R^1+R^2+R^3$, etc. Resistances in parallel are more difficult since the resultant R is the reciprocal (the quantity divided into 1) of the sum of the reciprocals, thus:

$$\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right)=\frac{1}{\text{TOTAL}}=R$$

In this connection it is useful to remember that two resistances of the same value, joined in parallel will have a total resistance of half the value of one.

Capacity

Turning now to capacity, the formulæ are similar, but reversed. Therefore, condensers in parallel are calculated thus: $C=C^1+C^2+C^3$, etc., while condensers in series are:

$$\left(\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}\right)=\frac{1}{\text{TOTAL}}=C.$$

Here, again, two condensers of the same value joined in series have a resultant value half that of one, so that two 0.0005 μF. condensers in series result in a total capacity of 0.00025 μF.

Inductance

Regarding inductance, it is not necessary at this stage to wade through pages of elucidation on coil design. This is a case where one can study the matter at any time and at any length. For the purposes of initial receiver design it is sufficient to think of inductance in terms of, say, a long- and medium-wave coil, or a 20 henry low frequency choke. It is far safer and more reliable in the first stages of construction to make use of commercial coils—home construction to one's own design can come later, when the theory has been grasped. But there is no point at the moment in worrying and making lengthy coil calculations when the ready-made component, tried and tested, is available at a modest price, and provides an acknowledged standard of efficiency.

The novice should be able to discriminate between high frequency and low frequency, alternating and direct current, and appreciate the basic principles of voltage dropping, smoothing, decoupling, etc.

Knowing these, he will, in turn, be able to analyse a circuit diagram into its H.F., DET., and L.F. sections. The same applies to the A.C. and D.C. power supplies.

Regarding such items as coupling and decoupling condensers, grid leaks, paths, etc., here again we may rely on the rule of thumb, or accepted practice. From reference to various designs we know that the value of a grid condenser of a detector valve comes within a certain range, therefore we would not be likely to make this value 2 μF.

For the remainder of the circuit, Ohms Law can be relied upon to see us through and an explanation of calculations, together with a certain necessary standard of ability in simple mechanics, will be given later.

Assuming we are now in a position to estimate out requirements with regard to a suitable receiver, this will naturally vary according to individual ideas and localities, but for the purposes of this article we cannot do better than to decide on a three-valve H.F. detector and L.F. receiver which always has good average sensitivity and acceptable quality. And for the purposes of greater explanation, the power can be provided from A.C. mains.

Design

If we attacked the problem of design scientifically we should say that for a given tiny input, a certain power output is required, and then proceed to find out how many valves would be wanted and the stage gain required to produce the results needed. However, previous designers have shown us that our three valves will give a good performance and it is now only necessary to decide on the types of valves to be used. This is where one's preferences may come into play and provides an opportunity to design the set around valves of one's own choice.

Output

The first thing to decide is how much power output (in terms of watts) is expected and as we are not concerned with batteries we can afford to be somewhat extravagant with current, upon which output is always dependable. On the other hand, the receiver is to be limited to three valves, only one of which will provide L.F. amplification. However, by using a pentode output valve which gives more watts output for a given anode current than does a triode, we can rely on about 2 watts, which (we will assume) is ample for our requirements. It should be appreciated that to realize this output a reasonably large input signal, such as that from a local station is necessary.

In order to provide as much sensitivity as possible to the receiver it would be wise to use H.F. pentodes for the detector and H.F. stages, so that we are now in a position to choose the valve types. In practice, of course, valves may be on hand which could be used, but as a start must be made somewhere, it is suggested that the receiver is built around type 6K7 for the H.F. stage, 6J7 for the detector and 6V6 for the output stage.

Coupling

The next question is that of intervalve coupling between detector and output valve. If a triode were being used as detector we could be sure of plenty of amplification by using an L.F. transformer. The use of this component, however, encourages hum pick-up and, in any case, is not suited to the H.F. pentode which it is proposed to use. On the other hand the gain of the H.F. pentode is greater than the triode so that with resistance capacity coupling, good amplification will still be obtained.

There is quite a choice of the type of coupling between the H.F. and detector stages; that most common being by means of an H.F. transformer. Choke coupling is also very efficient and may be considered as an alternative.

Selectivity

The question of selectivity has also to be dealt with; but in order to avoid complications at this stage we will content ourselves with two tuned circuits, one of which will provide coupling between the aerial and the first valve.

Reaction should be provided in order to increase the overall sensitivity of the receiver, but since this method of control is passing out of favour it can be omitted, thus obviating an extra control. We shall see later, however, when testing the completed set, how an alternative system may be applied.

Power Supply

The circuit is now pretty well lined up and it remains to provide a power supply to the valves. This is to be drawn from A.C. mains via a transformer. (It is proposed to explain later the requirements for an A.C./D.C. receiver.) The mains transformer primary winding should be rated at the voltage of the mains and in practice it is tapped for voltages between 200 and 250. On the secondary side, three windings will be required, i.e., the H.T. winding, the rectifier heater winding, and that which supplies the ordinary valve heater in the receiver. These latter are always run in parallel, therefore the current required is additive, the voltage being that of one valve. Reference to the valve data will show that this voltage is 6.3, whilst the combined current consumption of the three heaters is 1.05 amps. This then, is the rating for the transformer heater winding. Although the *voltage* rating should be correct, it is usual to allow a safe margin of current working and in this case up to 2 amps would be permissible.

Regarding the rectifier, we could have used the metal type, thus saving a secondary winding, but since this is intended to be shown in the A.C./D.C. version, the valve counterpart is suggested here for purposes of explanation. It is usual for a transformer incorporating a 6.3 v. winding to be provided with another at 5 volts for the valve rectifier. This is quite convenient as there are various types from which to choose, but we cannot decide on this until the H.T. requirements have been calculated.

Transformer Requirements

Full wave rectification is standard in A.C. (only) receivers and for this reason a centre tapped H.T. winding is required and it is now necessary to find out what voltage and current is to be drawn from it. Further reference to the valve data shows that at 250 (max. voltage) the 6V6 consumes 50 milliamps including the screen grid, which must not be forgotten. The 6K7 anode and screen will take 13 milliamps and the 6J7 a further 2.5. Actually this latter current will be lower because of the anode load resistance connected in the 6J7's anode, causing a severe voltage drop, with consequent low current; but the difference will not be sufficient to upset our calculations. The total current is therefore 65½ milliamps and it now remains to find the voltage required. The maximum voltage permissible for the anode of the 6V6 is 250. Note that this is *at the anode* and in the interests of quality and watts output it is advisable to maintain it. It is now necessary to calculate how much resistance (therefore voltage drop) will be in circuit between this point and the output point of the rectifier.

Loudspeaker

If we are to consider using a mains energised loudspeaker, now is the time to decide, because it will affect the voltage needed at the H.T. secondary quite considerably. The field coil of this type of speaker may well have a resistance of 2,000 ohms, to which may be added about 400 ohms for the primary of the output transformer. Note that the total current will pass through the loudspeaker field coil whereas only that of the output valve anode will flow through the transformer primary. By applying ohms law (I=C×R) the voltage drop across the field coil will be $\frac{65 \times 2.000}{1,000} = 130$ v and that across the transformer primary $\frac{45 \times 400}{1,000} =$ 18 v. In addition to this the grid bias voltage of 12 must also be considered.

(To be continued)

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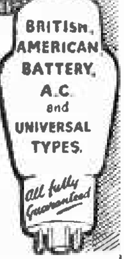

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AMERICAN RADAR RECEIVER APN4. Less Valves. In addition to the receiver components this aircraft receiver contains the power supply for the indicator. Contains shoals of components, including 15 valve holders, high voltage condensers, switches, I.F. transformers, etc., etc. Perfect condition. ONLY **17/6** (carriage, etc., 5/-).

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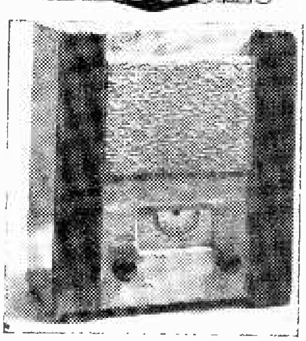

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TRANSFORMERS (AUTO), 1.6 KVA., 230v. 1-phase 50 cycles, tappings for 40-80-110-120-150-190v. at 7 amps., **45/-,** carriage 5/-. **TRANSFORMERS,** 0.4 KVA., tapped primary 180-200-215-230v. 1-phase 50 cycles, output 17.5v, tapped at 14v. at 20 amps., **35/-,** carriage 5/-. **L.T. RECTIFIERS,** metal, full wave, 12v. 1½ amp., with all data, **7/6,** post **9d. TRANSFORMERS,** input 210-230-250v., output tappings for 3-4-5-6-8-9-10-12-15-18-20-24-30v. at 2 amps., **20/-,** post **1/-. PARMEKO RADIO TRANSFORMERS,** drop through shrouded type, input 110-225-245v., output 250-0-250v. at 90 m/A., 5v. 2 amp., 6.3v. at 3 amps., screen, **17/6,** post **1/-. PARMEKO POTTED CHOKES,** 3.6 to 4.2 H. at 150 m/A., 20 H. at no D.C., weight 4 lbs., **7/6,** post **1/-;** ditto 100 H. at 10 m/A., 5,000 r.m.s., weight 1½ lbs., **5/-,** post **9d. BELL TRANSFORMERS,** input 200/250v., output 4 and 8v. at ½ amp., **2/6,** post **7d. IMMERSION HEATERS,** 230v. A.C. D.C., 500 watts, fitted high grade thermostat which cuts out at 80 deg. C. and in at approx. 3 degrees less, **12/6,** post **1/-. ROMEC VACUUM PUMPS,** also suitable as air compressors, rotary vane type gives even pressure, fitted 2in. long ⅜in. dia. shaft, **15/-,** post **1/3. GENERATORS,** MK-II "A", for electrical engine speed indicators, **10/-,** post **1/-. BOX KITES,** dinghy antenna type, 36in. x 17in. x 17in., flying cord and screw cap metal box container, **12/6,** post **9d. OIL TEMPERATURE GAUGES,** 0-100 deg. C., 40ft. flexible tube and mercury capsule, **7/6,** post **9d. TELESCOPIC DINGHY MASTS,** extend to 7½ft., ⅞in. dia. tapers to 7/16in., ideal for T.V. aerials, microphone stands, fishing rods, etc., weight 6 oz., **7/6,** post **6d.,** 3 for **20/-,** post **9d. SERIES MOTORS,** 12v. 20 amp. D.C., ¼ h.p., fitted ⅜in. dia. shafts, 7in. long, 4in. dia., an ideal motor for electric lawn mowers, etc., **15/-,** post **1/4. TELEPHONE SETS,** consists of 2 combined microphones and telephones, coupled with twin flex they provide Perfect 2-way communication, sound power, no battery required, with 25ft. twin connecting flex, **7/6,** post **9d.**
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Programme Pointers

This Month MAURICE REEVE Deals with Some More Recent Programmes

FREQUENTLY a certain thing happens with persistent regularity—under our very noses, as the saying has it—of which we are going to take notice some day, but never do. Usually it is something of no very great consequence to us, otherwise we would not let it go by week after week without giving it our attention. Nobody could imagine the original "Twenty Questions" or "Itma" living very long without receiving our very prompt and favourable patronage: might as well think of a leaking burst pipe or a barking dog going unnoticed. And so it was with "The Soviet View" until I read that questions about it had actually been asked of Ministers in the Mother of Parliaments as to the unwisdom of letting the thing be put over. I at once looked it up in the *Radio Times* and learned that no less than the twentieth instalment was to be heard on May 3rd.

What was all the fuss and blather about? We know funny questions get asked at Westminster about all sorts of peculiar things, but if number 20 of this excessively lengthy series struck the average for the whole, some of our representatives certainly seem to get the wind-up over very little. The usual quotations from the Soviet press—the whole thing is a collection of Russian press and broadcast points of view as directed to listeners in the U.S.S.R.—about the "capitalist beasts" and "the Western warmongers" left me stone cold and more than a little sceptical of the translator's abilities. Of the rest, I faintly remember something about barber's shops, the difficulties of the Russian housewife, and such-like innocuania. All very silly, futile and boring.

A very good programme of its type was "The Story of Madame Tussaud," April 18th. The first half, or more, might have been mistaken for "Scenes and Incidents in the French Revolution," so many heads fell into the basket, and so long and lusty were the shouts and huzzas of the mob—too lusty and too plentiful. But the story of how the original and young Madame Tussaud modelled them and afterwards brought them to England and toured with them, thus founding the famous exhibition, made a capital story which few of us, probably, knew anything about.

Scrapbook

"COUNTRY MIXTURE." The sixth of this scrapbook programme series, presenting facts, fancies, legends, songs and stories of the western counties, presented Dorset, and gave a delightful hour's entertainment. I hope the whole of Great Britain can be similarly covered. Dorset has ever been one of our most beautiful counties, perhaps a little undeservedly overshadowed by its illustrious western neighbour, but given a new lustre and added fame in recent years by the immortal Hardy. The series, free from the blight of the cheap, vulgar record which so mars "Down Your Way"—an otherwise rather similar feature on a parochial scale—brings home to us the beauties of our country in all its manifold variety and tradition; a salutary lesson for all.

Scott has long been a favourite author of mine, and though sales of his works are not what they once were, it does not necessarily prove us right and our fathers and grandfathers wrong. In any case, their bulk is sufficient to make any budding writer of to-day employ a whole-time secretary working out the income-tax they would render him liable to pay. The three-part adaptation of "Ivanhoe," by J. R. Gregson, made capital radio material, full of colour and alive with action. The effects department had a glorious time and did not labour in vain. "The Talisman" should be equally effective. And how about "The Bride of Lammermoor" for a Sunday evening serial? Galsworthy and Trollope are, I learn on the best authority, badly in need of a long rest.

Steel

"WE WORK IN STEEL" (April 11th) I also liked very much. The story, briefly, only dealt with the industry during the last 20 years, and was based on a steelworker and his family who, after passing through the great depression and drawing the dole in the '30s, recover their prosperity and a bit more in the boom of the war years, the whole winding up with a diplomatically balanced peep into the industry's future under nationalisation. Whether the programme might have been even more effective had a more historical approach been made to the subject; whether a little more of the origins and developments of steel-making processes and a little less of the joys and sorrows of Mr. and Mrs. Wilson and family would have been more acceptable, I wouldn't know. It would certainly have made a different feature. So we'll leave it at that and repeat that it was a very moving and human documentary.

"Itma's" Successor

"TAKE IT FROM HERE" may be "the successor to Itma," just as anything else may be styled the successor to Gilbert and Sullivan or "The Merry Widow." Whether the succession is justified is quite another matter. Everything has to be succeeded, we know, and if the heir is not as worthy as its sire it's just too bad, and the best available must come into the inheritance. But anyone who tells me that the present No. 1 radio variety show—which is how I believe it is ranked—is as good as Itma was, then I say, with all the deference that emphatic disagreement permits, "Sir, or Madam, you simply do not know what you are talking about." A very easy way of proving this would be to listen to an old Itma programme and compare the almost continuous hail of laughter which accompanied those programmes throughout their lengths with the comparative quietude and sobriety in which the present shows are played. There is not one character of "Take It From Here" that will be talked of five minutes after it gives its last show. But Col. Chinstrap, to name only one from Itma, is still talked of and quoted as we quote Dickens.

Theatre Productions

"FLARE PATH" and "Mary Read"—the latter notable for the presence of Flora Robson in the title role—were good theatre productions. "Flare Path" set Terrence Rattigan on his very successful career as a playwright. But, good as "Flare Path" is—and what a success it achieved during the war!—it seemed strangely unreal five years after; unlike "Journey's End," which moves us to our depths every time it is put on.

"Silence in Heaven" was also very interesting but I was very amused to notice that, though the story occurred in the house of a family which must have been able to easily afford excellent quality stair carpets, there was an excessive amount of running up and down obviously uncarpeted staircases.

The opera orchestra has settled down to a very capable instrument under the leadership of John Sharpe and conducted by Stanford Robinson. They give many well varied and interesting programmes. In a "Music in Miniature," one Friday, Cyril Smith played Albeniz's glittering "Triana" as though it were "Tunbridge Wells," by Archibald Snooks, from his "Famous Spas" cycle.

News from the Clubs

SOUTH MANCHESTER RADIO CLUB

Hon. Sec.: M. I. Wilks, 57, Longley Lane, Northenden, Manchester.

AFTER a very successful run with membership increasing at each meeting, activities were concluded with D/F Contest. The club station operated portable at Castle Mills and the first team under G2AUC located the site in one hour ten minutes, followed by G3ESK and his followers nineteen minutes later. Three other entries had difficulties with their receivers and in order to join the rest of the club for tea had to open the sealed envelopes containing details of the location of G3FVA/P. In spite of bad weather, all agreed it had been a most successful afternoon and plans are already under way for a repeat performance, with the winners this time operating the transmitter and the committee forming a team. An 8 mm. cine film was taken of the event by G3BVP, and it is hoped to show this at the Hamfest.

A later meeting was devoted to a general discussion, and a special general meeting was held to amend certain parts of the club's constitution the evening being concluded with last-minute arrangements for the D/F contest.

At the meeting on the 9th June, G2AUC and G3ESK spoke on their experiences during the D/F contest, explaining the gear used.

Several talks by outside lecturers have been arranged, but dates for these are not yet available.

Prospective members are invited to our fortnightly meetings at the Church Schools, Northenden, meetings for July are 7th and 21st at 7.30 p.m.

WORTHING AND DISTRICT AMATEUR RADIO CLUB

Hon. Sec.: A. B. Forge, G3FRG, 2, The Plantation, Worthing, Sussex.

MEETINGS of the above club are held the second Monday of the month at the Adult Education Centre, Worthing, at 7.30 p.m.

THE MIDLAND AMATEUR RADIO SOCIETY

Hon. Sec.: W. J. Butler, 32, Pilkington Avenue, Sutton Coldfield.

DR. SUMMER recently lectured on The Human Vision in relation to Television. The membership greatly appreciated the lecture and looked forward to further evenings with Dr. Summer.

The Society holds monthly meetings on the third Tuesday at the Imperial Hotel.

THE WEYMOUTH RADIO AND TELEVISION CLUB

H.Q., 74, Franchise Street, Weymouth, Dorset.

THE Club has now settled into new H.Q. A transmitter has been installed with the call-sign G3GNU. Membership is good; a few members holding their own licences. A receiver has been installed and various equipment for the use of members. Monthly meetings are held on the last Thursday of each month at 7.30 p.m. The club is open every evening and members have their own keys for the H.Q. Lectures are being given each week on the construction of television and of local details for the club's own television in the future. Prospective members are always welcomed. The section is anxious to increase its membership. A club news sheet is published each month. Morse classes are available for those wishing to commence or improve their C.W. The club is now eight months old, and it is hoped to increase the membership. A visit to a B.B.C. transmitter is soon to be arranged for members.

READING RADIO SOCIETY

Hon. Sec.: L. Hensford, G2BHS, 30, Boston Avenue, Reading.

RECENTLY Dr. Lemon (G2GL) gave a talk and demonstration on Lightning. The generation of high voltage electric charges, and some of the properties of these charges were shown. The effect of installing lightning conductors was demonstrated by subjecting models to very high voltage D.C. discharges (100KV approx.). Many questions followed.

Mr. Stride, of Ekco, Ltd., talked on Frequency Standards and Frequency Measurement, demonstrating a "Ham"-built frequency meter, with an accuracy of two parts in 100,000.

A postal ballot has shown the majority of members to be in favour of the present system of two main society and one instructional section meetings per month; but with a higher proportion of talks and demonstrations by local Hams at the main society meetings, in place of the commercial firms as at present.

BRIGHTON AND DISTRICT RADIO CLUB

Hon. Sec.: L. Hobden, 17, Hartington Road, Brighton.

CLUB evenings, during the summer months, will have talks and ragchews on alternate Tuesdays. More ragchew time seems essential, as members find time short after any talk or demonstration held. The club TX (G3EVE) will also get more frequent "airings." June programme includes a further talk on aerials and a lecture by a local society connected with T.V.I. locating. The club is also participating in NFD.

EDINBURGH AMATEUR RADIO CLUB

Hon. Sec.: David A. E. Samson, 56, Elm Row, Edinburgh, 7.

THIS club is going along very well and now has its own transmitter operating under the call sign GM3HAM.

During the summer months meetings will be curtailed, but weekly meetings will continue until the first Wednesday after NFD, and thereafter at fortnightly intervals until the annual general meeting on September 13th.

POOLE AND DISTRICT AMATEUR RADIO CLUB

Hon. Sec.: J. Loader, 5, Highwood Road, Parkstone, Dorset.

THE club, now five months old, is going ahead, three more members being enrolled at the last meeting, when G5GG gave a talk on Audio Filters. Meetings are held on the first and third Mondays in the month, a junk sale being held shortly in order to raise funds for the club's ticket, due any day now, when the club's Tx will be active on 160, 20, 10 and 2. New members are always welcome and will be sure of a seat as the club can seat 50 comfortably (on chairs, too!). Refreshments will shortly be provided.

THE WEST MIDDLESEX AMATEUR RADIO CLUB

Hon. Sec.: P. F. Blomfield, 213, Harrow View, Harrow, Middlesex.

MEETINGS of the club are held on the second and fourth Wednesdays of the month at 7.30 at the Labour Hall, Uxbridge Road, Southall, Middlesex.

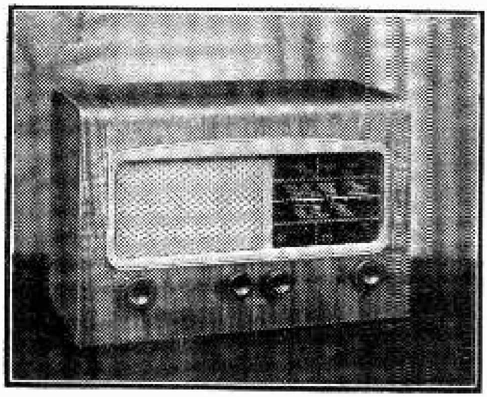
At the annual general meeting the following were elected as club officers and committee.

Hon. Chairman: H. C. Bostock.
Hon. Sec.: P. F. Blomfield.
Hon. Treasurer: C. Gott.
Hon. Asst. Sec.: G. E. Bunt.
Hon. Librarian: H. K. Winwood.
Committee: L. E. Hickingbotham, P.T. Smith.

News from the Trade

A New "Melody Maker"

LAST year's Radiolympia revival of the Cossor "Melody Maker" has proved immensely popular with both trade and public, but there are many who have asked for a wood cabinet version. This has now made its appearance as Model 500 at 17½ gns., tax paid. While following the general specification of the current set, the opportunity has been taken to introduce one or two circuit modifications which result in improved signal-to-noise ratio and more efficient tone control.



The new "Melody Maker," Model 500.

The appearance is very nice, with polished walnut cabinet, larger dial with three-colour calibrations, and "gold" metal grille.

A. C. Cossor, Ltd., Highbury Grove, N.5.

High-voltage Adaptor

IN the next column is an illustration of the Model 341 High Voltage Adaptor being produced by Taylor Electrical Instruments, Ltd., the nett price being 37/6.

By use of this adaptor the D.C. voltage range of the Model 170A Electronic Testmeter can be extended up to 10 kV.

With the present demand for reliable indication for voltages up to that figure this adaptor increases the scope of usefulness of Model 170A to a considerable extent, particularly where television service work is concerned.

Taylor Electrical Instruments, Ltd., 419-424, Montrose Avenue, Slough, Bucks.

New Miniature Hearing Aid

FOR the past 27 years Mr. Victor Foot, F.I.P.I., A.M.Inst.B.E., the well-known radio engineer and inventor, has devoted his life to the improvement of hearing aids. In 1938 he was the first man to instal Hearing Aids in London Theatres, Cinemas and Concert Halls.

Now Mr. Foot has produced a new Ossi-Caide hearing aid which weighs only 4 ozs. This compares most favourably with the government "issue" hearing aid which weighs 1 lb. 10 ozs. It incorporates the three miniature valves recently developed by Mullards. Made of aluminium its case contains two minute dry batteries and its size is only about 3 × 4 in. But these new Ossi-Caides can also be bought with an electro-magnetic pick-up and would thus enable a deaf person to listen in to the radio while working out in the garden, hearing a baby cry indoors while outside their house, etc. The retail price is £31 10s. 0d. (thirty guineas).

Ossicaide, 24, Kensington Church Street, W.8.

Mr. Victor Foot demonstrating his latest miniature hearing aid to trade buyer Joan Masters, of New Malden, Surrey, at the B.I.F.

Service Aids

THREE interesting new lines are announced by the British Distributing Co. They are:

Nylon Drive Cord.—50ft. card, retail price, 4s. 6d. A guaranteed perfect grip, non-stretch, glass-cored drive cord. This material is available to manufacturers and large users, on reels of a few gross yards at a lower price.

Radio Cement.—Retail price, 1s. 6d. Perfect adhesive for all radio and workshop uses. (Cellulose cement based).

Switch and Contact Cleaner.—Retail price, 3s. A very efficient dirt and verdigris remover, for use on all electrical and radio contacts.

The British Distributing Co., 66, High Street, London, N.8.

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).

R.F. Capacity Meter

SIR,—I have studied with interest the article describing the "R/F Capacity Meter," in the June issue of PRACTICAL WIRELESS, and wish to point out that the appendix to the article contains a number of errors, some of which may have been introduced in printing and of them you may well be aware.

The whole of the proof, however, is very misleading since it sets out to prove that the capacity of a condenser can change with frequency, which is not true. The writer of the article has, in fact, shown that a given parallel circuit of resistance and capacity can be replaced by an equivalent series circuit (with properly chosen values of Rs and Cs) giving the same impedance and phase relationships for a given frequency as the original. At low frequencies the values of Rs and Cs will approximate closely to the values of R and C used in the parallel circuit but at high frequencies the formulae derived in the appendix to the article will have to be applied to given values of Rs and Cs applicable to each frequency used. Under no circumstances, however, can the capacity of a perfect condenser be regarded as anything but a fixed quantity.

The true reason why a low frequency investigation of capacities below about 0.1 μF cannot be made with accuracy is that the impedance offered by such condensers to low frequencies is very high and small differences between these high impedances are difficult to measure. Using the apparatus described with a frequency of 1 Mc/s or so and producing audible beat notes with a fixed radio frequency carrier, a high degree of accuracy may be expected. The use of too high a frequency would, of course, make the reactance of the condensers used very small and the ordinary circuit wiring losses would become important, and 1 Mc/s would seem to be a good compromise frequency for the range of capacities to be tested.—A. W. DALE (Leeds).

[The Author states: I have given Mr. A. W. Dale's letter a very careful reading and have come to the conclusion that he has failed to grasp the purpose of the appendix to my article. That purpose was, as the first sentence states, "To prove that a condenser behaves as a lower value of capacitance at increased frequencies due to series resistance." We are not considering perfect condensers, such do not exist except as concepts to simplify and clarify calculations. What we do consider is the sort of condenser an amateur or a radio service engineer handles every day—a practical condenser possessed of a variety of imperfections due to dielectric polarisation, lead resistance, plate resistance (especially in silver micas, etc.), insulation resistance and effects due to corona in high-power, high voltage condensers.

It is standard practice, as you will very well know, to consider a normal, every-day condenser as being equal to a perfect condenser with a resistance added either in series or in parallel to simulate the effect of lumping all the causes of power-loss into one easily handled quantity. The magnitude of the resistance is chosen so that an equal amount of energy is lost in it as would be lost in all the imperfections of the normal condenser.

I would refer Mr. Dale to the following text-books, where he will find that the capacity of a condenser can and does change with frequency.

1. *"Experimental Radio Engineering"—Rapson. Exp. 43 and 44, Pp. 69-71.*
2. *"Fundamentals of Radio"—Terman. Pp. 10-12.*
3. *"Radio Engineers' Handbook"—Terman. Pp. 109 and 110.*

As to the errors in the equations these are so slight that nobody is likely to be led astray by them. They are, 1. three "pFds" have slipped down out of line with the division bar, they also should be Fd's, i.e., Farads. 2. A slide-rule slip gave the final answer as 42.3 pF, this should be about 46 pF.—R. H. Q.]

One-valve Signal Generator

SIR,—In the June, 1950, issue of PRACTICAL WIRELESS you have printed a circuit of a one-valve signal generator (Page 249) from 5-206 metres.

Looking at the circuit at A.2, R.F. is connected to a 25 kΩ pot via .005 μF condenser to H.T. +.

Surely no signal will pass due to the 16 μF electrolytic condenser from H.T.+ to earth? This will stop any signal passing. Can you please check this, as I am very interested in the circuit? Also, can you explain the need for a 150 pF trimmer across the 500 pF tuning condenser for extending range?—P. POYNTER (Sutton).

[In reply to Mr. Poynter's letter, may I say he is quite correct in his opinion that the 16 μF electrolytic will bypass the R.F. to earth. The original signal generator was built as a separate unit and used with a commercial power pack which, no doubt, had a dropper resistor between the 16 μF capacitor and the output terminals which in this case would, of course, be the R.F. output connection. The power pack diagrammed was, in fact, an afterthought added simply for the benefit of younger readers who may not be familiar with power supply connections.

An H.F. choke or a resistor of about 10,000Ω will serve effectively to prevent this bypass action if placed between the electrolytic and the R.F. terminals.

The purpose of the 150 pF trimmer is to extend the range of the medium-wave coil to cover the 465 to 473 Kc/s. frequencies used in so many I.F. stages. The coil used is a standard medium-wave coil which, with a .0005 μF tuning condenser, covers up to about 550 metres. The addition of the trimmer extends the range to 645 metres, in other words 465 Kc/s.—T. W. D.]

"Simpliscope"

SIR,—With reference to my article in the June issue, the "Simpliscope" was designed for use in the audio frequency band. Only one range of sweep control was incorporated in the oscillator circuit as it was felt that there was little to be gained by including sweep frequencies much below 50 c.p.s., and the range chosen has an upper limit at about 500 c.p.s. For normal use this is quite sufficient if the user does not mind seeing a number of waves in the trace; for instance, a 5,500 c.p.s. input will give about 10 waves on the screen and normal sine wave distortion may readily be observed. If a higher range is desired, the 500 pF condenser from V_1 anode to grid should be reduced to, say, 100 pF. It should not be necessary to alter the value of the screen to suppressor condenser, thus a simple switch may be used, but the leads must be kept short.

The signal amplifier will give reliable results up to the highest audio frequencies, but there is no compensation for the phase shift which occurs at high frequencies and may lead to some distortion on, say, a square wave trace at frequencies above 5 Kc/s.

I have taken care to point out and even exaggerate the shortcomings of the instrument when compared with a normal commercial machine, but over ten years of experience with oscilloscopes has convinced me that simplicity is the goal to aim at in the design of a general workshop 'scope and, if any extra facilities are required, the circuits can be "added on" and designed to suit the type of work in hand.—F. R. PETTIT (Herne Bay).

Delivery Dates

SIR,—I read with interest in your discussion columns Mr. Baker's letter from Bristol *re* "delivery dates" in the June issue. I have had a similar experience.

I purchased a double-diode-triode battery valve of a well-known make at the full standard price (14s.) through one of your advertisers. Unfortunately for me, I had it some time before using it, as my time was very limited towards building the set I intended it for, which was a P.W. experimental set for battery fidelity in which the valve was used as a detector amplifier.

The results were excellent, excepting that the valve was intermittently microphonic. Clarity and volume were good, but the slightest touch on the valve caused the speaker to ring like a bell, and the slight ringing rose and died away intermittently whilst the set was in operation.

The retailer to whom I returned the valve for his opinion suggested sending it to the manufacturer for "test" with a view of replacement, and gave me the necessary form to fill out. And that was the last I saw of my valve. The result of the "test" was contained in a statement from the manufacturer a fortnight later, which told me that the guarantee period had expired—just that and no more.

I waited a fortnight or so for the return of the valve and then wrote asking for it back. The reply came back stating that as it had been through a third person's hands they hinted the retailer might have it. I wrote him and he, of course, had not received it.

I wrote a second letter to the manufacturers and informed them of this, and asked for my property back as they should have no interest, as the guarantee had expired, and offered to send the cost of packing and postage.

Their reply to this was that *all valves* sent to them were "tested" irrespective of the guarantee having expired. Those valves which did not come up to their standard were disposed of. This I was told was the usual method of the trade.

I wrote a third letter pointing out that legally I considered they had no right to destroy my property, especially as the valve was perfectly usable and I might have been able to minimise the defect by cushioning the valveholder.

To this I had a reply that since I sent the valve at my own invitation they could not be expected to accept any responsibility for its safety—but had I stated on the form or with it, which accompanied the valve to the manufacturers, that I wanted it to be returned they would have returned it.

Unfortunately for me, this question did not appear on the form as to the valve being returned to me, so I unknowingly sent the valve 200 miles or so to be scrapped after a try-out with the set and at a cost to me of 14s.

These faults should be found out at the test bench before the valves are marketed, and not at the user's expense.—W. GOSLING (Liverpool).

The Beginner

SIR,—I have recently spent a few evenings in reading through back numbers of PRACTICAL WIRELESS, and a paragraph on the Editorial page of one of them has prompted me to write to you.

On February 1st, 1936, you wrote: "... Future issues will devote a considerable amount of space to the newcomer, and articles will be given ... to bring the beginner into line with the experimenter who has been following broadcasting since its inception."

This was practical and sensible and I, for one, would be glad to see this policy adopted afresh to meet the needs of a new generation of newcomers to this most fascinating of hobbies.

The basic principles of radio, I suggest, are best learned by a combination of theory and practical work. Would it be possible to embark on a course, starting with the simplest receivers as a basis to illustrate elementary theory and adding to these as the reader's knowledge increased?

With proper guidance, such as your journal could give, it is possible to obtain a good deal of knowledge and experience without heavy expense, and I suggest that to help your less experienced readers along such lines would be to render a real service to amateur radio.—F. PICKBOURNE (Liverpool).

[*We commence a useful series for the Beginner on page* 356 *of this issue.*—ED.]

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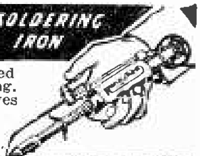

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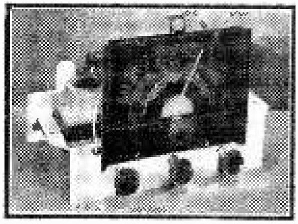

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Impressions on the Wax

Review of the Latest Gramophone Records

FRANZ SCHMIDT'S opera "Notre Dame" was a big success when first performed at the Vienna Opera in 1914, and the "Czardas" which has been recorded on *H.M.V. C3975* gives ample indication of its tuneful attraction. An Austrian born in Bratislava, Schmidt was at first a 'cellist in the orchestra of the Vienna Court Opera, before concerning himself quite extensively with composition until his death in 1939. Four symphonies of his show his qualifications to use an orchestra. Johann Strauss's "Furstin Ninette," which is on the reverse side, appeared in 1893, product of a period in which Strauss was producing operas at a rate of nearly one a year. This "Ninette Polka" is typical of his engaging style. For both dances the Vienna Philharmonic Orchestra under Karl Bohm give sparkling performances of this Austrian music.

A set of records that should appeal to most is a recording of Sibelius's "Symphony No. 6 in D Minor, Op. 104," on *H.M.V. DB6640-2*. It is played by the Royal Philharmonic Orchestra under the able baton of Sir Thomas Beecham, Bart.

Bach's "Prelude and Fugue in E Minor" for the organ, recorded by Fernando Germani, is notable for the fact that it was made in Westminster Cathedral, London. The Prelude is in four parts on two 12in. records—*H.M.V. C3984-5*.

Other orchestral recordings from which you may take your choice are "Siegfried Idyll," by Wagner, played by the Philharmonia Orchestra conducted by Paul Kletzki on *Columbia LX1296-7*. "Londonderry Air" and "Handel in the Strand," played by the Philharmonia Orchestra conducted by Warwick Braithwaite on *Columbia DX1660*, and Borodin's "Overture Prince Igor" orchestrated by Glazounov and played by the Philharmonia Orchestra conducted by Issay Dobrowen on *H.M.V. C3979-80*.

Recordings from Italy

The Parlophone Company continue with their Cetra Series of recordings from Italy by Italian artists with "Don Carlos," sung by Cesare Siepi, bass, accompanied by the Orchestra Sinfonica Della Radio Italiana conducted by Arturo Basile on *Parlophone R30016*. "Don Carlos," first produced in Paris during the Universal Exposition in the spring of 1867, was the last work written by Verdi before he achieved acclaim with "Aida." The libretto of "Don Carlos" was adapted from Schiller's tragedy, and although the opera has not succeeded in remaining in the regular repertoire as a complete work, there are several excerpts of wide popularity. This recitative and aria from Act 4 is one of the most famous fragments. This fine Italian bass gives full dramatic intensity to the situation. Also in this series is a recording by Gabriella Gatti, soprano, of the Mozart aria from the second act of "The Marriage of Figaro" and Act 3 of Weber's "Oberon." The number of this record is *Parlophone R30017*.

Light Music

Two very old favourites are introduced by Andre Kostelanetz for his latest recording of "St. Louis Blues" and "Stormy Weather," on *Columbia DX1662*.

"Waltz of my Heart," from Ivor Novello's "The Dancing Years," is featured by Roberto Inglez and his Orchestra on *Parlophone R3287*, coupled with "Los Celos Y El Viento" and Josef Locke, the popular tenor, gives us that firm favourite of Milne's, "Christopher Robin is Saying His Prayers" on *Columbia DB2696*, on the reverse being "The Story of the Sparrows."

Records by two well-known choirs will be welcomed by those who like this type of singing. The Luton Girls' Choir whose records are becoming increasingly popular, have chosen "Some Day My Heart will Awake," from Ivor Novello's "King's Rhapsody," and "Take the Sun," from the film "The Glass Mountain"—*Parlophone R3293*. The choir is conducted by Arthur E. Davies, with orchestra conducted by Philip Green.

The Kirkintilloch Junior Choir, conducted by the Rev. J. R. Macpherson, sing "Morag's Cradle Song" and "The Isle of Mull" on *Parlophone R3294*.

Debussy's "Ballade" forms a fitting subject for a pianoforte solo by Walter Gieseking on both sides of *Columbia LB97*.

Variety and Dance Music

The popular Saturday night broadcasting singer, Terry, the Irish Minstrel, has recorded "Peggy O'Donovan" and "My Way" on *H.M.V. B9917* and the Tanner Sisters, with the Hedley Ward Trio, have selected the hit tune of the moment "Choo'n Gum," coupled with "A Load of Hay," on *H.M.V. B9923*.

When Donald Peers resumed broadcasting earlier this year, after a break of several months, it was suggested by some listeners that his voice had gained fresh quality. Certainly the reception he has been given since his return proves that he is indeed one of the biggest attractions in show business. His latest H.M.V. contributions include the British ballads, "Down in the Glen" and "When There's Love at Home" on *H.M.V. B9907*.

Ivor Morton and Dave Kaye continue their series of Tin Pan Alley Medleys with a number of popular tunes on *Parlophone F2408*; Jack Simpson and his Sextet play "I'd've Baked a Cake" and "Six Times a Week and Twice on Sunday," on *Parlophone F2411*; and finally, Joe Loss and his Orchestra play "A Media Luz" (Tango) and "Chiquita Bacana" (Samba), on *H.M.V. DB6069*.

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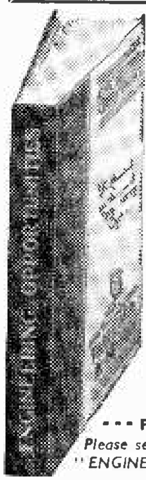

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