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The circuits presented in this series have been designed by G. A. French, specially for the enthusiast who needs only the circuit and essential relevant data.

No. 63. A Shorted-Turns Tester for Line Output Transformers

One of the more difficult faults to detect, during the servicing of tele-receivers, is that of short-circuited turns in the line output transformer. Troubles of this nature are unfortunately somewhat frequent, and they are difficult to diagnose because their existence does not necessarily result in complete loss of picture or horizontal scan. Particularly is this true if the short-circuit occurs between adjacent turns in the line output transformer, or between turns in successive layers. In such instances it is practically impossible to detect any fault in the transformer by normal ohmmeter readings, since the resistance of the transformer coil will only be very slightly lower than that of a serveable winding. Furthermore, the resistance of the faulty coil may remain within the limits imposed by wire and winding tolerances.

Despite these points, it is still possible to detect a line output transformer with short-circuited turns by reason of the fact that the short-circuit causes both the inductance and Q of its winding to drop considerably. This alteration in value enables certain checks to be made on a line output transformer without removing it from its televiser, and an experimental item of test equipment suitable for making such checks is described this month.

This Month’s Circuit

The circuit of the test equipment accompanies this article. It will be seen that it comprises a simple a.f. triode oscillator employing grid-leak bias and a conventional series-fed tuned circuit arrangement. The triode may be any low-mu valve of the 6J5 class. Two test prods are connected effectively across the oscillator tuned circuit; the latter consisting of the coil L1 and the condenser C2.

Connected in series with the grid leak of the oscillator is a microammeter with an f.s.d. of 500μA. The purpose of this microammeter is to show the negative voltage at the grid of the triode and thus provide an indication of the oscillatory voltage built up across L1.

The test equipment is employed by connecting its test prods across the anode winding of a line output transformer which is suspected of having short-circuited turns. If the transformer is serviceable it will impose little loading on the tuned circuit and the microammeter reading will remain unaltered or will drop only slightly. If the line output transformer has short-circuited turns it will impose considerably heavier loading on the tuned circuit, with the result that the microammeter reading will drop by a large amount. This drop will still occur, incidentally, if the short-circuited turn is in the e.h.t. winding; since the load imposed by the faulty e.h.t. coil will be reflected back to the anode winding.

A particularly useful point about the test gear is that it may be used to check the line output transformer in some receivers without disconnecting the transformer at all. Such occasions exist when the transformer windings are not heavily damped by parallel resistors, width-controls, or by similar components. The fact that the deflector coils remain connected to the transformer being tested should not normally cause any difficulty. If a short-circuited turn is indicated, the deflector yoke may then be disconnected. Should the short-circuited condition disappear then there is the strong probability that the fault lies in the deflector coils themselves.

Technical Details

It was mentioned above that a series-fed oscillator is employed. The reason for this choice, instead of a parallel-fed circuit, is merely that of obviating the high-inductance choke which would otherwise be needed in the anode circuit of the oscillator valve. The series-fed circuit has the slight disadvantage of necessitating the employment of h.t. isolating condensers in the test leads. One of these condensers, C4, is that which is employed, in conventional manner, for decoupling the h.t. rail. The other, C5, provides d.c. isolation between the "hot" end of L1 and its test prod. The resistor R1 is included to prevent static voltages with respect to chassis appearing on the "hot" test prod.

An important precaution to observe when using the test equipment is that it should be connected across all, or nearly all, of the line output transformer anode winding. If it were connected across, say, two adjacent tappings, the low value of inductance existing between such tappings would load the tuned circuit too heavily to enable precise readings to be obtained.

As will be imagined, the gear should be capable of checking quite a large number of inductors having relatively high values of inductance, in addition to line output transformers. It might be inadvisable to employ the equipment to check inductors wound with very fine wire, such as are used in hearing-aids.

The tuned circuit inductor, L1, is the most important part of the equipment. It is necessary for this inductor to have a relatively low value of inductance in order to prevent large alterations in oscillator frequency when the transformer winding under test is connected across it. A good practical choice for the inductor would be a small or "miniature" speaker transformer intended for use with mains output valves. The primaries of such transformers do not have a large amount of inductance, and what inductance exists can always be reduced by removal of some of the laminations, or by increasing the space in the joint between the two sets of laminations. Many miniature speaker transformers have a tapping in the primary
at about a quarter to a third of the number of turns from one end. A transformer of this type is illustrated in the diagram, it being assumed that the tuned inductor, L₁, is provided by the winding between the taps, and one end of the primary. L₁ should constitute the greater number of turns, the remainder of the primary being employed for the feedback coil, L₂. The secondary of the speaker transformer, L₃, is used only during the initial setting up of the instrument.

Setting Up

Setting up the test gear should prove to be quite simple to carry out in practice. A condenser of at least 50pF should be connected temporarily in the C₂ position, and a pair of high-resistance (2,000 ohm) headphones, or an a.f. amplifier with a high-impedance input, connected to the secondary, L₃, of the speaker transformer. This enables a check to be kept on the frequency of oscillation. Different values of condenser should then be inserted in the C₂ position until a pure a.f. oscillation with a frequency around 1,000c/s is obtained. The temporary 50pF condenser should now be removed, and the value of C₁ increased in stages, starting from 100pF. The idea behind this operation is to find a value for C₂ which enables maximum current sensitivity to be obtained. The best value will be that which causes the microammeter to indicate about 75 per cent of the maximum possible reading obtainable before squelching sets in. (A normal reading would be around 900 to 4000 mA.) The headphones, or amplifier, may then be disconnected from L₃.

The instrument can next be checked by connecting its test probes across the anode winding of a line output transformer known to be good. This should cause a slight drop in microammeter current. Two adjacent taps on the winding should then be temporarily short-circuited together, whereupon a considerable drop in current reading should occur. The temporary short-circuit should then be removed and a final test for sensitivity made by looping a piece of wire around the line output transformer core alongside the anode coil and touching its ends together to constitute a single shorted turn. If the test gear is sufficiently sensitive a marked drop in microammeter current will result.

It is found that, on initially connecting the test probes to the serviceable line output transformer winding, a large drop in microammeter current occurs, too high an inductance in L₁ is indicated. Its inductance should then be reduced in the manner described above, i.e. by removing laminations or by increasing the butt joint gap. Reducing the inductance of L₁ will, of course, necessitate finding a new value for C₂.

Can Anyone Help?

D. JOSEPH, 16 Hurley House, Kingwood Estate, Dulwich, London, S.E.21, is anxious to obtain data on the TR1154M transmitter.

A. HARRISON, 12 Frankland Street, Eldan Road, Leeds 11, wishes to buy or borrow the circuit or switching arrangements for valve testing by the "Dynamic Mutual Conduction Tube Tester" of 1927, made in U.S.A.

J. G. EUSTON, 12 Blackthorne Avenue, Manchester 19, is anxious to hire or buy service sheets, circuits only, or any helpful data on the Lincat 8137 receiver and/or the Reax LSIV receiver.

A. C. BINSTEAD, 1 Wickham Close, Crookham, near Aldershot, Hants, wishes to buy or borrow the circuit of the Brunswick model BTA/3.

E. PRICE, "Arflyn," Pensby Road, Howley, Flintshire, requires the circuit and/or data on the 6-valve valve test receiver E.119, ref. 10D/11742, covering 31/200 metres. He is particularly puzzled by the two terminals of the 4L1 and H.T. -/+1/C, and is willing to pay for any help.

J. K. OWEN, 3 Carlton Avenue, Westcliff-on-Sea, Essex, wishes to buy or borrow the circuit or service data of the Marconi V114 and V116 television receivers.

C. GALLOWAY, 177 Beacon Lane, Leatherhead, Manchester 19, wishes to obtain the circuit or data on the Indicator unit type 63A, ref. 10Q/37, serial A.C.C. 31470.

Requests for information are inserted in this section free of charge; subject to space being available

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D. F. HUNTER, 11 Lynmouth Place, High Heaton, Newcastle-upon-Tyne, requires data on, or to buy service information on the Tx/Rx type 38 Mk. 2, Amateur, receiver.

W. CHILDS, 4 Woodland Dell, Charleton, Hebden Bridge, Yorks, would like to obtain, on loan or otherwise, the handbook for the Tuner Amplifier B21B, Admiralty Pattern W.5416B.

J. ROSE, 57A Valon Road, Arborfield, Berks, wishes to obtain information on the McMurdo-Silver "15-17" or other similar portable beacon receiver. He is particularly interested at the output voltage of 465 v, E.B., and on the Philips model 7999A Projection Televisor. The factory furnished power is preferred, and reasonable payment made where necessary.

G. NORRINGTON, 29 Priory Road, Hull, Yorks, wishes to buy or borrow the manual of the DST-100 Mk. 2 communication equipment for the Admiralty.


BAND III TELEVISION for the HOME CONSTRUCTOR

PART 8. by S. WELBURN

This month our popular contributor discusses interference on Band III, including especially that given by asynchronous line out from television programmes. He also introduces the new Osmor Band III Converter, which will be fully described in next month's issue.

A CONSIDERABLE AMOUNT OF INTEREST has been caused recently in the trade by an article which appeared in the November issue of Wireless World. In this article it is stated that Band III converters having an output at a channel on Band I for connection to the aerial socket of an existing television are liable to cause re-radiation and interference with neighbouring Band I televisions. The article then goes on to describe methods of curing the trouble.

Aerial Radiation

Whilst the Wireless World article introduced a new and most interesting sidelight on the question of possible mutual interference between televisions, the present writer feels that one or two of the points raised in it might merit further discussion.

Let us begin with the type of interference described. It was pointed out in the article that the trouble of mutual interference is most probably liable to arise when the Band III converter is used with a t.r.f. receiver. In such a case the Band III signal is converted to Band I and amplified by the r.f. strip of the receiver until it has an amplitude of several volts at the video detector. At this amplitude it is quite possible for re-radiation to occur, thereby causing interference with neighbouring receivers. The frequency at which the converter will not be exactly that of the Band I signal, but will float around that frequency as the oscillator in the converter drifts. In consequence, interfering patterns are liable to be given on the screens of neighbouring receivers tuned to the Band I signal. (It has to be pointed out here that the re-radiation could be just as severe when the t.r.f. receiver is tuned to the Band I signal as when it is used with its Band III converter. However, as the neighbouring receiver would also be tuned to the same Band I frequency no beat patterns would be visible. It requires the slightly off-set frequency of the converted Band III signal to provide the visible interference pattern.)

It is stated in the Wireless World article that the high-amplitude signal at the video detector may be picked up by the Band I or Band III aerial leads and re-radiated. No emphasis is laid, however, on the possibility of radiation by the circuits in the receiver itself or by the mains lead and wiring. Whilst it is obvious that re-radiation may occur via the Band I aerial, it must be pointed out that if the Band I aerial downlead were capable of picking up radiation from the video detector circuits, such pick-up would form a feedback loop with possible resultant instability when the t.r.f. receiver was employed in its normal manner.

There is also the fact that, in most converters, the Band I output is connected to switch contacts which are very close to those switching the Band I aerial itself. There is, therefore, a greater possible source of trouble at this point, where stray coupling capacities can exist. A short run is given by the pick-up of energy from the video detector circuits. In the November issue of The Radio Constructor the writer dealt in some detail with Band III switching circuits, and it would appear that the circuit given in Fig. 2 in that issue should provide a very good protection against re-radiation via the Band I aerial.

As was stated in that article, the Band I aerial could be terminated, via a pair of switch...
contacts, with a short-circuit or a 75 ohm resistor; and the switch contacts used for this job were screened from those handling the converter output.

**Timebase Interference**

Another source of mutual interference which the best of the writer's knowledge at the time of writing, has not yet been mentioned in the technical press, is asynchronous line timebase interference. This interference is caused radiation from the line timebase of one receiver interferes with the picture of another receiver tuned to a different programme.

As is well known, many line timebase circuits create radio interference, this being due mainly to the fact that pulse voltages at high power are handled by the line output stage at a rate of several thousand hertz, frequencies which are multiples of the line frequency are often detected by sound receivers positioned close to the television concerned.

The greatest voltage surge in the line output stage occurs during the flyback period. It is possible to pick up and observe pulses of energy during this period with the aid of an oscilloscope having an unshielded input lead held near the timebase of the television concerned or with the aid of another television working in exactly the same state. (The reason for the necessity of the second television being unsynchronised will become apparent shortly.)

So far as r.f. is concerned, it is also possible that the bursts of radiation occurring during the flyback period may be stronger by the presence of corona, or even sparking, in the line output transformer or deflector coils, or at any other high voltage point in the line output stage before the e.h.t. reservoir condenser. This surge is certainly borne out by practical television experience; although how far such a state of affairs (i.e. corona and sparking) can be allowed to become apparent before breakdown occurs in the associated receiver is problematic. It may be recalled that G. A. French recently contributed a suggested circuit for a "corona probe" in which advantage was taken of the fact that corona frequently occurred in pulses at line frequency.

If a television emits bursts of r.f. energy during the flyback period, these bursts of energy can be picked up on a neighbouring receiver. If, however, both receivers are tuned to the same signal, a negligible amount of visible interference will occur. This is due to the fact that the interference pulse will be received by the second receiver during its own flyback period, where it will be blanked out. If the interfering pulse exists for a short time after the end of the blanking period of the second receiver, the interference will only show at the extreme left of the picture, where its visual effect would be very small and where it could even be completely hidden by the picture itself. This second state of affairs should be quite infrequent, as it requires either a slow retrace time with consequent foldover in the interfering receiver, or very heavy ringing in the e.h.t. coil of its line output transformer.

The situation becomes quite different when the two receivers suffer from the same programmes. In this case the two retrace periods do not occur at the same time because the synchronising frequencies employed by the two transmitters will be of the same value. What will then happen is that the interfering pulses from one receiver will reach the other at any point during its line output stage at the time the second receiver is in a state with sufficient strength during part of its scanning period they will become visible on its screen.

The writer has seen several instances of this interference in a block of flats in London, and it seems possible that the trouble may become fairly widespread as more I.T.A. transmitters come on the air. The interference appears as a vertical line which travels fairly rapidly across the picture, and which is liable to drift either to left or right in random fashion. It may appear to have a broken appearance, in so far as it may be built up from a series of white spots, each spot corresponding to an occupation position on each successive horizontal line. The brightness of the line will, of course, depend on the nearness of the interfering receiver to the aerial of the second receiver, the effective gain of the latter, and the intensity of the pulses radiated by the interfering receiver.

Fortunately, the trouble should not normally be too difficult to clear. In the instances checked by the writer, the trouble was receiving the interference employed indoor aerials which were fairly close (walls intervening) to the interfering station. Suppression was found either by moving the indoor aerial further away from the interfering receiver or by re-positioning the latter a greater distance from the neighbouring aerial. A better solution from the technical point of view would have been given by providing more effective screening in the interfering receiver or by attempting to suppress its line timebase radiation by other means; but this did not prove necessary in the particular cases examined. It was interesting to note that the trouble only occurred when the interfering receiver was tuned to Band III and the neighbouring receiver to Band I. Even when, during a later check in the workshop, an experimental Band III dipole was brought close to an interfering receiver tuned to Band I, no noticeable interference resulted.

Although he has not encountered this himself personally, the writer has also heard of one or two instances in which asynchronous line timebase interference has been picked up via an external Band I aerial, and not via an indoor aerial close to the interfering television. If this is so, then the radiation from the interfering receiver would be fairly strong, and it seems safe to say that the set had a line output stage which is suffering from quite severe corona or incipient sparking. Clearing up this trouble would then involve the normal checks carried out on line output components and wiring for these two faults. It should be remembered that the line output valve, the booster diode, and the e.h.t. rectifier are occasionally capable of causing radiation troubles, and that the fault could conceivably be cured by replacing one of these. A cheaper solution would sometimes be provided by connecting a small choke in series with the anode of the line output valve. Such a choke could be made very easily by close-winding 20 to 30 turns of 32 to 36 s.w.g. wire on a small half-watt high-value resistor. (The purpose of the resistor is merely that of providing a convenient former, and it could have any value in excess of, say, 200 kΩ.) Such a choke occupies surprisingly successful results when used in this fashion.

It is interesting to see that asynchronous line timebase interference does not appear to have been picked up by other stations, where the large number of alternative programmes might have made it a common complaint. This is possibly due to the fact that the negative video modulation employed in the

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**The Radio Constructor**

The equipment shown on the right is all the work of reader Russell Haigh, of Wakefield, Yorks. The tape recorder is self-contained, and can be removed for outside use; several recording channels are provided via internal links. The television is a 3-channel single-sideband superhet with 12-in. screen. On the extreme right is a 5-watt superhet tuner, above a 3-speed auto-changer; these feed into a push-pull 6LM6 amplifier. A single 12-in heavy duty speaker is switched to the unit by the same push-button that selects the unit's mains supply.

**February 1956**

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The writer would hasten to add that a good f.m. receiver is designed such that it will not radiate interference from its oscillator. Also, in some f.m. receivers the oscillator frequency is below that of the incoming signal.

What appears to the writer to be a more probable cause of interference is radiation from the i.f. stages of f.m. receivers. At the limiter and discriminator stages of many f.m. receivers an i.f. signal can appear with high voltage amplitude and an almost square waveform. In consequence a considerable number of harmonics may be present, and such harmonics can easily interfere with television receivers. The writer has encountered one instance of this. The television, using indoor aerials both on Band I and Band III, suffered interference when an adjacent f.m. receiver was tuned in to a signal. The fact that interference appeared only when the f.m. set was actually tuned to a signal provided sufficient evidence that the trouble was given by i.f. radiation. The l.f. of the f.m. receiver was a nominal 10.7 Mc/s (later tests showed it to centre at 10.8 Mc/s), which allowed a fourth harmonic of 43.2 Mc/s to interfere with Channel 1 and an 18th harmonic of 194.4 Mc/s to interfere with Channel 9. As was to be expected, interference on Band I was far more noticeable than on Band III.

This, again, provides an instance in which interference would have been negligible on either Band if an outside aerial had been used.

Cleveland Television Converter

A new unit which has been passed to the writer for review is the Television Converter type AC29. This is made by Cleveland Electronic Products, Ltd., and was submitted by Wireless Marketing Supplies Co. of 29 Pried Street, London, W.2.

The Cleveland converter is a small manufactured unit which is housed in a neat hammered-grey metal case whose dimensions are approximately 9in by 4in by 2in. Two controls are provided, a “Gain” control and a “Band I–Band III” switch, and these are mounted on one of the 2in sides. Shaping holes are provided in the back plate enabling the unit to be fixed to the rear of the television without the need for disassembly of the converter. The two control knobs should then project at the rear side of the television for adjustment by the user.

The Osmor Converter

A unit now available to the home constructor is the Osmor Television Converter. This unit embodies the coils manufactured by the company, and employs the latest techniques acquired from practical field experience of Band III transmissions.

A three-valve circuit is used, this consisting of a cascade input stage, a triode oscillator, and pentode mixer (the separate oscillator is chosen in the interests of frequency stability). The unit is fully isolated from the mains and metal rectifiers are employed for h.t. Full Band I–Band III switching is provided.

Full constructive and wiring details for this converter will commence in next month’s Radio Constructor.

Although the Band I aerial is not terminated in a short-circuit or 75 ohm resistor on Band III, care has been taken to completely screen the switch which switches out the Band I aerial. Such screening is a good design point. So also is the fact that full isolation from the mains is achieved by a small mains transformer. Rectification for h.t. is provided by a Westinghouse contact-cooled rectifier operated well within its limits. Yet another good feature is that, if slight re-orientation is ever required, it is possible to reach the slugs of all coils through small holes in the case, even after the unit has been mechanically fixed to the television with which it is to be used. Alignment instructions are provided with each unit.

No on-off switch is provided on the converter, and it would probably be best to connect it to the same mains socket as that feeding the television. Both television and converter could then be switched on and off at the same time by the switch at the socket. Alternatively, the converter could be wired into the television itself so that the television switch also controlled the mains to the converter as well. No circuit details were available to the writer but it was noted that two EF80 valves were employed.

Summing up, it can be said that the Cleveland Television Converter, which retails at £7 16s. 6d., is a very neat instrument which has been designed with imagination and considerable care.

R.S.G.B. NEWS BULLETIN SERVICE

Our readers’ attention is drawn to the weekly amateur news service being currently transmitted on G.B.R.S. on a frequency around 3,600 kc/s every Sunday morning at 1100 G.M.T. Amateur transmitting stations are requested to keep clear of this region of the band during the period 1035 to 1120 a.m. Reports on reception are welcomed, and a special Q.S.L. card will be sent in verification.

THE RADIO CONSTRUCTOR

AS IS BORNE OUT BY THE LETTERS continually arriving at the offices of The Radio Constructor, an important proportion of the readers of this magazine consist of those enthusiasts who have not yet been “in the game” for very long. Many of these readers are attempting to get together test gear for use in their own workshops, and some are finding that this process is a little expensive. Such a state of affairs is especially true of some of the items of manufactured test equipment: and our contributor, W. Pickering, is to be commended for the series of articles describing the construction of an inexpensive a.m.–f.m. signal generator which has been appearing in the last few issues of this magazine.

Testmeters

Manufactured signal generators are always a little costly, and the possibility of their construction at home definitely represents a useful saving in cash. Their construction also provides useful practice in the functioning, design and operation of test equipment.

This month I would like to talk about another similarly useful and indispensable piece of workshop gear. This is the multi-tester, an instrument capable of taking a large amount of different voltage, current and resistance values. Its central unit a reasonably sensitive moving-coil milliammeter or microammeter. Now, I know that descriptions of multi-testmeters have been appearing with steady regularity in the constructional press for at least the last twenty years, so I must hasten to point out that I am not going to give full constructional details, nor am I about to describe at great length the box in which the meter is to be fitted, or the exact components which must be employed. Instead I hope to give a general outline of the best methods of tackling the design and construction of a reliable and accurate multi-testmeter using whatever materials may be to hand, or whatever components are available at reasonable prices.

Voltmeter or Voltmimeter?

Before going any further, the first thing to be decided is the question of how ambitious the completed instrument is going to be. This raises the supplementary question of the number of ranges which are to be fitted to the tester, and the functions these are intended to carry out.

Basically, a multi-testmeter consists of a moving-coil milliammeter which has suitable values of resistance connected in series with it to make it read volts, which has suitable shunts connected in parallel with it to make it read current, and which has a suitable battery and resistance circuit connected to it to enable it to measure resistance.

Probably the easiest circuit to fit in a home-made tester is the last of the three mentioned above, that which requires fitting a battery and resistance arrangement in order to make the basic meter function as an ohmmeter. The reason for this is that there is no necessity to choose accurate values of resistor for this purpose. Apart from certain precautions (which will be dealt with next month) it is safe enough to say that discrepancies in individual resistor values can be taken up in the variable series resistor which is used for setting the meter to the “zero-ohms” position.

The next circuit in descending order of “ease” is that of fitting the various series

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resistors needed to enable the moving-coil meter to cover a series of voltage ranges. Such a process is reasonably easy because the switching circuits are simple and because the series resistors can be made up from a few components which are readily available. Also, the equipment needed for finding the values of series resistance in the testmeter is widely available.

Probably the hardest job in constructing a multi-testmeter consists of making the shunts needed for the current ranges. This is due to the fact that the business of preparing shunts is somewhat fiddling, and because the apparatus required for providing steady test currents needs more preparation than that needed for steady test voltages. In addition, switching circuits have to be designed with care if accidental damage to the meter is to be avoided.

I feel, personally, that for general radio work a home-made multi-testmeter which covers voltage and resistance only is very nearly as useful as one which has additional current ranges as well. Many radio networks in which current flows have a convenient relatively low-value resistor somewhere in the circuit across which it is possible to measure a voltage. In such cases it is quite a simple matter to determine by calculation the current flowing through the resistor. Indeed, it is frequently also quicker to measure the voltage across a resistor and work out the current flowing through it than it is to go to the trouble of unsoldering one end of the resistor so that a meter can be inserted to read the actual current directly. To take an example, if a valve has a cathode resistor of 2k ohms and this resistor has a potential of 5 volts across it, then it does not take many seconds to calculate that the current flowing through the resistor is 2.5mA.

In consequence of the above, I do not think I would be giving bad advice if I suggested to the novice who does not feel like tackling a really ambitious instrument in one operation that he starts off by making a multi-testmeter which covers volts and ohms only. The current ranges could then be added later, with the realisation that these were gilding a lily which is especially presented as most useful and serviceable item of workshop equipment. Whatever choice the reader makes (and I hope it is no worse than my choice of metaphor in the above passage) it is important that the instrument be to be in possession of a testmeter suitable, as it stands, for constructional and service work.

Calibration

One of the things which is usually glossed over in the description of home-constructed testmeters concerns the question of calibration. This point is, in fact, one which could raise quite considerable difficulties for some readers. The reason for this is that it is advisable to check the calibration of the home-constructed testmeter with another which is known to be good; and the latter may, in some cases, be the instrument whose performance is to be improved. Even if the constructor employs very low tolerance series resistors and shunts (a somewhat expensive process) another testmeter is a necessity.

Many of those readers who are not already in possession of a reliable testmeter of their own will have access to suitable instruments, and for the loan of such meters for several evenings can often be arranged. Others less fortunately placed might be able to make contact, incidentally, with their local radio club. Some small radio shops, especially in the provinces, can be surprisingly obliging in the matter of the loan of a testmeter for the period of a.M. meters.

Another possible source of sensitive moving-coil movements is offered by thermo-couple ammeters, the idea behind their use being to remove the thermo-couple and connect up to the meter movement proper. Unfortunately, whilst such movements are frequently quite sensitive they do not always exhibit a fall-off of sensitivity once the low resistance external circuit provided by the thermo-couple has been removed. In consequence, their needles may be expected to show a fall-off of sensitivity once the final reading before settling to rest. For those who like to experiment it might be possible to clear this trouble by connecting a low-voltage electrolytic condenser of some 100µF or more across the coil of the meter (employing correct polarity); but I would not like to guarantee the success of such an arrangement, or its long-term stability.

Probably the best choice for the basic movement, in series case, meter inputs, is for use as a milliammeter or microammeter. In the surplus market there are still some excellent meters of this type available, and the price desired to check the performance of a particular instrument. A particularly good choice is provided by ex-Air Ministry 0–1 milliamperes intended for panel mounting and requiring 24V or 120V cut-out. Some of these have adjustable shunts and others 100 ohm coils, but the difference in coil resistance is immaterial for our purposes here. (The coil resistance of these meters, incidentally, is usually shown on the scale.) Such meters are sometimes mounted in small desk-panels bearing the words: "Use with R.1084." The prices at which these F.M. meters are offered is liable to vary between retailers, and it is advisable to do a little scouting around before making the final purchase.

Other, cheaper, meters of the same size, but having an f.s.d. of 5 or 10mA, are also fairly easy to obtain. However, the voltmeter section of a multi-testmeter employing a 0–1mA meter as a basic unit is liable to be rather insensitive by radio standards.

The Voltmeter Circuit

When used as a voltmeter, the testmeter circuit which is switched in consists essentially of the basic meter movement in series with a resistor. This arrangement is shown in Fig. 1. Without the presence of a resistor the series resistance by suitable switching circuits in order to read different ranges of voltage.

A useful technique for working out the value of series resistance required for the testmeter is given by finding its sensitivity in "ohms per volt" for the particular basic meter employed. The number of ohms per volt then tells you the series resistance required for each range.

To give an illustration, let us assume that the meter shown in Fig. 1 has negligible coil resistance, and that it has a full-scale deflection of 1mA. If we wish to use it as a voltmeter having a full scale deflection of 1 volt, the series resistance must have a value such that 1mA flows through it and the coil of the meter when 1 volt is applied to the two test terminals. The value of resistance required is therefore about 1,000 ohms. In consequence of this we can now say that, when a 0–1mA meter is employed as the basic unit in a testmeter, the meter has a sensitivity of 1,000 ohms per volt. The usefulness of this concept should at once be apparent. If, for example, we wish to have an f.s.d. of 20 volts then the series resistance will need to be 20,000 ohms. In a similar manner, whilst a 0–1mA meter provides a voltmeter sensitivity of 1,000 ohms per volt, a 100mA meter has a sensitivity of 10,000 ohms per volt, a 5mA meter one of 200 ohms per volt, and so on.

Four practical multi-range voltmeter arrangements are shown in Fig. 2. In each case a different value of resistance is connected in series with the meter for each voltage range. In Fig. 2 (a) and (b) separate sockets are employed, in Figs. 2 (c) and (d) a switch is used. So far as the home constructor is concerned there is little to choose between any of the arrangements shown.

Practical Values

When, just now, we discussed the number of ohms per volt of our multi-testmeter we assumed negligible resistance in the coil of the basic meter. In practice, of course, this cannot be assumed, and we have, in consequence, to subtract the value of the coil resistance from the total calculated resistance for each voltage range to find the actual series resistor required. Thus, if a 0–1mA meter has a coil resistance of 75 ohms and is required to read 1 volt, the actual value of series resistance required will be 1,000–75 (i.e. 925) ohms. At high voltage ranges, however, the coil resistance will normally be too low compared with the series resistance to be of any great account.

In the construction of a practical meter we have two methods of approach to the question of fitting the various series resistors needed. One consists of working out the exact values

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Fig. 1. The basic arrangement needed to enable a moving-coil meter to function as a voltmeter
of resistance needed for each range, and of obtaining these in low-tolerance (±1%) types. The other consists of "manufacturing" the resistors required by empirical means. Of the two techniques the second is cheaper and entails only a little additional effort on the part of the constructor.

A very simple method of "manufacturing" the series resistors consists primarily of setting up the basic meter in the circuit shown in Fig. 3. The source of voltage shown in this diagram may be a battery, an h.t. point in a receiver chassis, or any similar steady source of potential. What is required is to find a physical resistor which, when connected in series with the meter of Fig. 3, enables it to show a reading which corresponds to that given by the calibrating meter. The latter is, of course, an ordinary testmeter which is used as a standard.

The constructor will know, from the number of ohms per volt required by the basic meter, the calculated value of series resistance needed for each range. In consequence, it is a good plan to commence operations at each range by trying out, in the test circuit, one's stock of individual low-tolerance (10 or 20%) resistors having approximately the calculated value, in order to see if one of these fortuitously happens to have the required resistance. If none of the resistors checked happens to have the correct value then, still working empirically, that value can be made up by the combination of several resistances in parallel or series-parallel. If the required resistance value is below, say, 20,000 ohms it is a good plan to initially fit a resistor having a slightly higher value (shown by a slightly low reading on the basic meter) and "trim" it by connecting high value resistors across it. By starting at 2MΩ and "working down," the requisite value should not normally take long to find. If the series resistance required is fairly high, say, above 20,000 ohms, a reverse method may prove useful. This consists of starting off with a resistor whose value is slightly below that required, and of then inserting small value resistors in series with it until the correct value is found. After the correct combination of resistors for each voltage range has been found it may then be soldered permanently into the instrument. If the
There are several advantages to the technique just described. The first of these is that conventional 10 or 20% resistors are recommended practice of filing V-cuts in the resistor until it has the correct value is employed."

Scale Doubling
A very useful addition to the voltage ranges of a home-constructed multi-tester is given by means of a scale-doubling switch. All this switch needs to do is to connect a resistor whose value is equal to the coil resistance across the basic meter. A typical arrangement is shown in Fig. 4. As will be seen from this diagram, when the switch is closed it is necessary for twice the voltage to be applied to the test terminals to provide the same scale deflection. In consequence, a very acceptable increase in the number of effective voltage ranges is obtained at little extra cost.

The value of the scale-doubling resistor required in Fig. 4 can be found empirically by employing the same method as was used for finding the series resistor combinations described above. It is best found when the meter is switched to a fairly high voltage range, because the scale-doubling circuit is liable to introduce slight inaccuracies at low voltage ranges.

Next Month
In next month's issue we will be carrying on to discuss ohm and current ranges, the former including both "series" and "shunt" circuits. It is also hoped, if space permits, to give a circuit for a complete multi-tester. This will show values suitable for use with any reasonably sensitive basic movement.

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**Mr. R. Hammans is new R.S.G.B. President**

Mr. R. H. Hammans, G2IG, President-Elect of the Radio Society of Great Britain, is currently Chief Engineer to Granada Television Network Ltd., who are the Independent Television programme contractors for weekdays in the North Region. Mr. Hammans, who has held an Amateur Transmitting Licence since 1929, is Vice-Chairman of the Society's Technical Committee and a past winner of the Norman Keith Adams Prize.

During the early 1930s Mr. Hammans installed ship-to-shore radio equipment for International Marine Radio Company. He joined the B.B.C. in 1935, in which service he remained until taking up his present appointment a few months ago. Whilst with the B.B.C. Mr. Hammans undertook the first radio link television outside broadcast ever to be transmitted in a public service—Wimbledon 1937. From 1939 to 1943 he was at Tatsfield Receiving Station, from which he was transferred in 1943 to the Transmitter Drive Section of the B.B.C. After three years he went back into television, in the Planning and Installation Department. During the succeeding nine years in that Department he became Head of the Television Unit.

In amateur radio circles Mr. Hammans has made many technical contributions to the R.S.G.B. Bulletin. He has specialised in the design and construction of measuring equipment and communications receivers for amateur frequencies.

Mr. Hammans has represented the R.S.G.B. at International Amateur Radio Union conferences in Paris, Lausanne and Amsterdam, and is a member of the I.A.R.U. Region 1 International Committee.

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**RADIO—AND CONTROL**

**PART 4.**

by RAYMOND F. STOCK

Practical Pulse Systems

The units up and us, previously referred to, must produce a small angular movement (of constant value) for each pulse received, and the easiest method of ensuring this is to use an electromagnetically driven ratchet wheel.

Fig. 16 shows the idea, which is self-explanatory except, perhaps, for the inset (right), which illustrates the design and operation of the pawl and teeth. D prevents any backward movement of the wheel, P is the pawl which rides back over a tooth when the electromagnet is energised; at the locking of the wheel between movements. The wheel cannot rotate in reverse due to the action of D. Should it tend to rotate forward it could only do so by lifting the pawl away from the centre due to the wedging action of the tooth angle. This is prevented by the fixed stop S.

These points are noted in case it may be desired to make such a unit, but a fair degree of precision (and access to machine tools) would be necessary, so most amateurs will use the mechanism of a rotary selector switch which is very suitable for the purpose. Two such units are needed, one receiving end of a pulse the armature returns, spring loaded, and carries the wheel round one tooth. This principle of making the return stroke the working movement is very important as, firstly, it ensures that each wheel movement occurs with a fixed, reproducible torque independent of variations in battery voltage; secondly, it facilitates the port-going pulses and the other starboard-going pulses.

Fig. 17 shows how the two units are combined "back to back" with a differential gear between them to combine their separate outputs. The differential could be made from Meccano parts, but surplus computing gear
frequently contains just the right unit. In any case, the principle must be that the two opposite-handed outputs are fed to the two bevels BP and BS. The bevel pinions

A steering unit of this type is usually known as a ratchet motor, and can be made up quite well from surplus components using only hand tools.

Fig. 17

P can rotate freely on their cross-shaft but the cross-shaft is rigidly connected to the centre spindle S, free to move within the two ratchet wheels RP and RS.

The spindle S rotates either way, depending on whether port-going or starboard-going pulses are fed in, and (irrespective of the size of the bevel pinions and gears, of course) always turns at half the speed of the selected ratchet wheel.

In many cases it may be found difficult to bring S out through an existing ratchet wheel assembly, particularly when the latter is a commercial product, and in this case, because the angular movement of the pinions is usually limited, the cross-shaft may be extended one side and coupled to the rudder by a push-pull rod. Fig. 18 shows this.

Fig. 18

An interesting feature of the idea is that should pulses be fed simultaneously to the two ratchets—this, of course, needs two independent radio channels—then the two angular movements are cancelled out by the differential and no rudder movement occurs; but if a pair of auxiliary contacts is arranged, one on each electromagnet, so that the armatures close them when attracted, then by connecting these contacts in series we have another virtual channel for control at no extra expense. Fig. 19 indicates this arrangement.

Control Gear

It is neither possible nor desirable to transmit the pulses for this system manually. If the gear is to be considered truly proportional it must have a reasonably high resolution—say, within 2° (though this is an arbitrary figure and must depend upon one's own tastes and the type of model).

Now, any control channel will have a limiting speed of operation, usually set by the electro-mechanical components. Let us suppose that the gear can handle up to 20 pulses per second on either channel; if we fix the minimum movement (resulting from one pulse) at 2° we can operate at a maximum rate of movement of 40° per second, and to go from amidships to port 30°—the usual maximum rudder angle—would take ¾ see. If a finer degree of control was required we could alter the ratchet wheels (or the gear ratio to the rudder) and produce steps of only 1°; but now it would take 1¾ secs to put the helm hard over.

Fig. 19. X could be any Secondary Control unit

Whichever combination seems desirable, it is obviously a good thing to keep the pulse-handling rate as high as possible; but there is always the chance that the control wheel will be turned too fast, in which case the system will respond to only a proportion of the pulses sent. The remaining pulses will be lost, and the rudder will then be out of phase with the steering wheel. This is a danger which can only be avoided by operating well within the speed of the gear; but it will be remembered that no such snag occurred in continuous systems.

(To be continued)

PHILIPS "RECORDEGRAM MAJOR"

A new, portable, twin-track, magnetic tape recorder, the "Recodegram Major" (Model AG8106), has been introduced by Philips Electrical Ltd.

It incorporates all the well-known features of its forerunner, the "Recodem", plus the following up-to-the-minute refinements:

(a) A three-figure counter, rather like a taximeter, which counts the revolutions of the tape spool and permits immediate selection of any desired passage for playback.

(b) A foot-pedal (available at extra charge) for starting and stopping the tape; this leaves both hands completely free.

(c) Two recording speeds, 3½ and 1½ per second. A normal 600ft reel of tape provides one hour's recording at 3½ per second, and two hours at the slower rate. With an 850ft reel of long-playing tape, three hours recording is possible at the 1½ per second rate.

The "Recodem Major" is made in Holland and is suitable for operation on 110-150/200-250V a.c. 50 c/s. It is contained in a washable plastic carrying case, which is fully ventilated. A "magic eye" modulation indicator facilitates well balanced recording and special switching arrangements guard against accidental erasures. The instrument is provided with a highly sensitive moving coil microphone fitted with a long lead. Recorded music and speech can be mixed in any required ratio and intensity. In addition to the instrument's self-contained amplifier and loudspeaker, there is provision for playback through a radio or external amplifier, and the instrument can also be used as an amplifier for microphone or gramophone reproduction.

Other details:

Model ... AG8106—"Recodegram Major"

Price ... 62 gns. (free of tax). The optional foot-pedal is £2 2s. 6d. (free of tax).

Accessories Moving coil microphone, reel of tape and spare take-up reel.

Consumption 60W maximum.

Speaker 5in.

Controls Knobs and push-buttons.

Valves EF86 (2) EL84, ECL80, EZ80, EM34 ("magic eye").

Weight ... 32lb

Dimensions 16¾ x 12½ x 8½.

Frequency range 3½ -50,000 c/s, 14

75/4,500 c/s.

Fast Wind or Rewind (600ft tape) ... 2 minutes.

FEBRUARY 1956
Radio Miscellany

A Quarter of a Century Back

Thinking of readers' letters brings me to one from Mr. R. Allen, of Newton Ferrers, Plymouth. He sends along an interesting Radio Diary for the period 1931-32. One unusual feature about it—it covers a period of sixteen months, from September 1931 to December 1932. It is just a year younger than himself, and he pays tribute to its compilers in saying that he still finds many sections of it useful for reference purposes. It was published by A. C. Cossor Ltd., and was obviously designed to cover both the needs of “the trade” (as distinct from “the industry”) and the amateur.

True to its period, only one of the many circuits included is for a “supersonic heterodyne receiver.” This is a 6-valve battery portable using a separate triode oscillator. A “straight” portable is also depicted—a five-valve affair using all triodes.

This well-produced diary contains much information which is still of contemporary reference value, as well as features which, if brought up to date, might well be included in 1956 versions. Sixteen pages are given over to topics such as this, and there is a “Valve Stock” table (based on actual experience) of the types a dealer is recommended to keep on hand. Typical of the period, the dealer who carries a stock of 100 replacement valves is recommended to keep 80 battery types and only 18 mains valves. But what about the odd two, you ask? Well, they are a couple of small rectifiers for use in the then popular H.T. Eliminators—a great many of the latter, of course, used metal rectifiers.

The section on fault-finding reveals that trouble shooting in those days must have been a simple business, although it may not have seemed so at the time. Motor-boating (an effect which some of our younger readers may not even have heard) is given a special section to itself.

Altogether a very interesting pocket reference book containing a surprising amount of information which is more or less permanently up to date. Can anyone beat it with a still better one?

TV Battle-front

Provincial readers must wonder whether converters for I.T.A. programmes are going to be a worthwhile proposition for them—depending on which newspaper they favour. A couple of our national daily newspapers apparently lose no opportunity to headline any report, however slightly unfavourable, to “commercialised T.V. Oddly enough, another daily reports all I.T.A. news very favourably. The latter, taking the long view, secured some interest in T.V., and I can only imagine the former are jealous of the threat by an over-successful I.T.A. to part of their advertising revenue.

If you should have any doubts as to the influence of newspaper publicity, ask the opinion of anyone who has never even seen I.T.V. on what they think about it. Often they have very definite opinions on the subject, based on prejudices formed by their daily reading. According to one survey, only 4% of the listeners were irritated by the advertising. I am one of the 4%—not because it is advertising. It is those maddeningly stupid jingles. The family still give a little more time to I.T.A. than to B.B.C., but personally I find the former's programmes less satisfying than they were. Several of the better items have been cut in length or taken out of the popular hours. However, the public seem to like it, and it is no unusual experience for me to find myself in a minority.

All the independent polls taken so far show that the majority of viewers with access to both programmes prefer I.T.V. Yet the B.B.C. Listener Research Department managed to make the comparison look so favourable that I am almost convinced they are in the wrong line of business. They ought to be in advertising!

Finding Inductance of L.F. Chokes

Very often the experimenter has a smoothing choke on his hands and would like to know its inductance. A simple method of determining the inductance is described below.

The choke is connected across the 5-volt winding of a mains transformer, in series with an a.c. current meter, and the current flowing in mA is put into the following formula:—

\[
\text{Inductance} = \frac{16}{I} \text{ henrys} \]

Thus, if the current were 2mA, the inductance would be 8 henrys.

Proof

This may be proved by applying Ohm's law.

\[
\text{The impedance } Z \text{ (reactance plus resistance) of the choke may be found from } Z^2 = R^2 + (2\pi f L)^2 \quad \text{(Z in } \Omega, f \text{ in c/s, } L \text{ in H)}.
\]

By Ohm's law, \( I = \frac{E}{Z} \)

where \( E \) is in mV, \( I \) in mA and \( Z \) in ohms.

or, \( I = \frac{E}{Z} \times \frac{1}{2\pi f L} \times 2 \times 3.14 \times 50 \times L \)

\[
\text{Thus, if } I = 16 \text{ mA, } Z = \frac{5,000}{314} \text{ L}.
\]

Thus, \( I = 16 \text{ L} \) or, to put it another way,

\[
L = \frac{16}{I} \text{ henrys}.
\]

J. E. GUNN

FEBRUARY 1956

THE RADIO CONSTRUCTOR

CENTRE TAP talks about THIS and THAT

Popularly

Unlike some Editors and columnists who unblushingly write of the dozens of Christmas cards they receive from their admiring readers, I had only one. Even this, I suspect, is from the same joker who a year or two back sent me a card of Ye Olde Snow-Covered Cottage on which he had drawn several long wire aerials with lead-ins entering via the chimney and letter-box, a 10-metre beam and a wobbly T.V. “H” aerial. This year he added an I.T.A. aerial and touched up both T.V. antennas with shiny silver paint. Serves me right, I suppose, for swanking about how long my ex-W.D. dural has lasted.

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A MODERN PRE-SELECTOR

by JAMES S. KENT

At some time or another most short wave listeners, whether owners of commercially built or home-constructed receivers, eventually encounter the problem of improving both the selectivity and the sensitivity of the equipment in use. The solution to these problems lies in the construction of a carefully designed pre-selector, the main purpose of which is the amplification of signals received from the aerial in order that they may be passed to the receiver input terminals at greatly increased strengths. In addition to acting as a voltage amplifier, the pre-selector also considerably assists in obtaining greater selectivity—particularly if the receiver in use has no existing r.f. stages.

Most pre-selector designs usually only feature one r.f. pentode in the circuit and, while one r.f. stage is better than none at all, little or no attempt is made to match the output into the receiver input. Again, such designs are, more often than not, coupled direct to the aerial, i.e., no buffer stage is included—the result being that the loading effects of the aerial cause indifferent performance at various frequencies.

In the design presented herewith, it will be found that a buffer stage (untuned) completely isolates the aerial from the following stage (tuned), and the resultant r.f. amplified voltage is passed on via a cathode follower output valve. The first stage imparts a small gain to the r.f. signal; this being tuned by $V_2$, greatly amplified, and passed to $V_3$. The function of this latter valve is mainly to match the output of $V_3$ at the correct impedance into the receiver. Although theoretically there is little inherent gain in a cathode follower stage, there is in practice an apparent gain due to the correction of any mismatch between the output of $V_2$ and the receiver.

Most receivers of the communications type are designed to have an impedance at the aerial terminals of some 400Ω and, to obtain a good transfer of r.f. voltage, the pre-selector output should be at the same value of impedance at whatever frequency, or band of frequencies, over which the unit may be tuned; the cathode follower stage ensures that this is so. In order to further illustrate the value of including $V_3$, consider a pre-selector with an output impedance of $1.5\text{MΩ}$ as would be the case using a valve such as the 6BA6—a high slope vari-mu r.f. pentode—and feeding direct from the anode, via a condenser, into the receiver input terminals. Assuming the receiver input to have an impedance of 400Ω then the mismatch would be 3750 to 1, not a very good match by any standard—and yet such designs are fairly common! The correction of this mismatch has to be heard to be believed, the overall gain (apparent) of the cathode follower making its inclusion virtually a necessity if
maximum performance and efficiency is to be achieved.

General Features

The unit was designed for rack mounting, but inclusion within a cabinet is perfectly possible if so desired. The front panel photograph shows the various controls before the appropriate wording and calibration of the dial. However, the top left-hand control is the 3-way yxlay switch S1 of Fig. 1. In the left-hand position the aerial is switched on, and then the aerial is fed direct to the receiver input bypassing the pre-selector, while the remaining position is used for putting the aerial into circuit with the limiter. By the operator is able to bring the pre-selector into use or, alternatively, either connect or disconnect the aerial at will. The top right-hand control is for on and off a main traffic condenser across the main tuning control used for bandspread and fine tuning. The left-hand bottom control is R8, a 5kΩ potentiometer used as r.f. gain. Centre is the wavechanger switch, S2, of Fig. 1, and from this it may be seen that four ranges are available. These are 10-30, 15-50, 50-220 and 200-750 m metres. The right-hand control is the on/off switch S3 of Fig. 1, an old pot, with switch being used for this purpose; only the switch portion, of course, being utilised.

Circuit

The first r.f. stage is untuned and merely acts as a source of the aerial and the following tuned stage. A gain of about ten may be expected from this stage. The aerial is fed into the grid via C4 and coupled to earth via R.F.C1 (see component list). The anode and screen h.t. supply are both taken from R2, this being a one-watt component. Cathode bias is obtained from R4 and C2. Neither the grid nor the cathode and the internal screen should be joined externally and taken direct to chassis. This stage is capacity coupled, via C5—a mica type condenser—into the following tuned circuit. Both of the first two stages are constructed around the Mullard EF41, which is somewhat similar in characteristics to the wartime EF30 but more efficient and compact. The EF42 has a slope of 9mA/V at an anode current of 10mA, and with this high maximum a-c output it is a high impedance circuit. These must then be wired to the yxlay switch (S2 of Fig. 1). The coils required are those supplied by the Telefunken Company and are: HFA4, 10-30; HFA3, 15-50; HFA7, 50-220 and HFA5, 200-750 metres. Each of these coils has a variable iron dust core and is wound on an Aladdin Former with a fitted tagging.

The power supply is conventional and needs little explanation. In order to conform with the other valves used in the circuit, another of the same range has been selected, the Mullard EZ41 full-wave rectifier. All the valves used in this design are of the B8A range.

Construction

The mains transformer, C4 and C5, together with C1, are mounted above the chassis while the remainder of the components are contained undernearth. It will be noted that C4, although shown in the circuit diagram as a single gang condenser is in fact a two-gang component. Only one-half of this is shown, however, in order to illustrate the nature of a two-gang condenser being by virtue of the fact that a single gang is rather difficult to obtain in the normal way.

The coils as received are single items, i.e., not as a coil pack, and these are therefore mounted on a small piece of aluminium, one end of which is bonded to chassis. These must then be wired to the yxlay switch (S2 of Fig. 1). The coils required are those supplied by the Telefunken Company and are: HFA4, 10-30; HFA3, 15-50; HFA7, 50-220 and HFA5, 200-750 metres. Each of these coils has a variable iron dust core and is wound on an Aladdin Former with a fitted tagging.

The aerial input is made of the co-ax. connector type, but this may have to be varied to suit individual requirements. The output connection to the co-ax. aerial is the type of connector, the short length of co-ax. used for connecting the pre-selector to the receiver must have the metal braiding earthed at both ends in order to eradicate unwanted direct signal pick-up on the connecting wire.

The h.t. components supplying the anodes of V1 and V2 are wired direct to the anodes, the h.t. being brought to a 3-way tap strip mounted to the chassis wall. The L.F. choke is bolted to the chassis wall and the associated condensers are soldered direct to the choke terminals.

Once construction has been completed, it is an easy matter to calibrate the dial simply by keeping the unit in step with the receiver and making channel calibrations of the latter by tuning the pre-selector to exact resonance, marking off the dial at each megacycle or 100kc/s point as desired.

In operation the unit will be found to give all the gain that can possibly be required. The receiver selectivity and sensitivity will be greatly improved, and freedom from secondary channel interference will be most marked. The overall performance of any receiver will be improved out of all proportion to the cost and time involved in the construction of this modern pre-selector.

Component List

Resistors

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>100kΩ, ±10%</td>
</tr>
<tr>
<td>R2</td>
<td>5kΩ, ±10%</td>
</tr>
<tr>
<td>R3</td>
<td>10kΩ, ±10%</td>
</tr>
<tr>
<td>R4</td>
<td>100kΩ, ±10%</td>
</tr>
<tr>
<td>R5</td>
<td>5kΩ, ±10%</td>
</tr>
<tr>
<td>R6</td>
<td>100kΩ, ±10%</td>
</tr>
<tr>
<td>R7</td>
<td>47kΩ, ±10%</td>
</tr>
<tr>
<td>R8</td>
<td>400kΩ, ±10%</td>
</tr>
<tr>
<td>R9</td>
<td>250kΩ, ±10%</td>
</tr>
</tbody>
</table>

Condensers

<table>
<thead>
<tr>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001µF, mica</td>
<td></td>
</tr>
<tr>
<td>0.1µF, 350V, TCC type CPCN5</td>
<td></td>
</tr>
<tr>
<td>1µF, ±10%, ceramic</td>
<td></td>
</tr>
<tr>
<td>100µF, ±10%, ceramic</td>
<td></td>
</tr>
<tr>
<td>0.1µF, 350V, TCC type CPCN5</td>
<td></td>
</tr>
</tbody>
</table>

L.F. Choke

<table>
<thead>
<tr>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>10H, 60mA</td>
</tr>
</tbody>
</table>

Valves

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>EF42 Mullard</td>
</tr>
<tr>
<td>V2</td>
<td>EF42 Mullard</td>
</tr>
<tr>
<td>V3</td>
<td>EF41 Mullard</td>
</tr>
<tr>
<td>V4</td>
<td>EZ41 Mullard</td>
</tr>
</tbody>
</table>

LABGEAR TV INTERFERENCE FILTERS

These filters have been designed to eliminate interferences at frequencies lower than Band I, and will be suitable for use with TV sets on both Band I and III and for Band II.

Model EF 508 has a high-pass filter and eliminates interference at frequencies lower than Band I. It is suitable for use with TV sets on both Band I and III and for Band II.

Model EF 501 has a low-pass filter which eliminates interference at frequencies higher than Band I. It is suitable for use with TV sets on both Band I and III and for Band II.

Both models are fitted with standard co-axial terminating plugs and plug in the aerial lead and the input socket of the receiver. The radio price (either type) £5s. 6d. each.

Further details of the complete range of aerials, cross-over units and filters are available upon application to Labgear (Cambridge) Ltd., Willow Place, Cambridge.

FEBRUARY 1956

USEFUL HINTS

Small jars with screw tops can be fixed to the underside of a shelf by the aid of two small screws threaded through the lid. This is a safe and inexpensive method of storage of small components, nuts, bolts, etc. The method ensures that the component is stored in a position where they can be seen, so saving much time in finding.

A piece of old linoleum tucked to the top of the workbench gives a working surface that is easy to keep clean and free from grit. If the linoleum is brushed off prior to a receiver being serviced, then the chance of scratching the cabinets is greatly reduced. The material is insulating.

The storage of tools in their correct places can be made easier by the use of hooks and hooks for the various tools have a white or black outline of the tool drawn around them, so that it is easy to see if a tool is missing from its place and where any tool should go.

A board at the rear of the bench and to one end fitted and wired with all types of mains socket, will save a considerable amount of time when servicing—it takes time to change a plug.
The "TRANSISTORETTE"

by G. A. FRENCH

Introducing the miniature transistor receiver which created so much interest when it was exhibited at the last National Radio Show at Earl's Court.

As soon as transistors became available on the British market, The Radio Constructor commenced experiments in order to produce a practicable transistor receiver which could be built at home by the amateur. A considerable amount of development work was undertaken, and, as a result, we now introduce the little receiver which is to be described in this and the following articles.

This receiver, the Transistorette, is intended to provide good loudspeaker strength reception on the medium-wave band with the aid of a short aerial and an earth connection. Headphones are not required. It is hoped, at a future date, to dispense with the aerial and earth connection and make the receiver fully portable; and further experimental work to this end has already been set in progress. In the meantime, it is pointed out that the present version, requiring the aerial and earth system, is capable of giving excellent results in its existing form, and that it represents the nearest approach to a really "personal" transistor receiver yet to be described in the British constructional press. It is also emphasised that, apart from one or two resistors and similar small components, the receiver now under discussion will be capable of lending itself to the future modification for portable working without the necessity of any changes to the main chassis assembly at all. What extra circuitry is required will be accommodated by a small "add-on" chassis assembly. In consequence, constructors who built the present receiver will not have to make major changes when modification details are later published.

The Circuit

The circuit of the Transistorette is given in Fig. 1. As may be seen, the receiver consists of a three-transistor a.f. amplifier following a simple detector and input tuned circuit. It would be advisable to commence the theoretical consideration of this circuit by starting at the output stage and working backwards.

The output stage consists of a Brimar transistor type TJ3 (TR3 in Fig. 1) operated in the common emissor configuration. The output stage was chosen as it gives a high gain per stage which is essential for theTransistorette. The selection of the particular device is due to the fact that the output transistors were maximum gain units obtainable from the manufacturer. The biasing of this type of transistor is such that slight changes in the supply voltage can have a dramatic effect on the performance of the amplifier. Therefore, care was taken to ensure that the biasing of this stage was correct before connecting the output to the loudspeaker. The transistors in these stages were selected because of their low power consumption and the fact that they could be easily obtained from the manufacturer. The input stage consists of a simple detector followed by a simple tuned circuit. The detector is a half-wave rectifier followed by a simple tuned circuit. The output stage consists of a Brimar transistor type TJ3 (TR3 in Fig. 1) operated in the common emissor configuration. The output stage was chosen as it gives a high gain per stage which is essential for the Transistorette. The selection of the particular device is due to the fact that the output transistors were maximum gain units obtainable from the manufacturer. The biasing of this type of transistor is such that slight changes in the supply voltage can have a dramatic effect on the performance of the amplifier. Therefore, care was taken to ensure that the biasing of this stage was correct before connecting the output to the loudspeaker. The transistors in these stages were selected because of their low power consumption and the fact that they could be easily obtained from the manufacturer. The input stage consists of a simple detector followed by a simple tuned circuit. The detector is a half-wave rectifier followed by a simple tuned circuit.
The circuit of Fig. 2 (b) is, of course, that employed in Fig. 1 to provide coupling between TR3 and TR2. Not shown in Fig. 2 (b), however, is the 0.05μF condenser C5. The purpose of this condenser is mainly that of tone correction; although it may help, in one or two instances, to reduce any possible r.f. instability which may be caused by the relatively high gain of the a.f. strip at supersonic frequencies.

TR1 and TR2 are Brimar transistors type TJ2, and they form a conventional two-stage transistor a.f. amplifier. Both function in earthed emitter circuits. The two transistors are operated at a lower h.t. potential than that supplied to the output transistor; this lower potential being provided through the resistor R8 decoupled by the condenser C2. As a result of the lower h.t. voltage, surge precautions as used in the output stage are not required, and the more conventional transistor circuitry can be employed. This state of affairs does not infer, incidentally, that component values can be altered by any large amount from those shown in the parts list. If optimum results are required, component values in the TR1 and TR2 stages are still somewhat critical. The h.t. potential applied to TR1 and TR2 (i.e. that appearing across the decoupling condenser, C2) lies between 7 and 9 volts.

The input circuit for TR1 is very simple, consisting of the deaf-aid type step-down transformer L3, L4. The secondary of this transformer, L4, connects to the 5kΩ volume control R1, the a.f. tapped off by the slider of this potentiometer being passed to the base of TR1 via C3. (The isolating condenser, C3, is needed because the base of TR1 requires a small negative bias potential with respect to chassis, and this would otherwise be short-circuited by R1.)

Signal selection is provided by the tuned circuit L5, C1. The r.f. appearing across this circuit is applied to the primary, L5, of the step-down a.f. transformer via the germanium diode D1. The self-capacitance of L4 is sufficient to bypass the r.f. appearing in the rectified output from D1 and no further r.f. filtering is required. L3 is wound on a long ferrite core as this enables a tuned coil to be obtained with a high value of Q. The coil assembly is very similar in practice to a "ferrite frame" and it is, in fact, possible to obtain weak signals with this alone. However, performance in this respect can by no means be guaranteed, and it is pointed out again that the main reason for using the ferrite core is given by the high value of Q that it provides.

The coupling winding L1, which is also wound on the ferrite core, enables an aerial and earth to be connected to the receiver.

<table>
<thead>
<tr>
<th>Components List for the Transistorette</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resistors</strong></td>
</tr>
<tr>
<td>All 1/2 or 1 watt. (See note below).</td>
</tr>
<tr>
<td>R1  5kΩ volume control with s.p.s.t.</td>
</tr>
<tr>
<td>switch. Radiohm miniature.</td>
</tr>
<tr>
<td>(H. L. Smith, Edgware Road).</td>
</tr>
<tr>
<td>R2, R4 220kΩ, 10%</td>
</tr>
<tr>
<td>R3, R5 2.2kΩ, 10%</td>
</tr>
<tr>
<td>R6 5kΩ, 20%</td>
</tr>
<tr>
<td>R7 1kΩ, 10%</td>
</tr>
<tr>
<td>R8 10kΩ, 20%</td>
</tr>
<tr>
<td>N.B.—Maximum individual resistor</td>
</tr>
<tr>
<td>dimensions are ⅛ in. long by ⅛ in.</td>
</tr>
<tr>
<td>diameter. These may be specified</td>
</tr>
<tr>
<td>as ⅛W or ⅛W by different suppliers.</td>
</tr>
<tr>
<td><strong>Condensers</strong></td>
</tr>
<tr>
<td>C1 500pF bakelite dielectric (linear</td>
</tr>
<tr>
<td>capacity). (Wavemaster)</td>
</tr>
<tr>
<td>C2 20μF 12V Pb. wkq. T.C.C. type</td>
</tr>
<tr>
<td>CE30B</td>
</tr>
<tr>
<td>C3, C4 2μF 150V Pb. wkq. T.C.C. type</td>
</tr>
<tr>
<td>CE30B</td>
</tr>
<tr>
<td>C5 0.05μF 200 W.V. T.C.C. Mini-</td>
</tr>
<tr>
<td>ture Metamite (case insulated) or</td>
</tr>
<tr>
<td>equivalent wax finish</td>
</tr>
<tr>
<td><strong>Inductors</strong></td>
</tr>
<tr>
<td>L1, L2 Ferrite Frame, medium-wave, type</td>
</tr>
<tr>
<td>QFRI (Osmon)</td>
</tr>
<tr>
<td>L3, L4 Hearing-aid a.f. transformer.</td>
</tr>
<tr>
<td>Type T100 (Televith)</td>
</tr>
<tr>
<td>L5, L6 Output transformer, &quot;Transistor-</td>
</tr>
<tr>
<td>ette Miniature&quot;—7.00Ω. (H.</td>
</tr>
<tr>
<td>L. Smith, Edgware Road).</td>
</tr>
<tr>
<td><strong>Transistors and Diode</strong></td>
</tr>
<tr>
<td>TR1, TR2 Junction transistor type TJ2</td>
</tr>
<tr>
<td>(3X/301N) or T.S.2—Brimar</td>
</tr>
<tr>
<td>TR3 Junction Transistor type TJ3</td>
</tr>
<tr>
<td>(3X/302N) or T.S.3—Brimar</td>
</tr>
<tr>
<td>D1 Germanium Diode type GD3—</td>
</tr>
<tr>
<td>Brimar</td>
</tr>
<tr>
<td><strong>Loudspeaker</strong></td>
</tr>
<tr>
<td>2½in. cone diameter, type 2P/O1 (Elac)</td>
</tr>
<tr>
<td><strong>Battery</strong></td>
</tr>
<tr>
<td>22.5 volt hearing-aid battery. Type B110</td>
</tr>
<tr>
<td>or B122 (Ever-Ready).</td>
</tr>
</tbody>
</table>
The Aerial System

Due to the low input impedance offered by L1, an earth connection is desirable in addition to an aerial. Although the necessity for an earth connection may appear at first sight to be a disadvantage, quite the reverse holds true in practice. The reason for this is that in many cases possible to obtain a certain effective pick-up through the earth connexion itself, whereas on only a short aerial wire is needed. If, for instance, the earth terminal of the receiver is connected to, say, the mains conduit in a house, adequate sensitivity can often be obtained with the aid of an aerial only five to ten feet long. The same applies to any other effective earths which may be available when the set is to be used. Such earth connection may be kept by water pipes, mains conduit and the metalwork of a telephone dial.

In another locality similar results were given merely by twisting the earth lead several times around the mains flex to a reading lamp. The coupling in this case was provided by the capacity existing between the two leads. By the use of techniques such as this, there is no reason why the receiver should not be able to give good results when used as a travelling companion in hotel rooms, on picnics or in similar locations. The use of a short aerial, incidentally, assists in reducing any damping of L2 which may occur.

In localities where interference is very high, the simple tuning arrangements employ in this version of the receiver may not be adequate for clear reception of the local medium wave transmitters. In such instances it may be necessary to fit an external wavetrap in order to improve selectivity. This point is dealt with later in this present series of articles.

Precautions

As readers will be aware, great care has to be taken when working with circuits which employ transistors. This is due to the fact that, should any mistakes be made in the application of voltage to any transistor, it can be immediately and irrecoverably ruined. It is possible already has been discussed above in some detail with regard to the bias circuit for TR3. The following reminders may help to show some of the other precautions which should also be taken.

1. Never connect an h.t. battery to transistor equipment with incorrect polarity, or the transistors will almost certainly be damaged. In the Transistore the chassis is positive and h.t. rail negative. Connecting the h.t. battery wrong way round will burn out TR1 and possibly damage TR1 and TR2 as well.

2. Never make any circuit adjustments or even handle the components in the Transistore circuit whilst the h.t. battery is connected. Accidental surges may easily damage a transistor, and it is very easily possible for one’s hands or fingers to bridge critical components with resultant damage.

3. If testmeter readings must be taken when the h.t. supply is connected, care should be taken in the choice of test points. In the construction of the Transistore a test readings (apart from those given by a milliammeter in series with the h.t. supply) are required at all. Voltage readings at transistor terminals should not be taken unless it is certain that the current flowing through the meter will not cause excess bias current to flow in the transistor. Ohmmeter readings, when the h.t. supply is switched on, may also cause trouble if the internal battery in the meter happens to be connected such that it applies additional bias current to a transistor.

4. If a transistor amplifier breaks into violent a.f. oscillation it is advisable to switch off at once. This is due to the fact that the external bafting may be too loose. The fault causing the oscillation should be rectified by normal test procedure with the h.t. switched off or reduced in voltage.

The Transistore Supply

In the Transistore a fairly high h.t. potential (22.5 volts) is employed. It is advisable, when the receiver is being tested immediately after construction, to employ a much lower voltage than this to guard against possible component failures and mistakes in wiring, etc. One of the best methods of checking the receiver consists of employing two 9-volt grid bias batteries in series to provide h.t. for testing purposes, these being connected to the set via a moving-coil milliammeter whose f.s.d. is 10mA or thereabouts. During tests, the h.t. voltage may then be tapped up in 1.5 volt stages, whilst the milliammeter is used for excess current. The Transistore will function reasonably well during test, incidentally, with an h.t. potential between 6 and 9 volts only.

Next Month

In next month’s article, the first constructional details of this modern receiver will be given.

THE LONDON AUDIO FAIR 1956

The first London Audio Fair is to be held at the Washington Hotel, Curzon Street, London, W.I., on 14th and 15th April, 1956, immediately following the R.E.C.M.F. Exhibition, which closes on the 12th. The Fair will be open from 11.00 a.m. to 9.00 p.m. each day. The object of the Fair is to present high grade equipment for high quality sound reproduction to the general public as well as to the trade in a more effective manner than has been possible in National Radio Shows. It will be shown with its accent on domestic radio and television.

To this end the greater part of the ground floor will be taken up by stands for static displays; the principle accent, however, will be on demonstration of equipment under conditions similar to those encountered in the home. For this purpose the whole of the first and second floors, with one wing of the third floor, has been taken over, and the double bedrooms on these floors are being allocated one to each exhibitor for use as demonstration rooms.

The Circuit

The circuit of a simple receiver is shown in Fig. 1, and contains 2 valves: $V_1$, a triode, and $V_2$, a pentode. We need not worry too much at this stage how the circuit actually works. We can go into the theory more fully later on. For the moment, let's accept the fact that the first valve $V_1$, and its associated components, forms the detector stage. This stage converts the incoming signal into voltages suitable for amplification and connection to a loudspeaker.

The second stage, comprising $V_2$ and its associates, is responsible for the amplification of the signal received by the first stage; it also drives the loudspeaker.

Although there is no hard and fast rule, and no one but a purist will get upset if you decide against it, it is generally accepted practice to draw circuits with the aerial on the left and the loudspeaker on the right, this being the direction, of course, which the signal takes between aerial and speaker.

Working from the left, the first thing we meet that is unfamiliar is $C_3$, to which the aerial is connected. This symbol was not included in last month's batch; it is another, and miniature, form of variable capacitor, called a "trimmer." From $C_1$ the signal passes to $L_1$. Now all three coils—$L_1$, $L_2$ and $L_3$—would be wound on the same former, and these become what is virtually an air-

"tuning circuit" in which $C_2$ is the control used to tune in the desired signal from the front of the set. The signal has now arrived at the grid of the triode valve $V_1$ via the fixed capacitor $C_1$. The position of $C_3$ and $R_1$ earn them the names of grid capacitor and grid leak ($R_1$) respectively.

The valve $V_1$ "detects" the signal, as we already know. (It also has an amplifying effect on the signal, but this is not its real job, and is really poaching on $V_2$'s ground.) The extra winding on the coil $L_3$ is a reaction winding, used to increase the sensitivity of the receiver. Capacitor $C_4$ is the reaction control. We can conveniently defer further explanation on this subject until a later article.

The transformer $T_1$ couples the output of $V_1$ to the grid of $V_2$ by way of the volume control potentiometer $RV_1$. The tone control circuit is formed by $C_6$ and $RV_2$. We know that the pentode $V_2$ amplifies the signal and also drives the loudspeaker. In the cathode circuit of $V_2$ an electrolytic capacitor is used to by-pass the resistor $R_3$. As we discussed last month, the component values are marked on the circuit to conform with convention.

The description of this circuit is necessarily brief and some terms I have used have been left unexplained. However, I did not intend to explain the working of the circuit in detail, and I hope to guide the reader familiar with the use of symbols in circuit diagrams.

Layout and Wiring

No doubt you will find, when you start to make your instrument, that although the circuit is given, no suggestions are made for layout or wiring, these details being left to the constructor's discretion.

Of course, no single layout will do duty for every variation of an instrument; the requirements will differ from type to type. There are, however, some important basic principles, which must be closely observed. The first of these is the matter of long leads.
be kept short and which can be left long. The really important connections—which must be short—are marked with a cross in Fig. 1. With medium wave receivers and most amplifiers, earth leads and cathode, heater and h.t. leads can be left quite long without affecting the operation of the circuit. Grid and anode leads must be short.

While we're on the subject of grids and anodes, there is one most important point which should never be overlooked, and that is: never run these two leads parallel for any distance. It may be easier to remember this rule if you can learn to identify the grid as the input and the anode as the output; input and output leads of any circuit must not travel together for any distance. This is illustrated in Fig. 1, where the anode wiring of V2 is kept well away from its own grid, but at the same time it should not, under any circumstances, mix in with the wiring of V1 grid.

Another advisable precaution, with valves whose heaters are fed with alternating current supplies, is to keep the heaters away from grid and anode wiring as much as possible.

Very often, of course, the aggravating situation arises when, having carefully and methodically planned the ideal wiring arrangement, you find that it will have to be modified to allow the controls to be placed symmetrically on the front panel. Under these circumstances, the compromise between wiring efficiency and aesthetic considerations can become a problem of disproportionate magnitude. Clearly a decorative set that defies all attempts to get it working is not so fruitful a labour as one which, although not particularly attractive, goes like a bomb. The moral is, therefore, not to worry too much about sacrificing performance to looks (your attitude to the fair sex could be an excellent guide here).

The Chassis

Nowadays, it is normal practice to build everything on a chassis. Fig. 2 shows a simple type. As you can see, the ends may be closed or left open; without the end pieces, the construction is even more simple: the metal is merely bent in two places.

Suggestions for a possible layout of the circuit shown in Fig. 1 are sketched in Fig. 3. It has been laid out specifically to illustrate the compromise between efficient operation and symmetrical front panel design.

One method is to stretch the lead connecting T1 and C4 well across the chassis. This can, of course, be avoided if the whole layout is re-designed, with T1 placed close to C4. Such an arrangement would mean that T1 would be some distance from V1 and the coil. The layout shown is, however, perfectly satisfactory.

In Fig. 3, the components C3, C5, C6, R1 and R3 are all sufficiently small and light to be supported on their own wire ends, and this is true of many parts used in such instruments. However, C7 may be large enough to require a clamp to secure it to the chassis. This would depend on the manufacturer.

The aluminium chassis acts as the earth line, which has been drawn heavily in Fig. 1 to emphasise the fact. You will see in Fig. 3 that R1 and C4 are earthed at one point and C7 is earthed elsewhere. There is nothing wrong with that idea, providing the circuit diagram specifies nothing different. An example of a circuit where 'single point earthing' is required is shown in Fig. 4. This particular method of drawing means that L1, C1, R1, C2 and C3 must all be connected to chassis at the same earth tag. It is a practice very often encountered in very short wave receivers and television receivers.

Tolerances and Types

Now there is one stumbling block which nearly every constructor building his first receiver will fetch up against. He will set out with a list of components, having special values, and to his annoyance he may very likely find that in his particular area his specified types aren't available. His local dealers will glibly offer alternatives. Not unnaturally, the customer experiences suspicion and uncertainty. He is determined that the components and their values are obtainable somewhere, and he continues his search.

If he takes this attitude, it is clear that what he does not appreciate is that, in a well-designed circuit, there should be few critical components. Resistors, for example, are made with tolerances ranging from ±1% to ±20%. Most receivers and amplifiers only require ±20% tolerance resistors. Look at R1 in Fig. 1, specified as 2MΩ. A ±20% component could have any value between 1.8MΩ and 2.2MΩ.

The circuit is unaffected by such small discrepancies in value, and if a 2.2 MΩ resistor only is available, well then it can be used quite happily with no ill effects. Don't forget, though, that a 2.2 MΩ resistor would itself have a tolerance of ±20%, which means its value may be anywhere in the range of 1.78 to 2.42 MΩ. The same applies to capacitors—in fact, nothing is exact, every component has tolerances!

Not so easily dealt with are the other ratings. Take C3 in Fig. 1, for example. It should be a 250V working component. A 200V working capacitor will not therefore be suitable, but a 350V one will. Then again, R3 should be a 1 watt resistor, so nothing below 1 watt should be used. This will, of course, be somewhat confusing to start with, but practice will soon sort it out until you are picking the right value almost automatically.
With electrolytic capacitors you are completely at sea. They often have tolerances of $\pm 10\%$, in other words, they can have any value between that marked on the case to twice the amount. Really, your first reaction might be, why bother to mark them at all? However, unless it is specifically stated on the circuit that close tolerances must be used, it is quite safe to assume that $\pm 20\%$ is good enough. But on no account be lulled into believing that unlimited licence can be taken with a circuit, otherwise your performance and operation will suffer acutely for it.

![Diagram](image)

**FIG. 5.**

**FIG. 6.**

### The Colour Code

This is a very crafty but at first confusing system for marking the values on resistors. The value is seldom printed on these components nowadays, and instead it is striped and spotted according to a carefully devised code. Once the code has been memorised it becomes second nature to identify the values — and saves tedious peering and uncertainty at minute figures half obliterated by wear. A typical resistor and its marking is shown in Fig. 5.

There is a definite order of reading the colours which must be strictly observed. This is: body, tip and band. Sometimes the band is not used, but a dot. Then the reading is: body, tip and dot. The table of colours is as follows:

<table>
<thead>
<tr>
<th>Colour</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>0</td>
</tr>
<tr>
<td>Brown</td>
<td>1</td>
</tr>
<tr>
<td>Red</td>
<td>2</td>
</tr>
<tr>
<td>Orange</td>
<td>3</td>
</tr>
<tr>
<td>Yellow</td>
<td>4</td>
</tr>
<tr>
<td>Green</td>
<td>5</td>
</tr>
<tr>
<td>Blue</td>
<td>6</td>
</tr>
<tr>
<td>Violet</td>
<td>7</td>
</tr>
<tr>
<td>Grey</td>
<td>8</td>
</tr>
<tr>
<td>White</td>
<td>9</td>
</tr>
</tbody>
</table>

So, a resistor having a brown body, a black tip and a yellow band has the value of 100,000 ohms, or 10 kΩ. Yellow body, violet tip, red band means 4,700 ohms, or 4.7 kΩ.

If the band is omitted, it is to be assumed that it is the same colour as the body. For example, brown body and black tip means 100 kΩ.

An alternative method of marking is shown in Fig. 6. These are read in the order: A, B, C. If A were blue, B grey, and C yellow, the value would be 680,000 ohms, or 680 kΩ.

On this type a further band is sometimes included. This band marks the tolerance (silver, $\pm 10\%$; gold, $\pm 5\%$); they are quite distinctive colours, and are never confused with the value markers.

### NEW MULLARD LINE OUTPUT PENTODE FOR 90° SCANNING

The Mullard PL36 is an output pentode primarily designed for the line timebases of television receivers using picture tubes with a deflection angle of 90° and 16kV e.h.t. The new valve is octal based, and has a 25V, 0.3A heater, suitable for series operation.

### NEW MULLARD RECTIFIER VALVE

The Mullard PY32 is a new half-wave power rectifier valve for use in television receivers with series-connected heaters. The valve has a maximum rated output current of 275mA, a typical d.c. output voltage being 190V when the valve is supplied direct from a.c. mains, 200V.

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**Further Notes on**

**THE MICROAMP**

By O. J. Russell, B.Sc.(Hons.) G3BHI

Several requests have been received from readers for details of the layout of the "Microamp" miniature hi-fi amplifier (Sept. issue). While many readers will have no difficulty in wiring up the amplifier in some form or other, details for those seeking guidance have been prepared. There are, of course, three main ways of wiring up a circuit.

One way is the "components-slung-in-the-wiring" method of wiring—glued-on-to-valveholder-tags and stuck-in anywhere. Another way is to use a tabboard for a few major items, and to suspend some major components in the wiring. The third method is to put all possible components on to a tabboard.

Actually—for beginners—the "all on a tabboard" method is quite simple if a tab-board layout is prepared for them to follow. For the "Microamp," a single "Radiospares" tabboard with two cross wires has just enough tags to accommodate the components. The first diagram shows the tab-board with the interconnecting wires in position. These are run in 20 or 22 s.w.g. wire insulated by sleeving, so that the "Earth" and "H.T." buses can be run neatly along at the top. While shown outside the tabboard, these buses are only so drawn for clarity, and in real life are carried closely along the tabboard. Certain tags lead to valveholders and potentiometers, so that long "tails" are initially left where shown, so that they can be cut to size when the board has been mounted on the chassis and the connection to valveholders, etc., are being made.

The second tabboard drawing shows the components attached to the board in the correct positions. Thus after wiring in the busbars and cross wires on the board, the components are wired on to the board, and the board mounted to the chassis for the final connections to potentiometers and valveholders, etc., to be effected. Once a tab-board layout is effected, the job of wiring up tagboards and mounting in position is easier than jumbling components suspended in the wiring.

Incidentally, one or two other points raised in correspondence might be mentioned. A low cost high fidelity speaker appears to be sought by some readers. Well, the "Sten- torian" models of the Whiteley Electrical Radio Co., will provide this. The celebrated "W.B." hi-fi speakers are very reasonable—a ten-inch speaker costs just under £4 while an eight-inch model costs just over £3. These speakers, while "inexpensive," are built to really hi-fi standards. Please note that the ten-inch model has a bass resonance of 35 cycles, so that the best performance will be obtained in a substantial large size enclosure. The eight-inch model has a bass resonance of 65 cycles, so that a smaller enclosure may be used, although the bass will "cut off" an octave higher than the ten-inch model. The

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Whiteley people have, in fact, a pamphlet giving full details of suitable enclosures for these speakers. For the small enclosure to be described later, the very reasonable six-inch W.B. speaker at 52s. 6d. will be found very suitable. However, if you do decide to go in for a larger speaker, the details of the W.B.
"Microamp" is its use in conjunction with f.m. tuners and with tape recorders. Most f.m. tuners incorporate an "F.M. Corrector" to "de-emphasise" the top boosted in the f.m. transmissions, so that all these tuners deliver a "straight-line" output and this can be fed directly into the "Microamp" via a suitable coupling capacitor. As 0.01μF is ample, this should be used to the minimum, although if a larger condenser is available it will do no harm.

Some tape enthusiasts have found that feeding output from a tape unit into the "Microamp" gives too much bass. Generally, the simplest way of overcoming this is to record the tapes with the recording bass control at minimum. In this way the bass level comes within the "Microamp" buss control range, which was designed for record or radio reproduction and not for tape use. More often, the recommendation to record with minimum bass amplitude is one often urged by tape unit manufacturers. However, in cases where excessive bass is obtained—as perhaps from commercial tape recordings—then the solution is to use a "bass corrector" input network. A simple and effective way of doing this is to choose an input capacitor giving enough "bass roll-off" to bring the tape input within the range of Microamp bass control. With the 2megohm volume control specified in the original circuit, this requires only a 100pF coupling capacitor. To tidy up the requirements of records, radio input and tape inputs, therefore, a suitable input selecting circuit is given, so that the Microamp may be used for records, radio or tape reproduction. However, where tape input has not got excessive bass amplitude, the coupling capacitor should be increased to 100pF, or even to 0.01μF, and readers can make this adjustment to suit their own tape machine and reproducing head characteristics.

Finally, the author would like to thank the many letter-writers who have reported excellent results from the "Microamp," and regrets that he is unable to thank them all individually. Many points on which assistance was requested have also been dealt with, and some of these points have been dealt with above, as they are of general interest. Correspondence has, in fact, shown that there is a very high level of interest in "hi-fi," and that a simple low cost amplifier design has been welcomed as a respite from the more complex designs!

CLIFTON AMATEUR RADIO SOCIETY
Meetings are held every Friday at 7.30 p.m. at the clubrooms, 223 New Cross Road, London, S.E.14, where visitors and new members will receive a warm welcome. Details of membership can be obtained from the Hon. Secretary, C. H. Bolland, GIDIC, 25 St. Filbars Road, Cuffley, London, S.E.6.

Q.R.P. SOCIETY
The Society is preparing a certificate to be awarded to any W.L.'s producing confirmations from sea or more than 10 stations. It will be available to both members and non-members. Commencing with the current issue, a new section is being added to the Society's journal, "Q.R.P." This will enable members to build up a comprehensive Q.R.P. Handbook in loose-leaf form. The Society is also interested in starting a new section catering for those who wish to include elementary radio in their science curriculum. Interested science masters are invited to send comments and inquiries to Hon. Secretary, A. I. Whitehead, 92 Ryders Avenue, Walton-on-Thames, Surrey.

THE WINGSTEDT AND WOODFORD RADIO SOCIETY
The Society meets every Tuesday at 8 p.m. at Wingstedt House, 2 minutes from Wanstead station. Club transmitter is operated by G6SG on 144 Mc/s, having worked to date 15 countries, including PE1PE and F9CQ. Meetings are informal and provision for practical work is available.

ROMFORD AND DISTRICT AMATEUR RADIO SOCIETY
The Society's programme includes film shows, lectures by members, construction evenings and the monthly "hot" sales. The Club net meets every Saturday evening on 28 Mc/s, the participating stations being G4AF, G3PAK, G2WPJ, G2BNV and G1AUG. The Society meets every Tuesday evening at 8.15 p.m. at R.A.F. House, 12 Carlton Road, Romford, and all visitors and new members will be warmly welcomed. Further information can be obtained from the Hon. Secretary, N. Miller, 55 Kingston Road, Romford.

THE MEDWAY AMATEUR RECEIVING AND TRANSMITTING SOCIETY
All meetings are held at the Club headquarters, "Golden Lion," Old Bromley, on alternate Monday evenings at 7.30 p.m. Club transmitter G2JFA is used regularly on the air operated by transmitting members. Some Club calls include G6NI, G1GEP, G6CT, G5NO, G2CBA, G5BJ and G2ZP, etc. Kent/Essex "Record Room" first Sunday in each month on Top Band. Hon. Secretary, H. G. Chessman, G1KNO, 265 Cliff Road, Strood, Kent.

THE SLADE RADIO SOCIETY
The Club station at the Church House is open every day of the week for the use of members. Instructional classes are held every Monday, Tuesday and Wednesday evening and on every second Friday evening, Feb. 25th, Special D.T. Meeting. All members interested in D.T. are asked to attend this meeting. Full particulars of the Society and its activities may be obtained from the Hon. Secretary, C. N. Smart, 110 Woolmore Road, Erdington, Birmingham 23.

NOTTINGHAM AND DISTRICT AMATEUR RADIO SOCIETY
Meetings are regularly held on the third Friday of each month at Sherwood Community Centre, Manfield Road, Sherwood, at 7.30 p.m. Hon. Secretary, F. M. Hyde, 77 Sherwood Vale, Nottingham.

Details for insertion in this section should reach us not later than 7th of the month of publication. Insertions are subject to space being available.

FEBRUARY 1953
Technical Forum

Electrostatic Loud Speakers

Although the principle of the electrostatic speaker has been known for over 30 years, its use has not been seriously considered either by amateurs or receiver manufacturers until quite recently. This is attributed partially to improvements which have lately been made in the design of such speakers and partially to the ever-growing interest which is being shown in better quality sound reproduction. A loudspeaker, being essentially a device for creating sound waves, must be capable of agitating the air in such a manner that the required waves are formed. This agitation is usually brought about by mechanical means such as the piston-like movement of the cone of a normal speaker. However, for a cone speaker to be able to reproduce both high and low frequencies at the correct intensities it must possess negligible mass and be completely rigid. This is obviously impossible, although some speaker manufacturers have made very good compromises between mass and rigidity in their cones. In general, a cone which is large enough to reproduce low frequency notes will be unable to move sufficiently fast in its entirety to satisfactorily reproduce the high frequencies. Parts of the cone may move, whilst other parts remain relatively still; this effect produces waves travelling outward from the centre of the cone and seriously reduces the high frequency response. With the electrostatic speaker this trouble is overcome, because the mechanical drive to the diaphragm is applied uniformly over its surface, thus ensuring uniform movement and the elimination of cone "break-up." This is the term used to describe the non-uniform movement of the cone or diaphragm under high frequency oscillation. It is the idea of utilising to the full this possibility of uniform drive over the whole surface of the diaphragm which has attracted the attention of speaker designers for so long.

There are, however, certain inherent limitations to the electrostatic speaker, the first being that to achieve a reasonable sensitivity a very small space must be employed between the plates, thus limiting the movement of the diaphragm and hence the audio output. The second disadvantage is purely a physical one in that to reproduce bass frequencies in the region of 50 c/s the diaphragm would have to have an area of about one square inch in this region of 75 sq. ft. Except in a few very special applications, this requirement is likely to limit the use of electrostatic speakers to the higher audio frequencies. It is, in fact, for use as "tweeters" that the electrostatic speakers now being offered for sale are made. These units are small in size, being in the region of 5 x 4 inches, and they possess a frequency response of around 6 kc/s to 20 kc/s. They are entirely unsuitable for use by themselves, as they have virtually no output below about 2 kc/s and are not, therefore, capable of providing intelligible sounds. They are, nevertheless, admirably suited for use in conjunction with a normal speaker, which most probably has a maximum top response of 6 kc/s, to extend the range up to 20 kc/s. In this capacity they have been used in the more expensive a.m./f.m. receivers in Germany for some years, and at least one English set-maker has now followed suit.

In keeping with most other high frequency reproducing devices, the electrostatic speaker is rather directional in that the sound is radiated over a limited angle. To offset this disadvantage two such speakers are often mounted on opposing sides of a cabinet, with the main speaker occupying the conventional position in the centre. In receivers in which one electrostatic speaker is employed it is best mounted as close to the main speaker as possible. Where space is limited the additional speaker may be suspended in front of the main unit by strands of elastic.

Construction of Speaker

It is well known that two oppositely charged bodies will attract one another whilst like charged bodies repel. Thus when a voltage is applied across the plates of a capacitor there is attraction between the plates. This does not normally result in any displacement of the plates, because of their rigid fixing. However, if one of the plates were free to move it would do so in sympathy with any fluctuation in the applied voltage. This, then, is the principle of the electrostatic speaker. In its most popular form the rigid plate is perfomed and forms
the outer case for the unit. The moveable plate is a thin metallic foil which is coated with a very thin layer of insulating plastic. The foil is held in close proximity to the rigid plate by a pressure pad of foam rubber or similar highly resilient material.

Feeding the Speaker
The electrostatic speaker, being a high impedance device, may be fed from a relatively high impedance source at a voltage which is very high compared with that applied to normal moving coil speakers. E.S. units of the type under consideration require from 60 to 100 volts of signal to drive them. Such a voltage is most easily obtained from the primary of the speaker output transformer. With all electrostatic speakers it is necessary to employ a polarising voltage, which must be in excess of the peak of the signal voltage. Without polarisation the speaker diaphragm would move twice on each cycle (once on the negative half and once on the positive half), providing a frequency doubling effect. The polarising voltage is most conveniently obtained from the h.t. supply in the receiver via a suitable limiting resistor. The circuit diagram (Fig. 1) shows a typical method of connecting an electrostatic speaker to a single-ended output stage. The filter combination C1, R1 serves to attenuate the lower frequencies but passes the upper frequencies without loss. This in effect assists in reducing intermodulation distortion in the speaker itself. The capacitor C2 is for the purpose of blocking the d.c. path to earth. Between 250 and 300 volts are normally employed for polarisation, and where the h.t. does not exceed the upper limit it may be applied as shown in Fig. 1. If the h.t. is higher than this a simple resistive divider must be employed, R2 being taken to a tap at about 250 volts on the divider.

When the output stage is in push-pull, an unbalanced arrangement as shown in Fig. 2 may be employed. If more than one E.S. speaker is used the second unit is connected directly across the terminals of the first one, all component values remaining unchanged.

In conclusion, it is worth repeating that a small electrostatic speaker by itself will not provide intelligible sounds, but when used in conjunction with a normal speaker it will enhance the top note response, giving a more realistic reproduction.

TESTING AN OUTPUT STAGE FOR LEAKY COUPLING CONDENSER
AND ALSO FOR VALVE GRID CURRENT

If you have a set with an output stage which sounds slightly distorted or as if there is "just something wrong," the following test may show up the trouble.

Insert a 100mA meter in the cathode lead. Short the grid to chassis and see whether the anode current changes. If so, disconnect the coupling condenser and again short the grid to chassis. If now no change, the condenser is leaking. If there is a change, the valve is faulty and needs to be replaced. A temporary cure may be found by reducing the value of the grid leak.

G.B.

A SMALL TABLE-Top TRANSMITTER FOR THE LOWER FREQUENCIES

by A. C. GEE, G2UK

This small transmitter has been used quite successfully during the past year or so by the writer as a portable and fixed station unit on 3.5 Mc/s c.w. It is presented as a very suitable unit for R.A.E.N. use, as its power requirements are small. Together with an Eddystone 640 receiver, it has been run off a rotary converter giving 100 watts of 230 volt a.c. current. The one used by the writer was a war surplus 24 volt input type, which in its turn was driven by a 24 volt d.c. petrol generator. The whole station—transmitter and 640 receiver—can therefore be run either from the house a.c. mains or from the rotary and petrol engine. A very versatile set-up is thus available, ideal for R.A.E.N. service.

As described, a 230-0-230V receiver type transformer is used for the power supply and this gives the transmitter an input of ten watts. This is quite suitable for top band, R.A.E.N. service and general portable work, but for regular use on the 3.5 Mc/s band it was found that the QRM from high power transmitters made communication difficult. However, by enlarging the chassis and cabinet and substituting a 500 volt power supply, a useful increase in input can be obtained without any modification to the circuit.

The Circuit
The circuit is pretty straightforward. An EF50 strapped as a triode is used as a cathode coupled oscillator. A second EF50 also

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Rear top view of the L. F. Transmitter
connected as a triode acts as an untuned buffer stage, and the versatile 807 is used as the p.a. Keying is arranged in the cathode of the oscillator and a switch, S2, is connected in the cathode of the 807 so that the oscillator can be put “on frequency” without the 807 radiating, when QSYing.

A chassis $12'' \times 8'' \times 2''$ deep, and cabinet to fit, can be obtained from one or other of our advertisers who specialise in this type of work. C1 is used as the main capacitor in the oscillator circuit, with C2 the bandspread; C3 being controlled by the main tuning dial. C4 must be insulated from the metal chassis, and as can be seen from the photo, is mounted on a piece of polystyrene supported on two metal brackets held in place by the transformer fixing bolts. A fourth variable capacitor (not shown in the circuit diagram) can be seen in the photo. This is an aerial tuning variable capacitor, used if a Marconi type aerial is used, but more of this later under the heading of aerials.

The oscillator coil L1 is wound on an Eddystone miniature type former. The required number of turns for 3.5 Mc/s and the cathode tap are shown in the circuit diagram. By using really thin enamelled wire (28 s.w.g.) this number of turns can be got on to one of these miniature coil formers. For 1.8 Mc/s, two or three former units are required, which means extending the former somewhat to take them. The best way to do this is to slip a piece of polystyrene over the existing former, or alternatively to turn down one end of a short length of wooden rod to a diameter similar to that of the former, until a collett is formed which will slip into the end of the former, where it can be retained by a little glue.

L2 is wound on a standard 4-pin former, using 20 s.w.g. enamelled wire or similar.

Aerials

A few words about aerials. For 3.5 Mc/s it may be possible to use a half-wave dipole with low impedance twin feeder. In this case all that is necessary in the way of coupling arrangements is a two or three turn loop coil wound on the end of L2. A little experiment

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BOOK and CATALOGUE RECEIVED

R.S.G.B. Amateur Radio Call Book. The 1956 Edition gives a comprehensive list, in order of call sign, of the licensed amateur radio transmitters in the United Kingdom and Eire, with addresses and, where applicable, addresses of alternative (A) locations. Obtainable from the Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1, price 2s. 6d. (2s. 9d. by post).
AN IMPROVED TUNING WAND
by G3XT

The novel T-shaped tuning-wand shown in the sketch is an improvement on the ordinary straight type. It speeds up the work a little when several coils have to be checked, and the fact that it is flexible enables it to reach coils in awkward corners of a chassis. In a few cases it may even save quite a bit of time by enabling adjustments to be made without removing the chassis from the cabinet.

The device works on the usual principle of an iron-dust core at one end of the wand and a brass "slug" at the other. The brass knob at the handle end of the rod enables it to be twirled round quickly so that the iron-dust and brass inserts can be tried alternately as adjustments are carried out.

Materials required are a 3-in length of PVC sleeving of suitable diameter, an iron-dust core (which should not be too small), a brass slug, an insulating rod, about 4 or 5 inches long, and 3-in diameter, and a small bakelite knob to fit. (I got the rod and knob complete from a variable-inductance unit in a Government surplus Tx.)

Construction takes only a minute or two. Screw the iron core half-way into one end of the sleeve, and force the brass slug half-way into the other end. Make a saw-cut in one end of the rod, squeeze the sleeve flat in its middle and force it into the slot formed by the saw-cut. Fit the knob (if not already on) and the tuning-wand is ready for use. (I gave the whole thing a protective coat of transparent varnish.)

Inserting the dust-core in the end of a coil will increase strength if the inductance is too low, or tuned to too high a frequency, and inserting the brass slug will increase strength if the inductance is too high, or tuned to too low a frequency. When the coil is correctly tuned and adjusted, inserting either the iron-core or the brass slug will decrease strength, and the case of coils with adjustable iron cores which already fill up the inside of the coil-former, you may have to hold the wand ends against the outside of the coil winding instead of inserting it in the centre of the winding.

BOOK REVIEWS


In the 17 chapters of this book the author takes the reader through practically every aspect of present-day electronics and aims to give some understanding of the many and varied applications of this modern art. Starting with the nature of electronics, he leads his readers through the comprehension of the principles of control devices, circuit elements, radio communication, television, measurement aids, computer, industrial electronics, and so on.

The many diagrams reflect the care and thought that has gone into their preparation, and reveal the author's flair for clear expression to a correct circumstance. A minor error is noticed on page 205 where it is stated that the frame frequency of 50 cps in television transmission is derived from the line frequency (20,250 cps) by three dividers in cascade, using steps of 5, 2 and 2. This book is informative rather than instructive, and does at least reveal the enormous field covered by that convenient word, "electronics." — W. E. THOMPSON


World Radio Handbook now appears in its 17th edition. Its editor and publisher, Mr. O. Lund-Johansen, thus celebrates a jubilee and must feel satisfaction that the idea of this international book has proved a success, and is known and valued by the United Nations, UNESCO, the international radio federations and broadcasting organizations and thousands of listeners all over the world.

When the editor first toyed with the idea in the last year of the war, there were not many who believed in it. That it cannot be is shown by the fact that the circulation and the contents of the edition have been increased fivefold and sometimes more.

The head of the Dutch, "Happy Station" states that the World Radio Handbook is just as important to a broadcasting establishment as a telephone book for the use of the telephone.

This is true. With W.R.H. at hand one possesses a guide enabling one to listen to all the stations in the world. By its help one can bring into one's room the sounds from the most distant areas of the globe. The Handbook suggests various listening ideas and makes it possible to determine the identity of the many stations which can be picked up.

In the world of radio and television, changes are constantly taking place. All are brought up to date in World Radio Handbook. Excellent tables show the position of the various transmitting stations, and under the sections dealing with the broadcasting of the individual countries will be found not only all stations, their wavelengths and powers, but also the time of transmission, regular programmes, names of the leading personalities, and much else. If you hear an interval signal you can identify the station by help of the Handbook, as the notes of the different signals are given.

In addition to the broadcasting stations, television stations are also brought up to date. It is a fact that World Radio Handbook is used everywhere in the world where people are interested in broadcasting and television. World Radio Handbook is a Danish production and is also translated into several languages. The text is in English, and it thus helps to carry interest and understanding to many countries.

World Radio Handbook's 18th Edition is nicely produced and contains a mass of interesting illustrations from all over the world.

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www.americanradiohistory.com
During the course of almost any circuit construction, the enthusiast finds it necessary to produce a specific voltage at the junction of two resistors forming a bleed or dividing chain across either an h.t. supply or part of a circuit. Very often the voltage divider thus formed is used to provide a fixed biasing potential for a particular stage; at other times the divider may be an attenuator. Whatever its function, however, the calculation of actual values for resistors forming the network is often complicated by the fact that one is limited to certain values of resistance.

This chart has been designed to obviate some of the difficulties, being constructed around 10% component values. (It will be seen later that any value of resistor can be used by interpolation.)

The mechanism of the voltage-divider is appreciated by reference to Fig. 1, which shows an example often encountered in practice; namely that of providing bias to a cathode follower stage. Invariably the cathode of such a stage is of the order of 100 volts or more with respect to earth. To preserve the relatively small bias that the stage requires (say -1 or -2 volts) it is necessary to fix the junction of the two bias resistors within this value of cathode voltage. Having fixed this bias value, it merely remains to select those value of resistor, R1 and R2, conforming, say, to the 10% standard tolerance range, which give the desired value of bias at the grid.

Let us consider a practical example: a cathode follower stage operates from an h.t. supply of 300 volts. Cathode voltage is 100 volts, and the grid bias for correct circuit operation is -3 volts. What are the values of R1 and R2 to provide correct operation?

Obviously the bias potential must be 97 volts. Therefore the voltage across R2 is 97 volts while that across R1 is 300 - 97 or 203 volts.

Before we can use the chart we must determine what the ratio of the voltage drops is. In our example this ratio will be 203/97 which is 1.04.

It is easy to see that this voltage drop ratio is also equal to the resistance ratio R1/R2.

Reference to the chart will show that the horizontal axis is calibrated in this ratio but is limited to values between 0.1 and 1.0.

We therefore regard our ratio as being 0.185, remembering that we must correct for this error when we finally determine values for R1 and R2.

Locating this value as nearly as possible on the horizontal axis, we then seek a value of R1 which intersects a value of R2 at the required ratio.

The standard 10% range of resistance values are plotted on the sloping lines for R2, whilst those for R1 are plotted horizontally.

Our example is typical in that no two standard values in the 10% range give the exact ratio we require and it is therefore necessary to seek an intersection of R1 and R2 values as close as possible to the fractional ratio. The best that can be achieved is obtained when R1 reads 68 and R2 reads 330, giving a fractional ratio of 0.206.

Use of a 43 value for R1 (which is a 5% component) will give a ratio of 0.196 if used in conjunction with a 220 value for R2. This can be seen by interpolation as mentioned earlier.

We must now make the correction for the ratio and this is achieved, obviously, by multiplying the R1 value by 10.

Finally it remains to allocate practical values to R1 and R2 as determined from the chart. For the case in question, since the resistors are providing only a bias voltage, the current that the components draw is best kept to a minimum and a 680Ω and 330Ω resistor will be used for R1 and R2 respectively.

Of course the design chart is not restricted in its use to bias chains alone, but as mentioned earlier, may be used for attenuating resistance calculations and bleed chain designs for e.g., supplies and, in fact, in any similar circuit configuration in which no additional current is drawn from the junction of the two resistors forming the chain. It is important that this limitation is borne in mind when the circuit is designed.

Preceding next month’s article, a method will be given enabling dividing chains to be designed in which a known amount of current may be drawn from the junction. This method will involve the use of this chart and that of last month’s article and makes the possibilities of the chart much wider.

Next month’s article: Reactance/Resistance Chart.

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