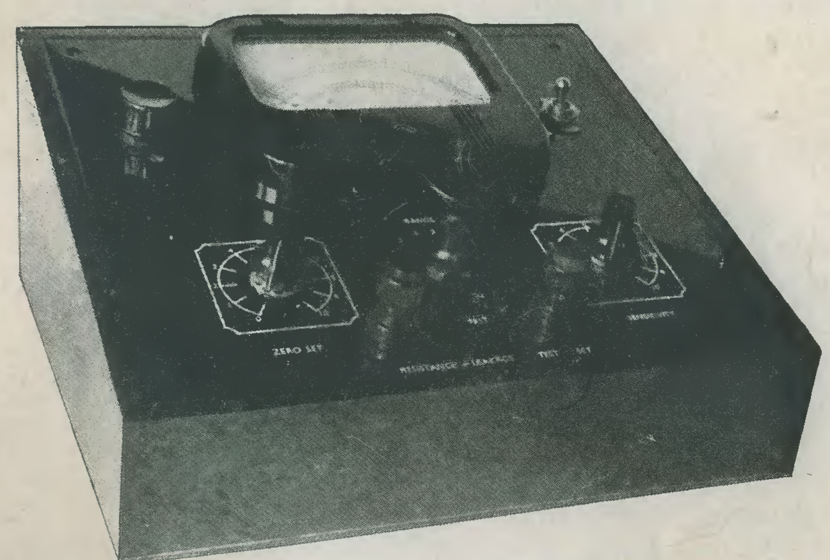
Printed in Great Britain for the Proprietors and Publishers Data Publications Ltd., 57 Maida Vale, London, W9, *by* A. Quick & Co. Ltd., Oxford House, Clacton-on-Sea, Essex. *Is obtainable abroad through the following:* Collets Subscription Service, Continental Publishers & Distributors, Ltd., William Dawson & Sons Ltd. *Australia and New Zealand:* Gordon & Gotch Ltd. *South Africa:* Central News Agency. *U.S.A.:* Gilfer Associates. *Holland:* "Radio Electronica." *Scandinavia:* Intrapress. *Registered for transmission by Magazine Post to Canada (including Newfoundland).*

The RADIO CONSTRUCTOR

for the Radio and Television Enthusiast

Volume 8
Number 8
MARCH
1955

ELECTRONIC RESISTANCE



AND LEAKAGE TEST SET

ALSO IN THIS ISSUE

THE PARAGON TAPE RECORDER Part 3
MODERN LINE TIMEBASE CIRCUITS
IMPROVING SIMPLE "UNIVERSAL" RECEIVERS
FURTHER NOTES ON THE 182A 'SCOPE' · SYNTHETIC BASS CIRCUIT FOR DOMESTIC AMPLIFIERS · NOTES ON RADIO CONTROL, Part 5
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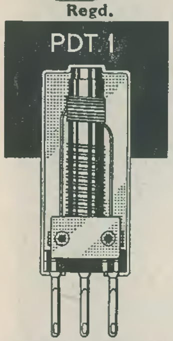

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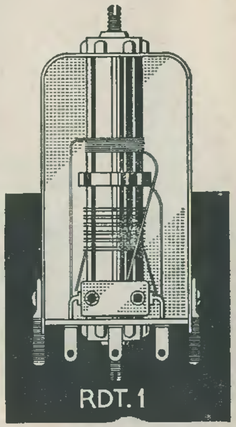

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VOL. 8 NO. 8

ANNUAL SUBSCRIPTION 18/-

MARCH 1955

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NOTICES

THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included.

All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

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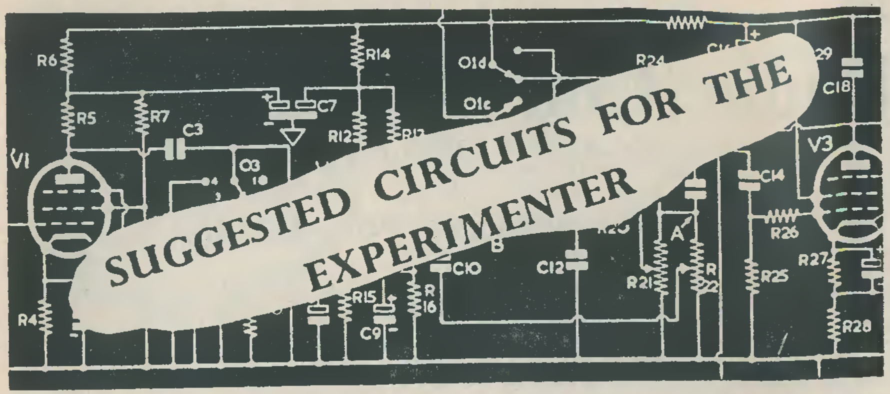


The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data*

No. 52. A "SYNTHETIC BASS" CIRCUIT FOR DOMESTIC AMPLIFIERS

ONE OF THE GREATEST PROBLEMS INCURRED when reproducing sound in the home is given by the difficulty of preventing attenuation of bass frequencies due to insufficiently dimensioned loudspeaker enclosures. To obtain a note of 50 c/s without noticeable losses it is necessary to mount the reproducing loudspeaker on a baffle which is at least ten feet square. A baffle of this size is, of course, far too bulky to be introduced into a conventional living room, and alternative solutions have to be sought.

Of these, the best choice is provided by fitting the loudspeaker into a properly designed enclosure which is intended expressly for high fidelity reproduction. This solution suffers only on the question of initial cost.

A more frequently encountered answer to the problem of reproducing bass at full level is given by the introduction of resonances (in the loudspeaker and/or its cabinet) which centre around the lower audio frequencies. These resonances then tend to boost, usually with considerable coloration, the frequencies which are lost by reason of the insufficient baffle area.

This month's Suggested Circuit takes advantage of a different idea altogether, and demonstrates a method of obtaining apparently enhanced bass reproduction (usually described as "Synthetic Bass") even when the loudspeaker is fitted to a baffle of quite small dimensions. Whilst the methods employed may not appeal to the high-fidelity enthusiast, they definitely represent an interesting field for experiment and, given the right conditions, are capable of quite impressive results. A particularly intriguing application is given by the introduction of a synthetic bass circuit into the amplifying chain of an electronic musical instrument. Such a circuit could effectively increase the tonal range of an instrument of this type without incurring condemnation on the grounds of deliberate misrepresentation of an original sound. This is, of course, due to the fact that the primary purpose of an electronic instrument is that of the creation of sound, and not that of reproduction only.

There is not a great deal of information concerning synthetic bass in "the literature," but readers who are interested may find a brief description of the principles involved, together with a commercial application, in the *Radio Designer's Handbook*[1]. Also, a full-length article describing a practicable circuit has been published in *Wireless World*[2].

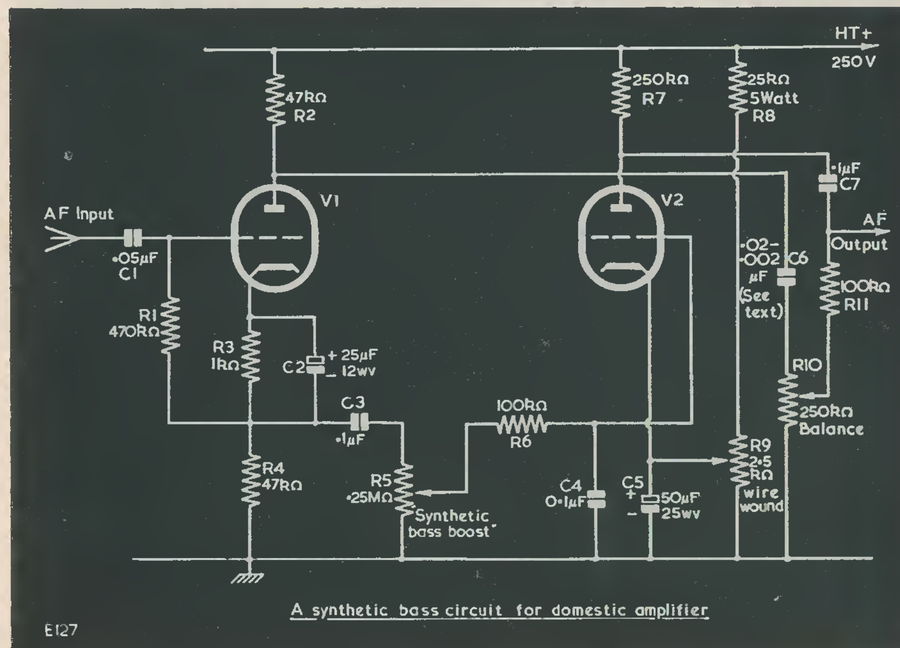
The Principles

To understand the principles employed in a synthetic bass arrangement it is first of all necessary to appreciate a particular idiosyncracy of the human ear.

Should one hear a musical note, consisting of a fundamental tone together with its family of harmonics, one is able immediately to recognise and classify the fundamental. However if, by some agency, the fundamental is removed, leaving only the harmonics, the ear is apt to replace the fundamental of its own accord; with the result that the note retains its original character. Indeed, so

developed is this property of the ear that it is very difficult to ascertain, merely by listening, whether the fundamental of a particular note has been removed or is still in existence!

This peculiarity of the human ear has been well known in musical circles for many years. In particular, especial advantage of the fact has been taken by the manufacturers of pipe organs. If a proposed organ pipe, which is intended to resonate at a very low frequency, is considered to be too long to fit into a particular building, or too expensive, it can be replaced by an "equivalent"; the latter consisting of several much shorter pipes designed to give the requisite harmonics in the correct proportion. So far as the subjective impression of the ear is concerned, the effect given by the equivalent set of pipes is virtually the same as that which would be provided by the single long pipe resonating at the fundamental.



A synthetic bass circuit for domestic amplifier

Synthetic bass, as applied to electronic amplifiers, embodies the same principles. It is assumed that the reproducing loudspeaker and its enclosure are incapable of fully reproducing the lower bass frequencies. These frequencies are, therefore, deliberately distorted in order to add harmonics to the original fundamentals. The harmonics, being within the range of the loudspeaker, are next reproduced. The ear, itself, supplies the missing fundamentals; and the impression of full reproduction of the bass frequencies is then provided.

The Circuit

The circuit in this issue illustrates a synthetic bass arrangement which could be fitted into an amplifier which is already in existence. The circuit provides no amplification (apart from that of bass fundamentals and harmonics), and should not in normal circumstances introduce any noticeable reduction in gain. For greatest advantage, the circuit should be introduced between the penultimate stage of the amplifier and the output valve grid (providing, of course, that a negative feedback loop is not in existence over these two stages).

The functioning of the circuit is quite simple. The input AF voltage is applied to the grid of V1, which functions as a phase-splitter. The AF voltage appearing on the anode of this valve is next fed, via C6, to the "Balance" control R10. The AF appearing on the slider of this control is then passed to the subsequent grid. As will be appreciated, the amplification offered by this process is nil and, apart from the fact that some attenuation of bass frequencies may take place due to the value of C6 (to be discussed later), no distortion of any sort is introduced.

Built up across the cathode load, R4, of V1 is an AF voltage similar in amplitude and phase to that applied to its grid. This voltage is applied, via C3, to the "Boost" control R5. The AF voltage tapped off by this control is then applied to the low-pass filter R6, C4. The values of R6 and C4 are such that only frequencies below about 100 c/s effectively reach the grid of V2. By reason of the bias voltage tapped off by R9 (combined with the effect of the rather high value chosen for R7), V2 is made to distort the voltages which are fed to its grid. Its output, rich in harmonics, is then passed to the subsequent grid via C7.

It will be noted that the outputs of V1 and V2 are in phase, and that no feedback can occur.

Setting Up

Setting up the circuit initially should not present too many problems, although an imaginative approach is essential if the effects given by altering different circuit values are to be judged correctly.

It would most probably be advisable to start off by choosing a value around 0.02μF for C6. A source of programme should next be fed to the amplifier, setting the "Boost" control to minimum and the "Balance" control to maximum. The "Boost" control should then be advanced, experimentally adjusting the "Bias" control at the same time, until the requisite amount of distortion, and apparent bass boost, is obtained. The greatest amount of distortion will be given when R9 is set nearly to cut-off point, although intermediate voltages may provide more pleasing results. R9 should not be taken beyond the cut-off point or V2 will not function on low amplitudes.

(An alternative method of obtaining bass distortion would consist of removing R8, R9 and C5 from the circuit altogether, and connecting the cathode of V2 direct to chassis. Final adjustments could then be made by varying the value of R7. This process would not provide as high a degree of distortion as that just described, however.)

Should it be found that the amount of apparent bass boost is too small to be effective, the "Balance" control should be retarded. This will reduce the level of the undistorted AF, increasing thereby the effect of the boosted bass harmonics. It is probable that in most cases this course would not be required however, whereupon, after the experimental stage has been completed, it would be possible to replace R10 by a fixed resistor. Also, in such circumstances, R11 could be removed, and C7 connected directly to the top of R10.

Although the primary function of V2 is to provide bass harmonics it will also, of course, amplify the fundamentals as well. If there is evidence of overloading of the output stage by these fundamentals when they are combined with those from the anode of V1, the value of C6 should be reduced experimentally until the overloading is cleared.

The Speaker

The success of the circuit will depend mainly upon the loudspeaker employed. If this has a high bass resonance, say above 100 c/s, the results given may not be as pleasing as they could be. The best speaker to employ is one with a low bass resonance, and having a fairly large-diameter cone with a soft and compliant suspension.

Valves

The choice of valves is not very critical. Either valve may be a low-mu triode (such as the 6J5); or both valves may be combined in a single 6SN7 or 12AU7.

References

1 *"Synthetic Bass"*. F. Langford-Smith; **Radio Designers Handbook**, 4th edition; pp 616, 676.

2 *"Bass Without Big Baffles"*. K. A. Exley; Wireless World; April 1951

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IN YOUR WORKSHOP

In which J. R. D. discusses Problems and Points of Interest based on Letters from Readers and his own experience

IT ALL STARTED OFF IN THE SEPTEMBER issue! In this copy of *The Radio Constructor* I referred to the circuit shown in Fig. 1, describing it as a "Mystery Circuit," which was thought, in the early days of radio, to give push-pull working merely by adding another output valve. As I said at the time, however, this assumption is quite untrue—the circuit is *not* push-pull.

Controversy

No sooner had the September issue been printed than I received several letters from readers telling me how wrong I was, and that the circuit was a long-tailed pair which most definitely did give push-pull results. One reader enclosed a "proof" of this (which I published in December); but, unfortunately, this jumped from amps to mA half-way through the working! As a result of this, even more letters are now rolling in.

I wish I could quote from all of them but, obviously, space would not allow this. One London engineer raises an interesting point.

"The reason," he writes, "why the 'Mystery Circuit' does not produce a true push-pull output is due to the fact that a sufficiently high value resistor in the cathode circuit cannot be used. If it were, and the grid voltages made suitable, considerable power would have to be wasted in the resistor.

"This may be overcome by using a choke in the cathode circuit, as shown in the diagram (Fig. 2). The resistance of this choke must, of course, be less than the required bias resistance and extra resistance added to make up the value. The second grid may be earthed or used to mix in another signal."

The only snag with this idea, of course, is that the choke in the common cathode circuit would have to be a pretty hefty component if

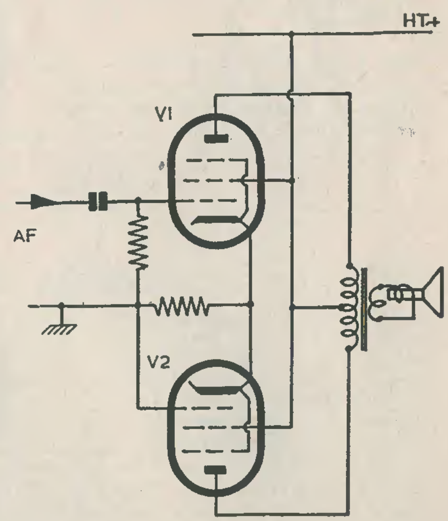

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Fig. 1. The supposedly "push-pull" circuit which was printed in the September, 1954, issue of The Radio Constructor, *and which has been the subject of a large number of letters from readers.*

a balanced bass response is to be obtained. Assuming, for instance, that two 6V6's were employed, the resultant steady DC current through the choke would be at least some 70 mA at normal HT voltages, and a small component would lose quite a lot of its effective inductance if it continually had to pass this current. On the other hand, the circuit of Fig. 2 might not be at all unattractive when small output valves are used and fidelity of reproduction is not of primary importance.

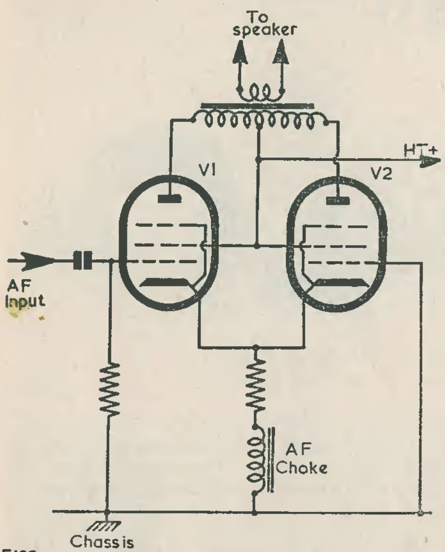


Fig. 2. A possible alternative to the circuit of Fig. 1. In this arrangement a high AF impedance in the common cathode circuit is obtained by means of a choke.

J. Kendall, whose articles and books are well known to readers, has also commented on the subject.

"The 'Mystery Circuit'," he says, "was originally developed by an engineer named Schmit, and is known as the 'Schmit Phase-Split Circuit.' However, like most circuits that were properly developed by competent engineers, it has been butchered to cut the cost. When the circuit was developed by Schmit about 20 to 25 years ago, he calculated that the circuit must have a cathode coupling resistor of at least ten times the value of the bias resistor required for two valves in push-pull. If, then, two valves of the 6V6 type are to be used with, say, 15 volts bias, then a cathode voltage of 150 volts above chassis is required. This necessitates a higher value of HT: i.e. 400 in place of 250. The normal method of designing the circuit is to return both grids to the bottom of the bias resistor (using the original value) by means of a suitable resistor around 500 kΩ. The 'spare' control grid is then 'earthed' via a 0.1 μF condenser. The 'coupling' resistor is connected between the bottom of the cathode bias resistor and chassis. (A circuit of this type is illustrated in Fig. 3.)

"I have recently made a directly coupled amplifier using this circuit. With a pair of EL84's I use a coupling resistor of 1.5 kΩ, joining one grid to the anode of the drive valve. Both grids are connected via a 470 kΩ resistor, the second grid connecting to earth via a 0.1 μF condenser. The balance is, as far as I can check, perfect."

J. D. Herring (Salisbury) includes, in a long letter, a circuit which *does* give push-pull working from a pair of output valves using normal HT voltages (Fig. 4). "This is not a very nice arrangement, however," he writes, "and is seldom used in practice. Since the grid leaks of output valves normally should not exceed 250 kΩ, condenser C will have to be large—say 1 μF—in order to preserve balance at low frequencies, and will have to be quite leak-proof at the full HT voltage. Also, the HT supply to the output valves will require extra smoothing as any ripple is fed differentially to the grid of the second valve. In addition, the chief merit of the circuit, its self-balancing action, is largely lost owing to the small voltage gain in the final stage; and balance will have to be set up by careful adjustment of the tap on the resistors joining the anodes."

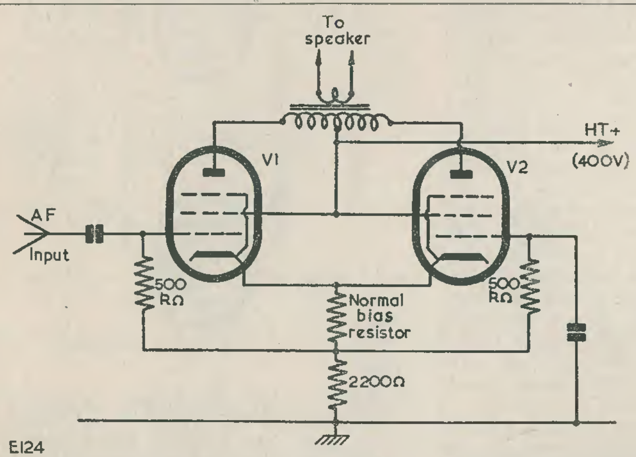


Fig. 3. The Schmit phase-split circuit, described in a letter from J. Kendall

Another reader, L. F. Sinfield, has sent a similar circuit, with the difference that the cathode by-pass condenser (shown as an electrolytic in Fig. 4) is omitted.

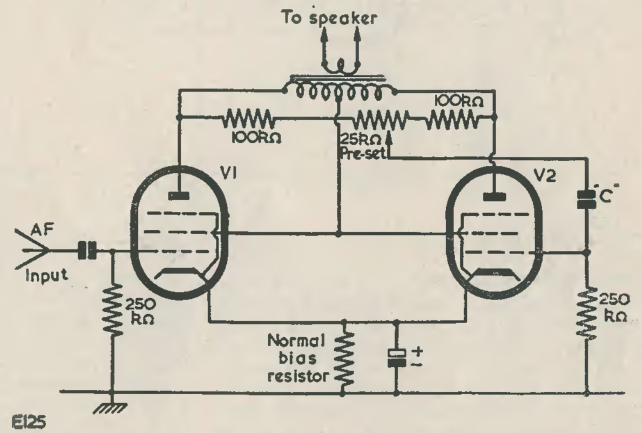


Fig. 4. Another version of Fig. 1, in which a largely self-balancing action may be obtained at normal HT voltages.

As mentioned earlier, I have received quite a few other letters as well concerning the "Mystery Circuit," nearly all of these concurring with the views just quoted; and I would like to take this opportunity of cordially thanking those readers who were good enough to write to me on this subject.

FM

I have recently started playing around with an FM tuner which is more or less of my own design, and I have obtained a considerable amount of satisfaction from the process. There is, indeed, quite a lot of pleasure to be had from FM construction, quite apart from the fact that the completed receiver ensures that programmes can be received at good quality and free from background. The first thing to do, so far as FM experimental work is concerned, is of course to try and get the practical "feel" of the circuits and techniques employed. Unfortunately, unless one has a suitable wobbulator and oscilloscope, one has to work in the dark until one's first receiver is nearly completed. Only after the frequency-changer and IF stages have been built is it possible to pick up the BBC test signals and really get to grips with the working of the circuits.

Those who are contemplating the design of their own FM sets (including, possibly, the coils and IF transformers) but do not have a great deal of test equipment on hand can find a reasonably useful short-cut by initially treating their receivers as if they were intended for AM. It is probable that, in most cases, the proposed receiver will incorporate a ratio discriminator circuit, such as is shown in Fig. 5. If this is the case, the electrolytic stabilising condenser may be removed temporarily from circuit and an AF amplifier connected to the load resistor, as illustrated in the diagram. The set then becomes, to all intents and purposes, an AM receiver with a somewhat inefficient detector circuit. Using an amplifier in this manner even allows the discriminator transformer itself to be initially tested. Should this transformer "peak" within the range of movement of its iron-dust slugs then one can say that at least a part of the battle has been won!

By connecting an output meter across the output of the amplifier and injecting a modulated signal into the IF stages one can also obtain a reasonably good idea of their bandwidth. A fairly flat-topped bandwidth of some 200 to 300 kc/s appears to be most desirable, and this should primarily be aimed at. Unfortunately, although over-coupled IF transformers seem to offer a very attractive method of obtaining such a bandwidth, they should not be used over-extensively since they may introduce phase-shift, with consequent distortion at the discriminator. More preferable are slightly staggered IF transformers which are just short of critical coupling.

When the AF amplifier is used, the signal injected into the IF stages for initial alignment should be as small as is consistent with a measurable output from the amplifier.

the VHF signal frequency band should, preferably, do so on fundamentals and *not* on harmonics. If a signal generator working on harmonics is used it is very easy to waste a lot of time chasing the wrong harmonic.

I daresay that quite a few readers, like myself, possess one of the more inexpensive commercial signal generators having a frequency range which extends up to some 100 Mc/s or so. These signal generators are

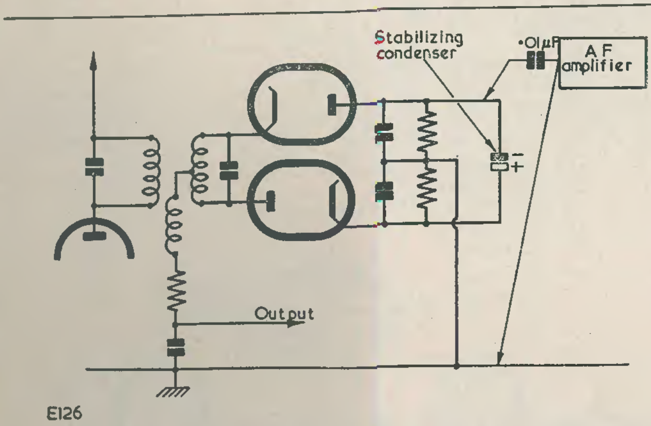


Fig. 5. A typical FM discriminator circuit. Experimenters who have not yet had practical experience of FM may find it helpful to disconnect the stabilising condenser and treat the circuit as an AM detector for initial alignment

The Frequency-Changer

One of the more difficult parts of the FM receiver to get into operation, when one is "starting from scratch," is the frequency-changing stage. Unless coils especially made for the job are available a signal generator covering the VHF band is well-nigh essential. Here, again, it is possible to start off by treating the set as an AM receiver and by setting up the frequency-changer to receive AM signals at the requisite frequency. It is worth while mentioning that the signal generator employed to cover

excellent jobs (for their purpose), and adequately fulfil the performance to be expected at the price one pays for them. However, at frequencies around 90 to 100 Mc/s it is possible for their attenuator readings to become somewhat erratic, and such readings as are given should be taken with a very large grain of salt. The reason, of course, lies in the self-capacities in the attenuator network of the signal generator itself.

As an illustration of the precautions one has to take with regard to this point, a friend of mine told me recently that he had experienced considerable trouble in attempting to line up an FM receiver when using one of the more inexpensive types of signal generator. Even when both attenuator controls (coarse and fine) were turned fully anti-clockwise, sufficient RF output was still given at 90 Mc/s to completely overload the receiver! The only solution consisted of completely disconnecting the signal generator from the receiver, moving it several yards away, and connecting a foot or so of unscreened wire to its output terminal. The radiation from this piece of wire was then just sufficient for it to be picked up by the receiver input coil and wiring, whereupon the set was capable of being finally lined up in a more-or-less normal manner.

RADIO COMPONENT SHOW

APPLICATION CARDS OUT

Application cards for badges for admission to the Radio Component Show, to be held at Grosvenor House from 19 to 21 April can be obtained by written request to the Secretary, Radio & Electronic Component Manufacturers' Federation, 22 Surrey Street, Strand, London, W.C.2.

The exhibition is intended primarily for engineers and technicians in all the user industries and in the Services. The wide list of those eligible covers research and education and the manufacturing, wholesale (not retail) and export sides of the electronic industries. Every bona fide applicant will receive a badge.

There will be 142 exhibitors—a record number.

MODERN LINE TIMEBASE CIRCUITS

by **S. WELBURN**

The first of two articles describing modern line timebase circuits which are intended especially for the home-constructor and experimenter

SOME TIME AGO THE WRITER CONTRIBUTED to *The Radio Constructor* a short series of articles whose subject was the "Repair and Maintenance of Line Output Transformers."[1] As a result of these articles a number of readers were good enough to correspond with him on one or two of the points raised. Some of the letters from readers were concerned with particular line output stage faults, and these were passed on to "Query Corner" where, of course, they rightfully belonged. Quite a few correspondents mentioned that, so far as television components were concerned, there appeared to be a dearth of new designs in the home-constructor field. They remarked that manufacturers appeared to be quite happy to carry on with the same designs year in, year out. Several readers, also, were interested in the possibility of using "direct-drive" line output stages in home-constructed televisors. (This type of transformer was dealt with in the first article of the series just mentioned).

The Present Scene

Taking the first question into consideration, the statement that manufacturers of home-constructor television components are content to jog on year after year is not entirely true, even though the facts appear to point that way. Let us take the case of scanning components. As many readers may be aware, there are several manufacturers of home-constructor scanning gear who have now been marketing the same components for quite a few years. (In passing, one cannot help but remark that the fact that these components are as popular as they were at their introduction goes a long way towards showing that their initial design and specification have been well proven in practice).

Whilst the writer does not wish to commit himself to any dogmatic statement, he would like to point out that much of the apparent hold-up in the development of home-constructor scanning equipment is, most probably, due to the non-availability of new tube types. Quite some time has gone by since the present 70 degree 14 to 17-inch (and, much more recently, 21-inch) tubes were introduced; yet there appears to be little likelihood of any *dramatic* increase in tube size for some considerable time. One cannot help but reflect a little sadly on the slowness of tube development in this country, especially when one considers the large advances that are being made in America.

The second point, that of the possibility of direct-drive components for the home-constructor, is rather easier to handle. So far as the writer is aware, it is doubtful if such components would ever be put on the home-constructor market at all; and, at any rate, certainly not for the time being. The reason for this is that there are too many snags to their operation. (This does not obviate the fact that direct-drive components might not be available from some suppliers in the form of manufacturers' surplus).

When compared with the auto-transformer circuit the direct-drive line output stage has one single advantage, and that is in the saving of cost in the materials which make up the line output transformer itself. Even then, the saving is not large and consists of a few shillings only. Against this one advantage have to be set the several disadvantages which are essentially inherent in the direct-drive circuit, viz, EHT generation in the scanning coils, with consequent risk of breakdown and corona in wiring and the yoke itself; heavy radiation of radio interference by *all* the line output wiring (including that to the yoke); and poor final performance, so far as EHT regulation is concerned. At the time of writing, the direct-drive system is only attractive to those home-constructors who have a reasonable

[1] *The Radio Constructor*, September, October, November, 1954.

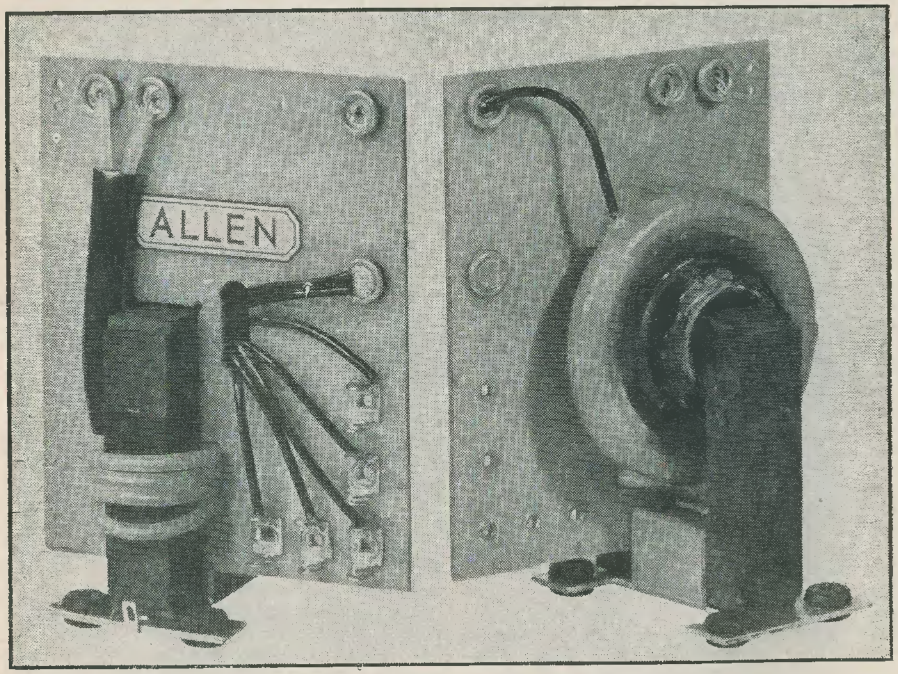
amount of test equipment immediately available, together with some practical working experience of the circuit.

A New Transformer

It is refreshing at this stage to be able to comment on the fact that a completely new line output transformer has recently been released on the home-constructor market, this transformer having been especially designed to cater for existing conditions and, so far as new CRT types are concerned, for what can reasonably be expected to develop in the next three to four years. The manufacturers[2] have introduced the transformer[3] not only to make their home-constructor range more up to date but also to ensure that a component is at once available to provide the higher EHT voltages which will be required for 21-inch tubes.

applied to the line output valve, this process reducing the line flyback EHT voltage generated by the transformer. The line output transformer which has now been introduced goes one step further. It is intended to scan the existing range of 14 to 17-inch tubes, whilst a slight increase in line output HT rail voltage is all that will be required to generate the additional EHT needed for 21-inch tubes when these are fitted. The new transformer is not really intended for use with the smaller, narrow-angle tubes.

The construction of the transformer involves a considerable break-away from present home-constructor practice. A point of interest is given by the fact that the metal base of the transformer is fitted to the televisor chassis by means of grommets, this assisting considerably in the reduction



Front and rear views of the New Allen LO352 Line Output Transformer

Readers who have built the Magna-View and similar receivers may remember that the wide-angle line output transformers used were not only suitable for 14 to 17-inch tubes, but also for 9 and 12-inch tubes as well. The smaller tubes were driven successfully by slightly reducing the HT rail voltage

of audible whistle radiation. Further, this metal base is fitted with a solder tag for a direct earthing connection to chassis; this connection earthing also the Ferroxcube cores themselves and preventing, thereby, the formation of static voltages which in previous designs were liable to build up in these cores. Photographs of the transformer accompany this article.

2 *Allen Components Ltd.* 3 *Lo 352*

It is important to note that the transformer does not match into existing home-constructor yokes, as the design requires a higher line impedance than that previously employed. A new scanning yoke[4] is therefore also available, this having the same frame impedance as the yoke it supersedes[5]. Thus, the new line output circuit may be built into existing televisors without the necessity of having to alter any frame circuits which may at present be in use.

Circuits

The circuit of the line output transformer and its immediately associated components is shown in Fig. 1. There is little of especial note in this diagram apart from the fact that an auto-transformer design is employed, and that a feedback tap is available from an extension of the anode winding. Although the manufacturers state that the transformer

this stage, especially insofar as no "Drive" control is needed at all. The reason for this omission is that the output stage has, largely, the characteristics of an inductive timebase and can consequently be driven either by a saw-tooth or by a square-wave. Under such conditions the inclusion of a "Drive" control is not merited and it can safely be dispensed with.

The multivibrator is synchronised by negative-going pulses, these being applied to the grid of the left-hand triode. Values have not been shown for R1 and C1 in the circuit, as these depend somewhat upon the type of sync separator employed and the amplitude of the pulses. For normal purposes, however, it will usually be satisfactory to employ a value of 330Ω for R1. The value of C1 may then be found by experiment, the best value being that which affords a positive lock over approximately one-third

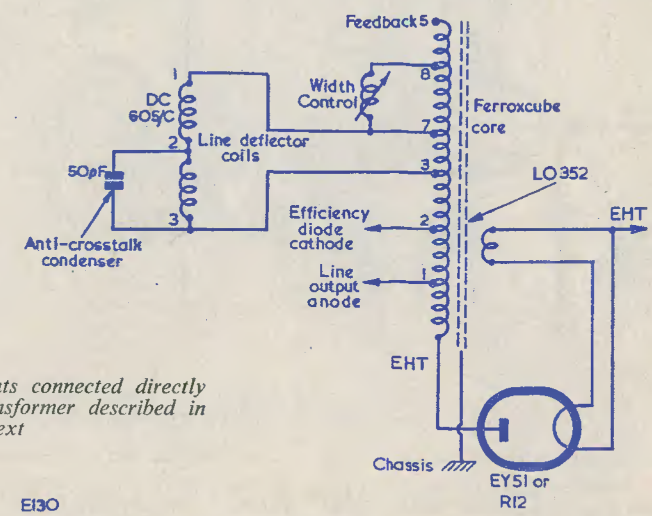


Fig. 1. The components connected directly to the line output transformer described in the text

functions at its best when the line output valve is driven by a separate oscillator, the feedback tap has been included for those who wish to experiment with self-running timebase arrangements.

Fig. 2 gives a typical example of a line timebase circuit employing the new transformer, in which the line output valve is driven by a multivibrator. This circuit, incidentally, is that recommended by the manufacturers for home-constructor use.

As may be seen, the line oscillator consists of a simple cathode-coupled multivibrator. Some economy of components is effected in

to one-half of the total travel of the "Hold" control R7. Normally, C1 would have a value lying between 10 and 50pF. Neither R1 nor C1 should be considered as being very "critical."

The output of the multivibrator appears across the discharge condenser C4, and is then applied, via C5, to the grid of the line output valve. The latter is a PL81 and feeds into the auto-transformer itself. All that then remains in the diagram are the components around the efficiency diode, PY81, and the linearity control. It will be apparent that the arrangement employed in this part of the circuit, also, is quite noticeably

4 *Type DC 605/C* 5 *DC 300/C*

simpler than those used in previous home-constructor designs. As is conventional in this type of circuit, a boosted HT voltage is available from the transformer, this being applied back to the multivibrator. The boosted voltage may also be employed by the frame discharge circuit, using normal practice.

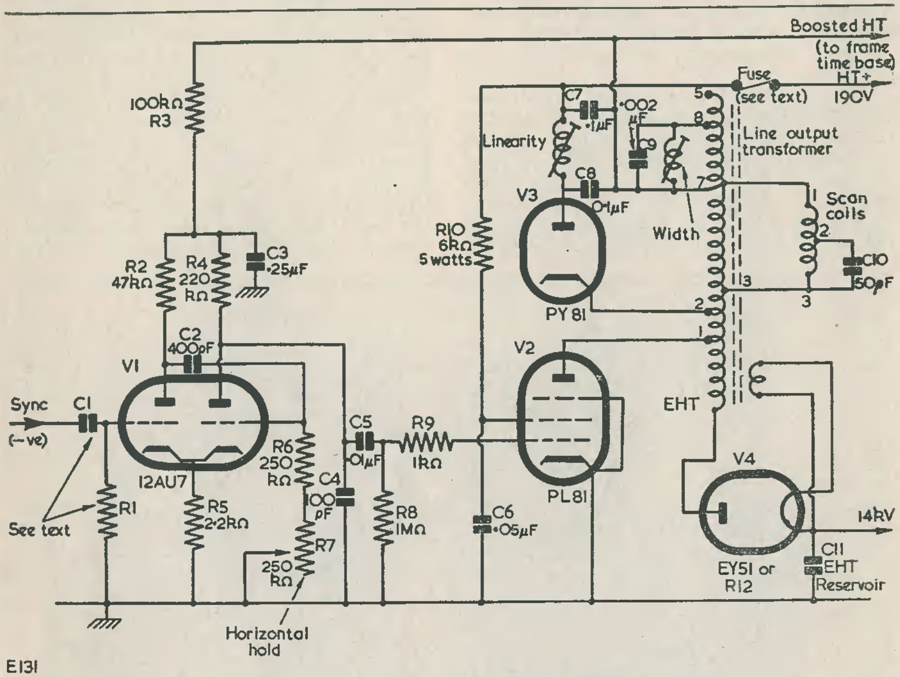


Fig. 2. *A particularly serviceable line time-base circuit employing the transformer of Fig.* 1

A further point of interest is given by the fact that a fuse has been inserted in series with the HT feed to the line output valve. The purpose of this fuse is to protect this valve in the event of cessation of oscillations from the multivibrator. Due to the self-biasing action at the grid of the PL81, cessation of oscillations would cause a continual zero grid bias, whereupon the valve might suffer damage. A fuse rated at 150mA will cope here. The fuse chosen should, however, be capable of passing the steady current of approximately 80 to 85mA which is taken by the valve when working normally. (The specified maximum safe cathode current of the PL81 is 180mA). The fuse is not entirely essential, of course, and a protective device of this nature is rarely fitted to commercial receivers in which similar eventualities are liable to occur. Whether it is fitted or not in individual televisors is left to the constructor's own judgment.

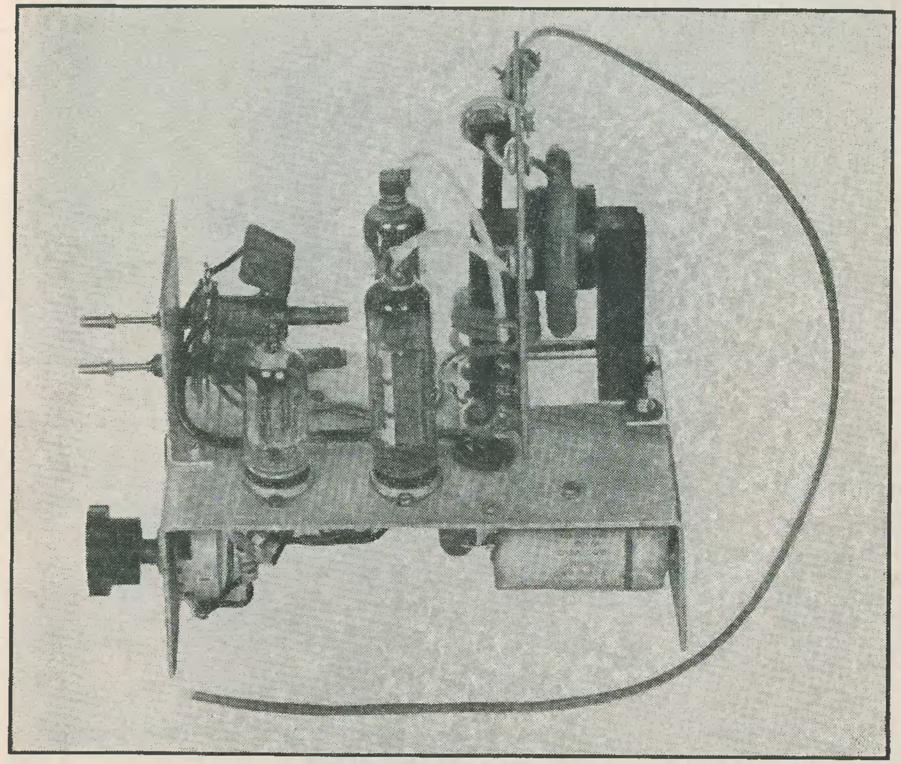
A word of warning is also worth while with regard to the screen-grid resistor **R10.** This resistor serves a very important function in that it limits the screen-grid current of the PL81 whilst the PY81 is warming up to full emitting temperature. (The PY81 takes considerably longer to warm up than does the PL81 owing to the high-voltage insulation which exists between its cathode and heater). On no account should R10 be reduced below the value shown (6kΩ) or the PL81 screen-grid may pass excessive current during this warm-up period.

Practical Considerations

The writer has been able to try out the circuit illustrated in Fig. 2, and is therefore able to pass on some points concerning its performance to readers.

The first fact that was noted was that the multivibrator circuit recommended had excellent frequency stability. Synchronising was positive, even when values as low as 5pF were used for C1. (A single-valve sync separator, operating from the video output

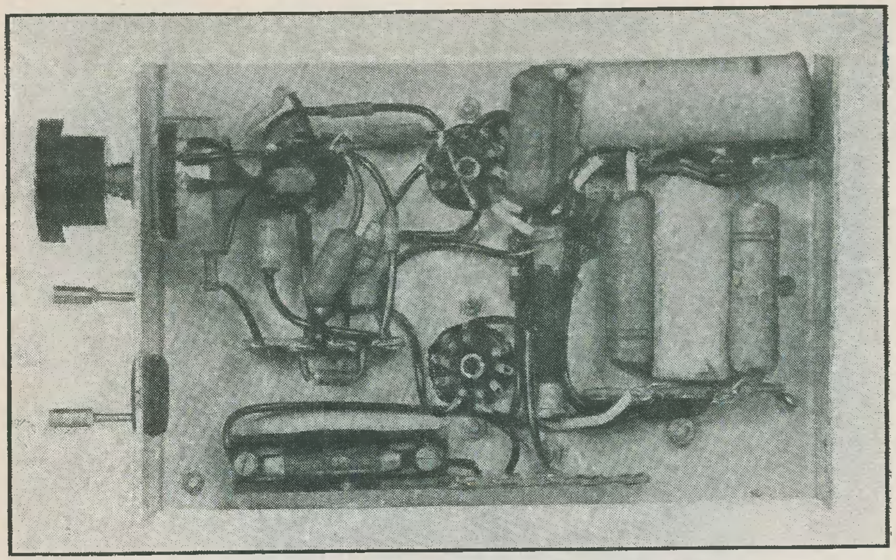
stage, was employed in the associated televisor). The absence of a "Drive" control was also appreciated, since it obviated the necessity of having to make fiddling adjustments when setting up. Once the timebase was locked there was no need to worry about the multivibrator any more.



View of Prototype Timebase using the Allen Lo 352 *Line Output Transformer*

Owing to the largely inductive nature of the line output anode load, the width and linearity controls have a slightly smoother effect than is the case in the earlier home-constructor circuits. The width control gives a variation of approximately one-seventh of the total scan, although this may be increased by removing its lock-nut and adjusting the threaded portion so that its end is nearly flush with the mounting assembly. Such a setting, that of extreme narrowness, as it were, would rarely be required in practice. An effective secondary control of width is also available by varying the value of C9. This condenser, which should normally be 0.002µF, may be varied between 0.001 and 0.0025µF; the smaller capacity giving the narrower picture.

What impressed the writer most was the excellent EHT regulation given by the transformer. The manufacturers quote an EHT source impedance of better than 5MΩ, and this certainly appears to be borne out in practice. Typical figures given in the writer's set-up, using an HT rail voltage of 185, are as follows. With the brilliance control backed off such that no picture was visible at all, the EHT given at the CRT final anode was 14.5kV. When the brilliance control was turned up to give a good, bright picture, the EHT dropped to 14kV. When the control was further advanced to a position whereby brilliance was obviously much too high, the EHT dropped only very slightly, to a figure around 13.7kV. It was only when the brilliance control was *grossly* advanced, far beyond its correct position, that the EHT began to drop noticeably, and, even then, only to some 11 to 12kV. The



Underneath view of the chassis shown on previous page

writer would like to see some commercial receivers with regulation as good as this!

Photographs

For the purpose of his experiments, the writer constructed a small chassis to hold the necessary timebase components. This chassis is illustrated in the photographs which accompany this article, and these give an excellent idea of the appearance of the new transformer when it is fitted into a typical televisor layout. As was mentioned earlier, a photograph of the new transformer itself is also reproduced.

Next Month

Next month the writer will introduce some alternative circuits suitable for use around the new components discussed in this article.

FM COMPETITION

The Radio Constructor is offering prizes of (1) 2 guineas, (2) 1 guinea, and two consolations of 10*s* 6*d* to the senders of the most informative report of reception at distances greater than 80 miles from Wrotham. The report should be concise, but should cover the following points:

(1) Type of aerial (1, 2 or 3 elements), and height.

(2) Approx. height of location above sea level, if known, or whether the site is shielded by hills from Wrotham.

(3) Comparison of reception with the local medium wave service.

(4) Details of FM Tuner or Receiver.

(5) Details of other equipment in use, e.g. 8-Watt push-pull output with 10″ speaker in bass reflex cabinet.

(6) Reliability of reception, and any other useful information.

ALL REPORTS SHOULD BE SENT TO ARRIVE AT:

"FM Contest," The Radio Constructor, 57 Maida Vale, London, W.9.,
NOT LATER THAN MARCH 10TH 1955.

NOTES ON RADIO CONTROL

5: TWO SIMPLE TRANSMITTING UNITS

By **QUENCH COIL**

HAVING DEALT WITH VARIOUS RECEIVER circuits and the installation of the radio control equipment in the model, we will turn our attention to the transmitting side of the system. Here again, one must emphasise that care in construction and good design pay dividends in reliability of operation. It is just as important to have the transmitter working as reliably as the receiver, if fault-proof operation is to be had.

the feedback required for oscillation being obtained by cross connection of the grids and anodes through small condensers. The circuit is shown in Fig. 1, in the form in which the components are arranged on the chassis. Very little skill is needed to construct this unit, and it is thus ideal for the newcomer to radio control. Wire up with 22 swg tinned copper wire and sleeving, keeping all wires as short as possible.

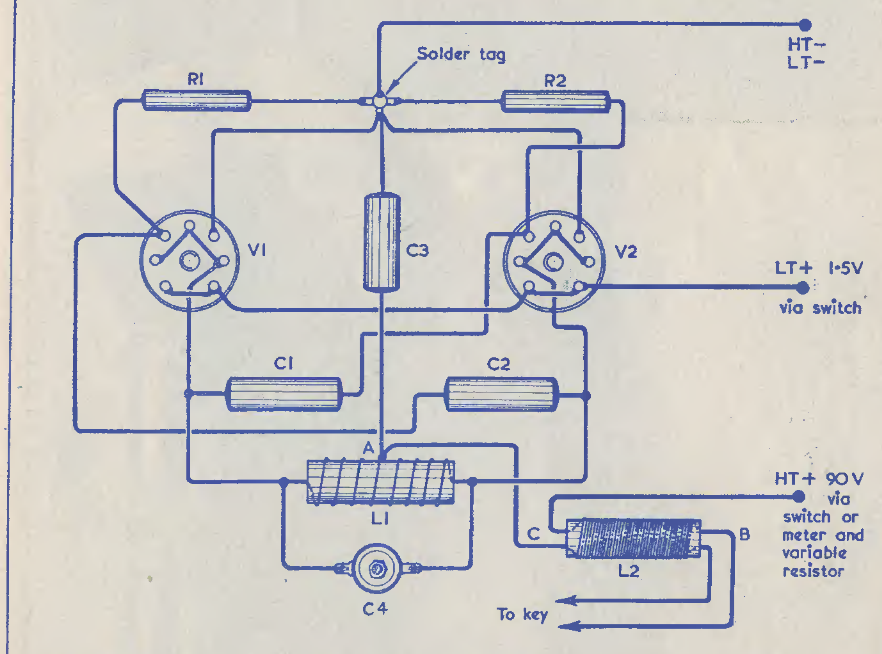


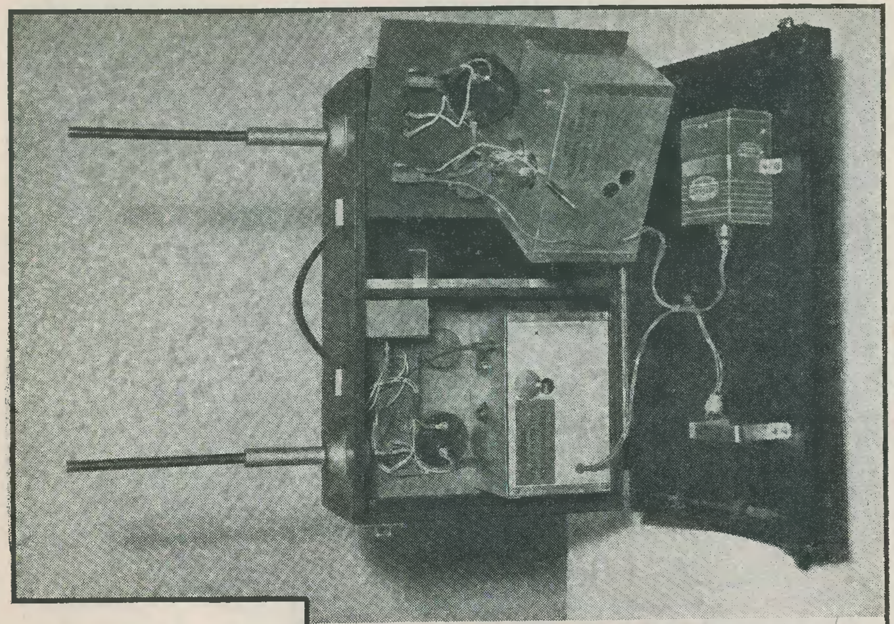
FIG. 1. WIRING DIAGRAM FOR PUSH-PULL TYPE TRANSMITTER USING 3S4 VALVES

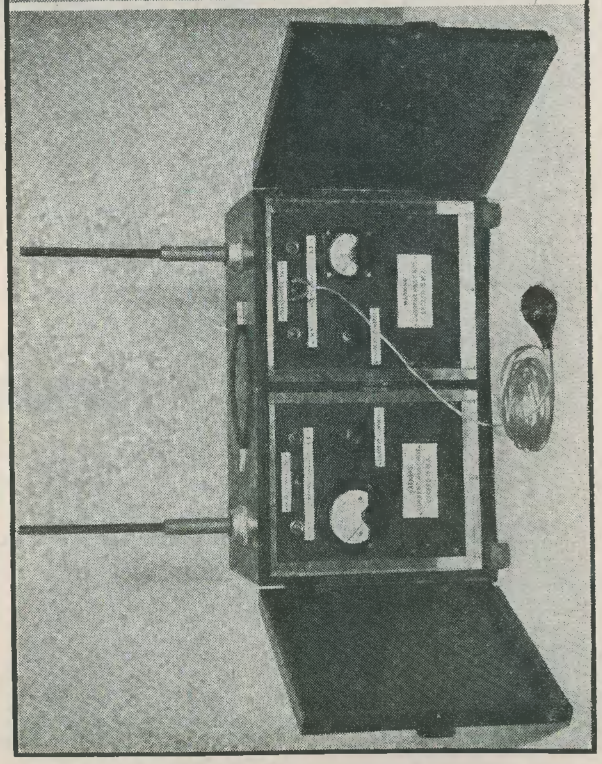
For key, see page 475

The first transmitter described is a simple one which will do well as a "first effort" for those who have not built equipment of this sort before. It uses two type 3S4 valves in a push-pull circuit and requires only one coil,

Testing

Check wiring carefully and if correct connect a 0–30 mA meter in the HT positive lead. Switch on LT and HT. The meter should read about 10 mA. Now connect the





Figs. 2 and 3. Photos show front and rear view of twin transmitter. Unit on left (rear view) two-valve using two 3S4 valves. Right, two-valve using two DL35 valves. Both transmitters operate from 90 volt HT. Note metal case enclosing unit and hole for adjusting tuning condenser. Note (front view) keying lead and clean lines of panel. Note aerial mounting; see drawing of same. Both transmitters have operated receiver over a distance of 1,000 yards

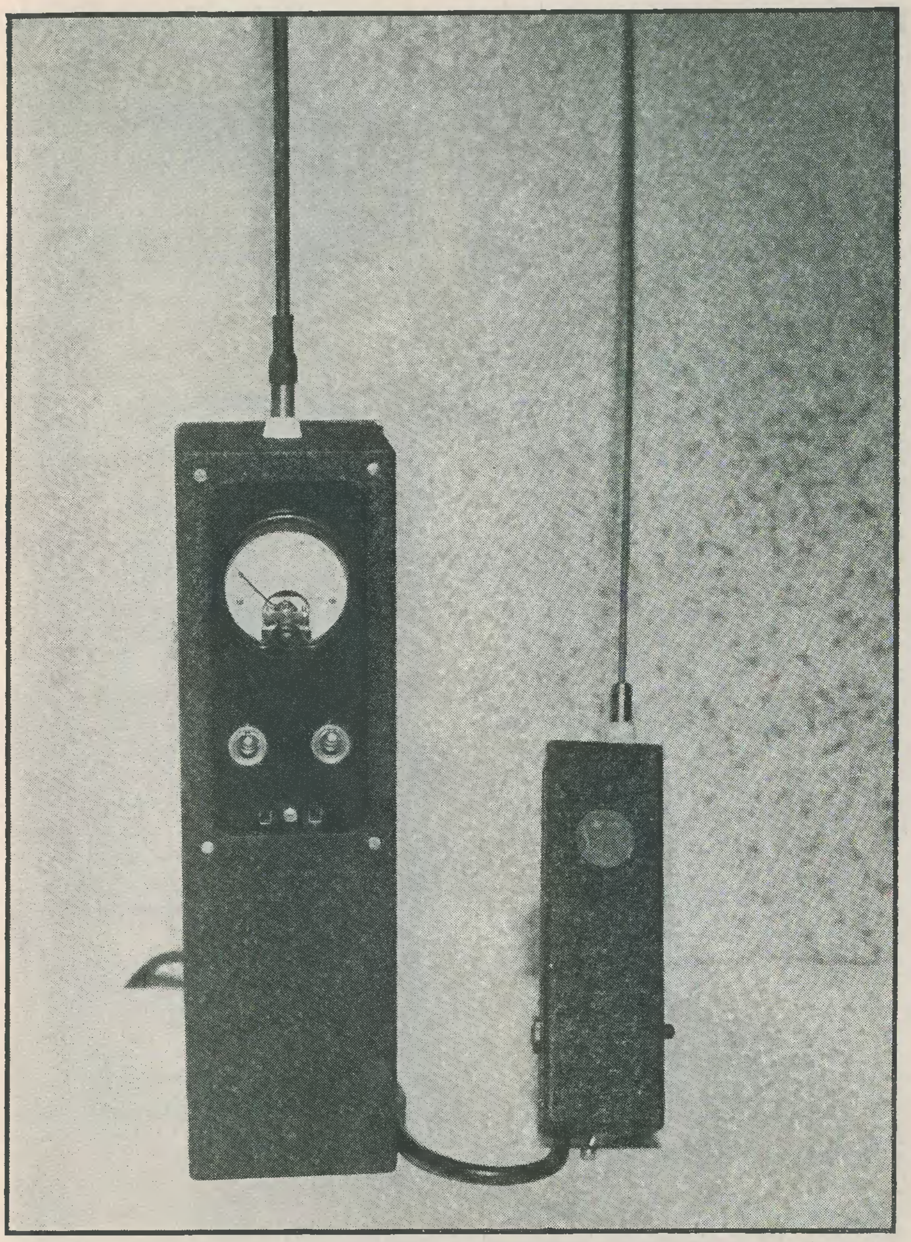
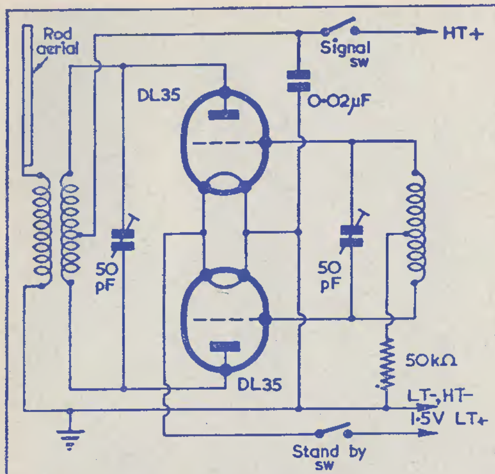
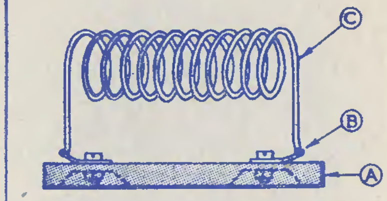


Fig. 4. Two small portable transmitters. (Left to right) Two-valve using 90 volt HT and LT $1\frac{1}{2}$ volt, both batteries carried in bottom part of case. Extra small transmitter using two DL70 valves. Batteries carried in small battery pack in pocket



Coils are 8 turns, 1" dia, 26 swg

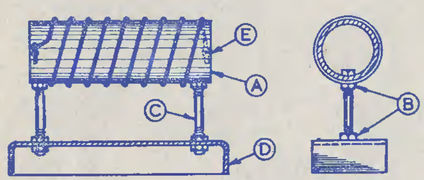
FIG. 5.



SELF SUPPORTING COIL AIR-SPACED

(A) Polystyrene base (B) Solder tags

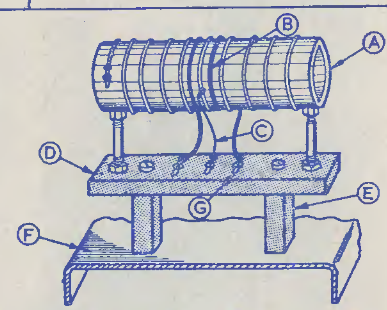
FIG. 6.



(A) Former (B) Locking nuts (C) Brass rod (D) Chassis (E) Solder tags

COIL WOUND ON FORMER

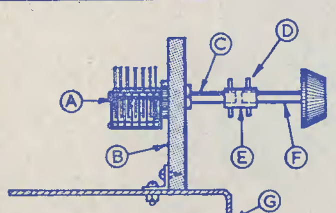
FIG. 7.



(A) Good quality former (B) Two-turn aerial link-insulated wire (C) Centre tap connection (D) Polystyrene bracket (E) Polystyrene rod (F) Chassis (G) Solder tags

TUNING AND AERIAL COIL MOUNTING

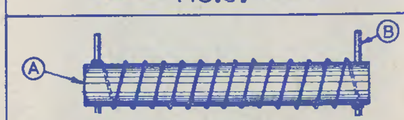
FIG. 8.



(A) Variable condenser (B) Polystyrene bracket (C) Spindle (D) Holding pins (E) Copper sleeve (F) Polystyrene rod (G) Chassis

VARIABLE CONDENSER MOUNTING

FIG. 9.



(A) Polystyrene former (B) Tinned wire pegs

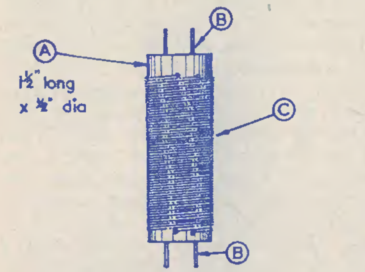
CHOKE WOUND ON FORMER

FIG. 10.

aerial. The meter reading should rise to about 15 mA, which is a safe current for this type of valve. Should the current be incorrect, it can be raised by lowering the resistor values; if too high, increase resistor values, keeping both resistors (R1 and R2) of the same value.

The unit should now be fitted in a metal case, and the whole unit, with batteries, enclosed in some form of carrying case. Various ideas for the latter can be gleaned from the photographs of some of the transmitters made by the writer, illustrating this valves protruding through holes in the lid. The meter, etc., batteries and so on are attached to the case as shown. In Fig. 4, on the left, an arrangement in which the transmitting unit is housed in the top of a metal case, with the batteries in the bottom, is shown. On the right is a smaller unit housing the transmitter only, the batteries being carried in a separate pack in one's pocket.

The transmitter must now be tuned to the correct frequency. This requires the use of an absorption wavemeter set to the frequency required. A suitable wavemeter will be



(A) Polystyrene former (B) Tinned copper wire fixing pegs
(C) Winding – two 28 swg DCC wires close wound together in a single layer

FIG. 12. DOUBLE WOUND KEYING CHOKE FOR 3S4 TRANSMITTER

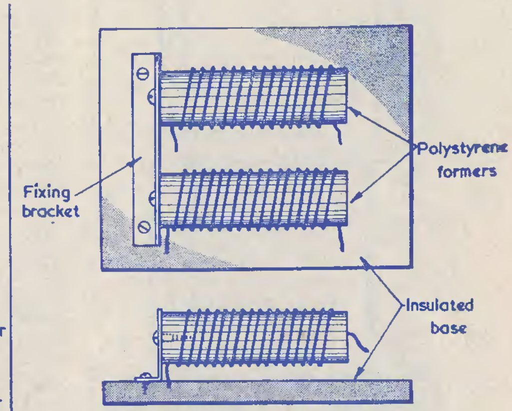
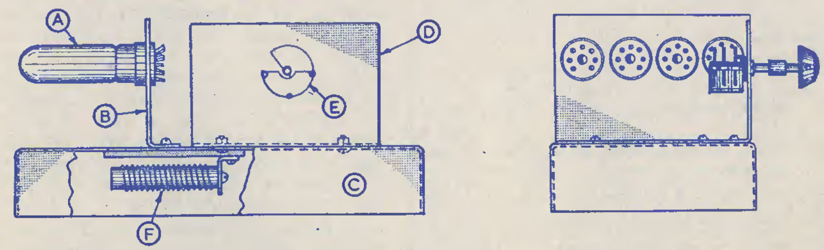


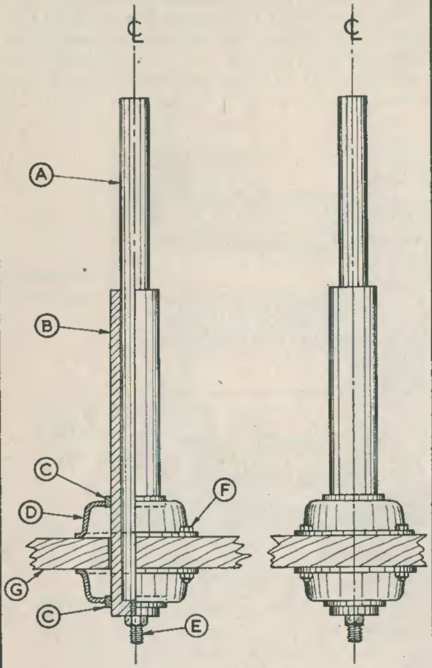
FIG. 11. KEYING CHOKE FOR TWO-FOUR TRANSMITTER



(A) Valves in line (B) Aluminium bracket bolted to chassis (C) Chassis (D) Polystyrene panel secured by bolts or angle bracket (E) Tuning condenser (F) Keying choke

FIG. 13. CHASSIS CONSTRUCTION & COMPONENT MOUNTING

article. In Figs. 2 and 3, a unit housing two small transmitters is shown. From Fig. 2, the arrangement of the transmitter in a screening box is shown, the tops of the two described later in this series, and the beginner is advised, if he cannot borrow one, or get some other enthusiast to help him, to consult his radio dealer or a local amateur radio operator. If he should have a good short-wave receiver which is accurately calibrated, he can use this by setting the tuning at 27 Mc/s and tuning the transmitter frequency on to this frequency. Tuning must, of course, be done with an insulated tool, and the full length of aerial it is proposed to use on the transmitter must be fitted.



(A)— First section of aerial
(B)— Polythene rod, drilled to take aerial a tight fit
(C)— Rubber mounting cut away to take polythene rod
(D)— Metal shock mountings with rubber cut away to take rod a tight fit
(E)— Threaded rod with nuts
(F)— Fixing bolts, four in number
(G)— Wood top of carrying case

FIG. 14.

G122

We can now test with the receiver. Switch receiver on and tune it until the receiver meter drops to nearly zero. When the transmitter is then switched off, the reading should rise again. Once this is in order, check the receiver relay and adjust for positive action. Then make range tests every 50 yards until the limit is reached, some slight adjustment to receiver trimmers being made for best results during these tests. In the writer's case a nine-foot-whip aerial is used, but the length of this is not critical.

The second transmitting circuit shown, Fig. 5, is of the tuned-grid, tuned-anode type, using two low drain battery pentodes of the DL35 type. The American equivalent is the type 1Q5GT. This circuit uses two coils instead of one only as in the first transmitter, and the design will give first class results. It forms the logical 'next step' for the beginner. A 0–50mA meter should be used this time, and construction carried through as with the first model.

To conclude this article, a few remarks about the construction of the coils, keying chokes, aerial mountings etc., may be of value to the newcomer. The more experienced worker will no doubt have his own methods, but he may find the writer's ideas on these components of interest.

The coils, or tuning inductances as they are called technically, can be either self-supporting or wound on a former. When only a few turns of wire are needed, the self-supporting variety can be used, the wire then being of a gauge firm enough to keep its shape, such as Nos. 14, 16, 18 or 20 swg. The coil is then wound over a mandrel of the correct diameter and a soldering tap attached at each end, by means of which it can be attached to a base as shown in Fig. 6.

If so many turns are needed that a thin gauge of wire has to be used, then the coil must be wound on a former; which must, of course, be of some insulating material such as polystyrene, paxolin and so on. The coil can be attached to the former as shown in Fig. 7, which also illustrates a method of mounting the completed coil on the chassis. Where a coupling coil has to be wound over the centre of another coil, as is necessary for the aerial coupling in a push-pull transmitter, for instance, the arrangement of Fig. 8 can be used, the small two- or three-turn link coil being of insulated wire and fixed as shown. Similarly a centre-tap connection can be taken as shown, if required.

Variable condensers should be mounted as near their inductances as possible, and they must frequently be mounted so that they are insulated from the chassis. Such an arrangement is shown in Fig. 9, an extension rod (F) being used to reach to the control knob on the panel.

Where an "RFC"—radio frequency choke—is specified, this can be made up of 30–40 turns of thin wire on a 1-inch long by ¼-inch diameter piece of polystyrene rod, and the wire fixed as shown in Fig. 10.

"Keying chokes" are frequently specified for connection in the leads from the "key" or switch used to actuate the transmitter. These may consist of two separate coils wound and fixed as shown in Fig. 11, or a "double-wound" choke may be specified as shown in Fig. 12, which is the type used in the 354 valve transmitter. Here, two separate wires are wound on to the former as shown. Each coil is kept separate from the other electrically, as insulated wire is used, but the turns are physically in touch if described as "close-wound." If described as "open-wound" or spaced, then they should not touch.

The general arrangement of the various components on the chassis is usually indicated in the building instructions if critical, otherwise it is in order to get a close approximation to the photos. Fig. 13 shows a typical method of laying out a transmitter, using four valves, which will be described later in this series.

The mounting of the aerial requires some ingenuity. One arrangement which the writer has found successful is shown in Fig. 14. The aerial itself consists of a nine-foot length of tubing, which may be made from narrow dural in convenient lengths, made to slip one into the other. Alternatively a war surplus whip aerial, which are still readily obtainable, can be used. A piece of polythene rod is drilled to take the lower end of the tube which passes right through as shown, a bolt and nuts being fitted at the lower end to take the lead to the transmitter. Two rubber shock mountings of suitable size are fitted as shown, a suitable hole being made through the rubber to take the polythene tube. These shock mountings can be obtained in various sizes from most ex-service stores. The drawings in Fig. 14 show the general assembly of the aerial mounting quite clearly.

KEY TO COMPONENTS AND VALUES OF FIG. 1

*V*1 and *V*2, 3*S*4 Valves. *C*1 and *C*2, 27 *to* 30*pF condensers.* *C*3, 0.001μ*F Condenser.* *C*4, 50*pF trimmer or miniature variable condenser.* *R*1 *and R*2, 10 *or* 15*k*Ω *fixed resistors.* *L*1, *Tuning coil. Wind on former* 8 *turns of* 18 *swg tinned copper wire, completed* 1″ *long,* 1″ *diam., make tap at centre 'A'. Aerial coil. Two turns of insulated wire wound round tuning coil. One end taken to earth, the other to aerial socket. L*2, *Double-wound choke in key lead. Wind with two* 28 *swg DCC wires, wind together close in a single layer, secure at each end on tinned pegs. Mount on small bracket. Size of former* 1½″ *long,* ½″ *diam. Mount components on* 18 *swg aluminium chassis. Keep tuning condenser and coil clear of chassis. Whole unit should be enclosed in a metal case*

BOOK REVIEWS . . .

PRACTICAL AERIAL TV MANUAL FOR BANDS I AND III, by R. Laidlaw. 72 pages, 72 diagrams. Price 4s. 6d.

This book has been received from the Technical Book Department, Kendall and Mousley Ltd., 18 Melville Road, Edgbaston, Birmingham. It is an excellent investment for those who wish to make their own TV aerials or experiment with different types to obtain the best reception in their particular locality.

The theory of the various types of aerial is clearly explained in a way that is very easy to understand. Matching of aerial to feeder, and feeder to receiver, is given due regard, and it is pleasing to find the characteristic impedances of the different arrays quoted so freely.

The methods of construction are simple yet sound, though many will perhaps wish to improve upon them for their own purpose.

There are two Appendices. The first deals with attenuators; the second comprises a series of tables which give details of the lengths and spacing of elements for all types of aerial described in the earlier parts of the book.

Those who read the book will perhaps realize that similar principles apply to aerials for FM reception, and it is a pity that there is no mention of this subject Similarly, something more than a passing mention of tilted wire, half-rhombic and kindred types of aerial might have rounded off an already wide coverage of modern antennas.

TELEVISION VIEWERS' HANDBOOK, by A. C. Armstrong, A.I.MECH.E. 190 pages. Price 6s. Published by The English Universities Press Ltd. St. Paul's House, Warwick Square, London, E.C.4.

A non-technical book dealing with many aspects of television receivers and principles. The many facets of the subject which are discussed include installation of receiver and aerial, correct use of controls, alternative programme reception, features of modern circuit design, use of the tuning charts, etc.

There is much to be learnt from this book, even by those who have possessed a receiver for a long time It also imparts essential knowledge to the uninitiated in such a way that they cannot fail to obtain the best from their sets and readily appreciate how it functions.

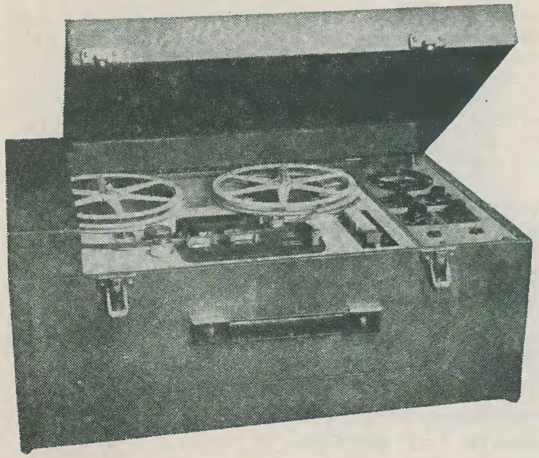
The book naturally follows the tradition of the now wide series of *Teach Yourself* books and is considered to be well in keeping with the accepted standard of the library.

PRACTICAL TRANSISTORS, by J. S. Kendall, ASSOC.BRIT.I.R.E. 48 pages, 36 illustrations. Price 3s. 6d. Published by Bernards (Publishers) Ltd., The Grampions, Western Gate, London, W.6.

This is one of the latest additions (No. 128) to the series of Bernards Radio Books. It deals with a simple method of constructing one's own transistors at home from readily available germanium diodes. Methods of forming and testing the home-made product are also given.

Several circuits are described, which can form the basis for further experiment. For those who wish to acquire basic knowledge in authoritive and lucid form, this book is ideal. The author is already well-known for his ability to write in this way, and this latest contribution is typical of his style.

W. E. Thompson



THE *Paragon* TAPE RECORDER

PART 3

by J. W. WALKER

Final details of this simple Tape Recorder, which has been designed expressly for the home-constructor

LAST MONTH WE DESCRIBED THE METHOD of fitting some of the more important parts of this recorder into the cabinet, and gave details of the construction of the amplifier chassis. We now carry on, in this month's article, to the remainder of the constructional work involved.

The Power Pack

As was evident from the circuit of Fig. 2, the power pack is of extremely simple design. In its practical form all the components, with the exception of the mains transformer, are mounted on a small chassis which is fitted inside the cabinet. The dimensions of this chassis, together with the layout of the component parts, are given in Fig. 16.

A word of explanation may be necessary concerning the resistor R33. In Fig. 16, one end of this resistor is illustrated as being connected to a "terminal." It may be remembered that R33 is the resistor through which passes the 150 mA braking current to the Truvox tape-deck. The "terminal" of Fig. 16 then refers to any suitable anchoring point capable of taking a fly-lead from the tape-deck motor-board. In the prototype a vitreous resistor, clipped to the power unit chassis, was employed. Since this resistor had metal ends it was possible to fit a 6BA terminal assembly to the component itself. However, if such a resistor is not available to the constructor any other type of "terminal" mounted on suitable insulating material could be used instead. A banana socket, for instance, would present an eminently suitable alternative.

The Mains Transformer

The mains transformer presents a small difficulty. This is not due to any trouble incurred in its mounting but to the fact that its position with relation to the Record/Playback head is somewhat critical from the point of view of hum pick-up.

Whilst the hum picked up by the Record/Playback head from the mains transformer was not too troublesome in the prototype, this state of affairs cannot be guaranteed in all models constructed to the same design. It is for this reason that the transformer has not been mounted on the same chassis as are the other power pack components.

It was found, in the prototype, that the best position for the mains transformer was on its side, as shown in Fig. 17. In this position it induced minimum hum into the Record/Playback head; and it could be mounted very easily with the aid of two angle brackets.

It is probable that this position for the transformer will cope in most models built to this design but, as has just been stated, such a state of affairs cannot be completely guaranteed. In cases where hum pick-up occurs, therefore, it will be necessary to rotate the transformer until a position corresponding to minimum hum is obtained. Care should be maintained to ensure that the position taken up by the transformer does not allow it to foul the tape-deck mechanism when fitted. It has been the writer's experience that, in really bad cases of hum pick-up, the trouble may be alleviated considerably, if not completely, by fitting additional mu-metal shielding to the head assembly. In the case of the Truvox tape-deck such shielding should be fitted between the heads and their cover, taking care to avoid damaging the heads and the associated wiring.

It is worth-while stating, at this point, that hum pick-up will only be apparent when switch S1 is in the Playback position; and that the hum may, of course, be picked up from external sources other than the recorder mains transformer.

The Cabinet

Fig. 17, besides showing the method of mounting the mains transformer, also illustrates the position of the various components which fit inside the cabinet. As may be seen, these include a 3-way mains voltage selector

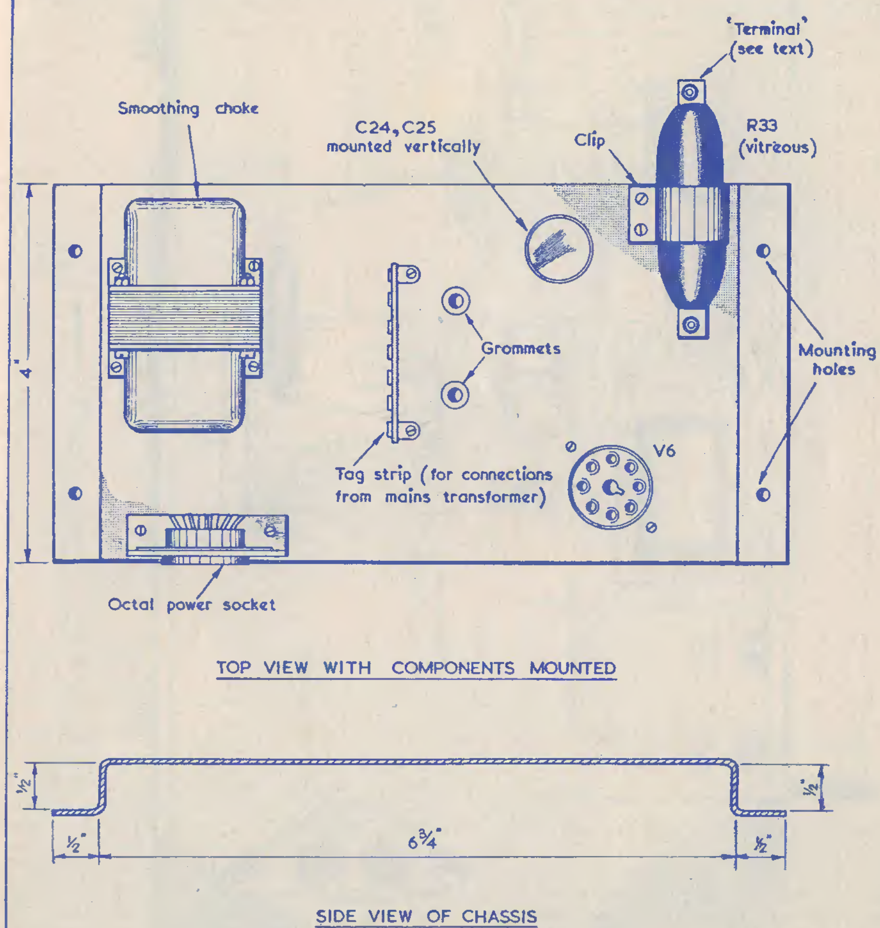


FIG. 16.

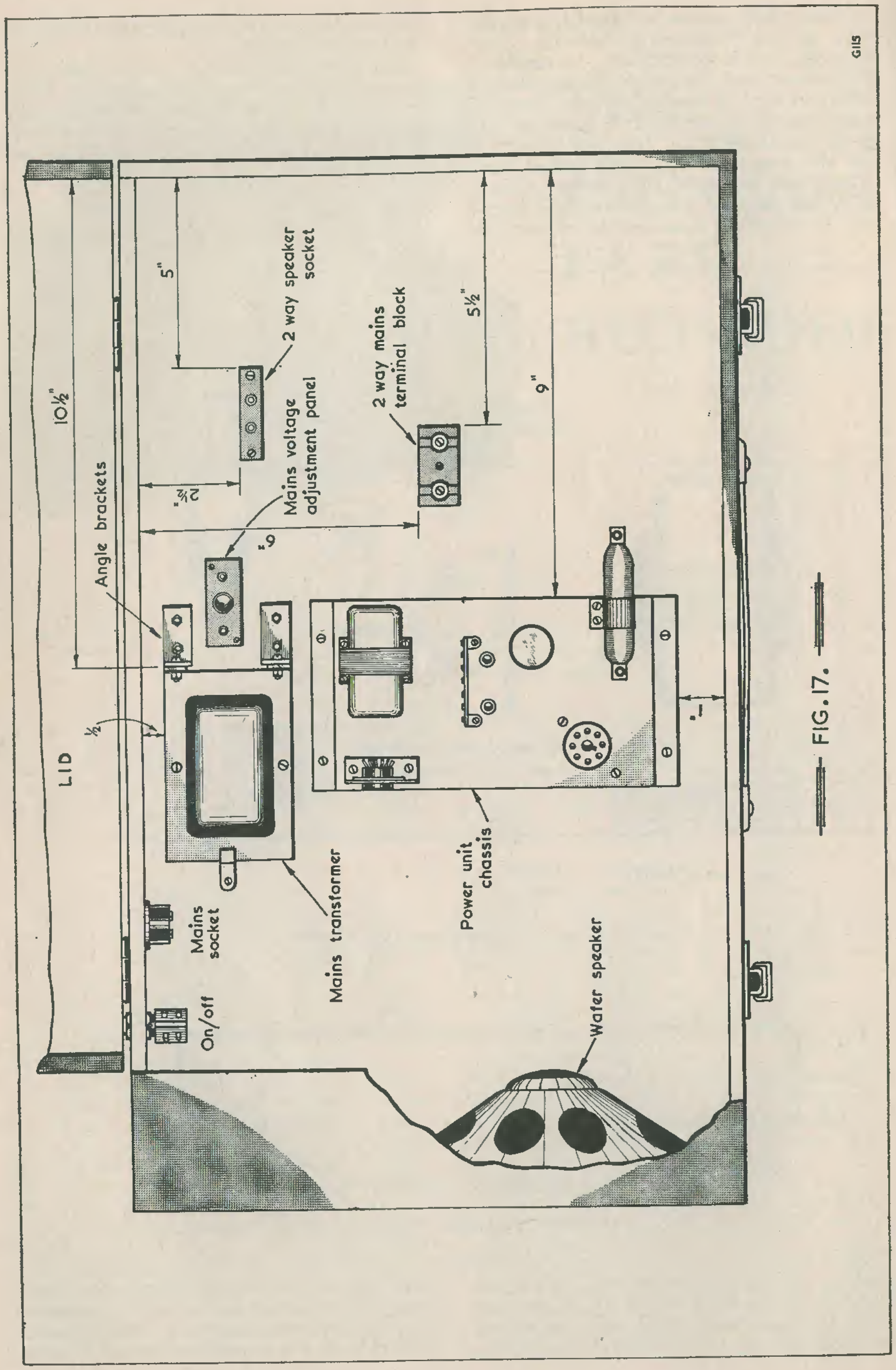


FIG. 17.

board (210–230–250 volt), a small two-way socket, and a two-way terminal block. The two-way socket connects to the loudspeaker, and is intended for the speaker plug illustrated in Fig. 15. The two-way terminal block carries the mains supply (after switch S4), and connects to a two-way fly-lead from the tape-deck. If desired, a plug and socket arrangement can be employed here instead.

It is important to ensure that the chassis and components illustrated in Fig. 17 are positioned as shown. If this is not done they are liable to foul the mechanism underneath the tape-deck motor-board.

"black" tag of the tag-strip. Strictly speaking, such a connection should not be necessary, but it ensures that a good earth connection is obtained at the motor-board for the 150 mA braking current. Unfortunately, this link forms a "loop" with the possibility of hum induction. It can be dispensed with, if desired, so long as the constructor satisfies himself that the earth connection between the "black" tag of the 5-way tag-strip and the tape-deck chassis is adequate for the braking current. The link caused no trouble in the prototype.

The two 16-inch screened leads connected to the 5-way tag-strip consist of conventional insulated single-screened cable.

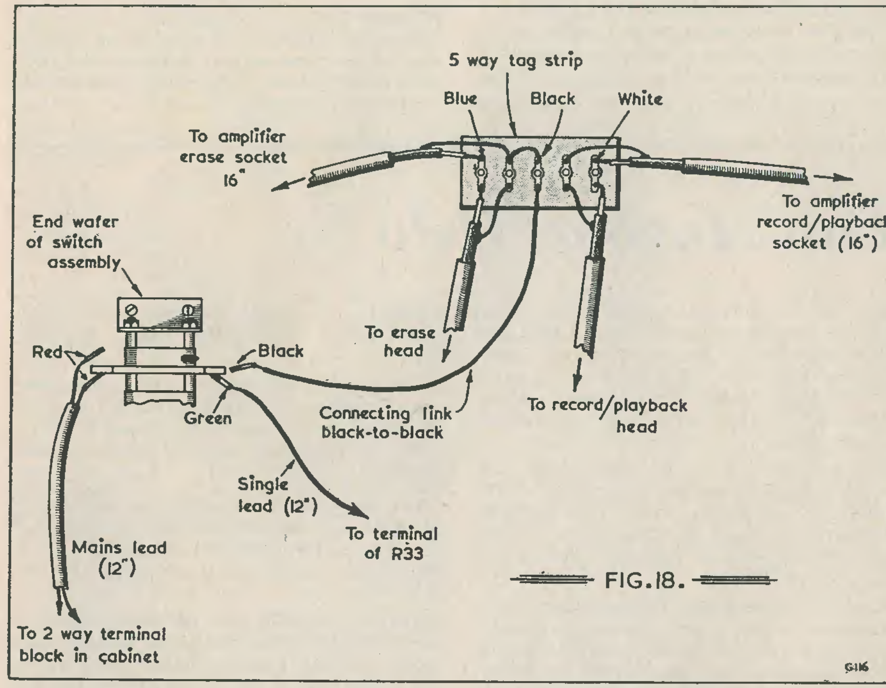


FIG. 18.

The Tape-Deck

The connections to the tape-deck itself are quite simple, and consist of various fly-leads, mostly terminated in plugs. These are illustrated in Fig. 18, which indicates also the recommended lengths for each lead.

Two points of some consequence are raised by this diagram. It will be noted, firstly, that the screening of the lead from the Record/Playback head is not earthed at the 5-way tag-strip. Instead, the screening is "carried on" to the amplifier chassis, at which point the earthing connection is finally made. This method of connection prevents the formation of "loops," and possible hum induction.

Secondly, a link is fitted between the "black" tag of the switch wafer and the

Assembly

The process of assembling the recorder is quite simple and need take little time.

After the power pack, mains transformer, and loudspeaker have been mounted inside the cabinet, the tape-deck motor-board may be fitted. This should be put into position with a little care, in order to prevent the motors underneath from fouling the rectifier valve. If the constructor feels a little uncertain about the safety of this valve when the recorder is being assembled for the first time, it may be fitted in its socket after the tape-deck has been pushed up against the left hand side of the cabinet. Access to the rectifier and the various plugs and sockets inside the cabinet can be obtained by tilting the tape-deck motor-board. This should be done by raising the right hand edge only.

For the first trial run it may prove helpful to keep the amplifier outside the cabinet. The connecting leads provided are sufficiently long to allow this to be done. Testing then proceeds in normal fashion.

After the amplifier has been checked, it next becomes necessary to reduce any hum pick-up that may be caused by the field around the mains transformer. The process of clearing up this trouble has already been detailed.

The final adjustment needed is that to the volume level indicator potentiometer, R20. This potentiometer is best adjusted at this stage by checking the volume level indication in the meter as compared with the sound obtained from the speaker.

Sufficient volume level for recording is obtained when the volume from the loudspeaker is just adequate for comfortable listening under normal conditions. This is by no means intended to be an accurate statement, of course, but it is sufficient for the purpose of primarily adjusting R20. After the recorder has been in use for some time and the constructor has found, by experience, the best volume levels for good recording, he may then set R20 to its final, accurate, position.

A Radio Unit

A simple plug-in radio unit for the Paragon was under construction whilst these articles were being written. This will be described in next month's issue.

Can Anyone Help?

DEAR SIR,—As a regular reader may I appeal through your columns for any details and circuit diagram of Admiralty Pattern Cathode Ray and Rectifier Unit W3664A, Design A. I would gladly defray any expenses.—D. C. Glanville, 88 Ermine Road, Lewisham, London, S.E.13.

DEAR SIR,—Could any of your readers help me by supplying details and circuit of the Admiralty Responser Unit Type W4790, Model A? I should be most grateful for any help received—R. G. Williams, 30 Prospect Park, Exeter, Devon.

DEAR SIR,—Could any fellow reader please inform me where I can obtain (purchase) a G.E.C. "Miniscope" Wobbulator attachment, also a double beam attachment for same? I have unsuccessfully scoured the radio market and would appreciate any available assistance.—R. Taylor, Waterside Farm, Wharf Lane, Send, Woking, Surrey.

DEAR SIR,—Can I, as a regular reader, appeal through your excellent journal for any details on an ex-service Valve Tester? The only reference on the instrument is 10S/658 on the left-hand panel and 10S/556 on the right-hand panel.—Yours faithfully, E. Evans, 8 Wobaston Road, Fordhouses, Wolverhampton, Staffs.

DEAR SIR,—Can I, as a regular reader, appeal through your columns for any details or diagrams of the AM Unit R3118, Ref. No. 10DB/545 and Unit R-18/APS-3 NXS 11272 425CPR? I would gladly pay for any literature or circuit diagrams.—J. Baldwin, The Dingle, Habberley Road, Bewdley, Worcs.

DEAR SIR,—Could any of your readers help me by kindly supplying circuit and conversion details of ex A, Set TR9H, please?—Yours truly, R. W. Jessup, 5 Holly Road, Ipswich, Suffolk.

DEAR SIR,—Could any fellow reader supply me with any information etc., on the PCR 6 valve Communication Receiver?—J. T. Saunders, 40 Granard Avenue, Putney, S.W.15.

DEAR SIR,—Could any of your readers be kind enough to let me know where I can obtain circuits, either on loan or on sale, of the following units: R9/APN/4; ID6/6B/APN4; BC-733/D; R3/ARR/2X; BC/229 and Control Box BC231?—Yours truly, E. W. Bithell, 61 Banbury Road, Stratford-on-Avon.

DEAR SIR,—Can any reader supply me with Manual or Service Sheet for Philips TV & Radio Console Model A 250 or the Mullard TV & Radio Console Model MTS 521? Any expense defrayed.—Yours truly, W. Akam, 203 Lyon Park Avenue, Wembley, Middx.

DEAR SIR,—May I, as a reader of the magazine, ask if anyone could supply me with a Service Sheet for a Derwent radio Model S1844? Willing to purchase.—J. H. Andrews, 43 Musgrave Road, Sheffield, 5.

AN ELECTRONIC RESISTANCE AND LEAKAGE TEST SET

by **JAMES S. KENDALL**, M.I.P.R.E.

THERE OFTEN OCCURS, IN THE WORKSHOP, the need for a meter which will carry out resistance measurements from a few ohms to a megohm or so, and yet do this with the application of a very low voltage. The instrument to be described here uses only a matter of 0.67V for resistance testing, and 67V for insulation measurement. These low potentials ensure that there is no danger of damaging a component when in use. Certainly, many multi-range meters may be adapted to read up to 10MΩ, or higher, with the aid of external power supplies—but usually the value of the external voltage needed is so high that it will exceed the working voltage rating of the component under test, and will cause damage either to insulation or by passing too much current through the component.

The circuit of the Test Set is by no means new or original, and is merely an old design used for audio work. Basically, it is the Schmitt phase-split circuit. The valves used are two of the Mullard DL96 battery output pentodes strapped as triodes. The common "cathode" resistor has a value of 1kΩ and is of the half-watt type, as is the grid stopper component, this having a value of 10kΩ. The primary function of this latter resistor is the suppression of any parasitic oscillations which may occur.

The overall accuracy of this Test Set is some ±2%, which is considerably better than that of many compensated Ohm Meters. The balance and compensation of the unit are electronically isolated from the measuring circuit, thus ensuring the maximum accuracy. For resistance measurements the meter is set to full scale reading by the application of a voltage via a series resistor. One "standard" resistor has to be used for each resistance range; "standards" are also employed for the insulation ranges. Those used in the prototype are Dubilier 1% high stability types, and may, as in the original, be a series combination of 100Ω, 900Ω and 9kΩ; alternatively, they can be switched separately, in which case the values will be 100Ω, 1kΩ and 10kΩ.

The meter is one which has been specially designed for this instrument by Measuring Instruments (Pullin) Ltd., and it has two scales, one calibrated for the resistance ranges and the other for insulation.

The cabinet is in polished hardwood, and is both durable and pleasing to the eye. It is 2″ deep at the front, 4″ deep at the rear, and takes a metal panel 9″ long by 8″ deep. This panel is stove enamelled black and, as may be seen from the cover illustration, combines very well with the use of Panel-Signs transfers.

Fig. 1 gives the complete circuit of the instrument. There are two anode load resistors, which should be equal in value to within 2% or better; the use of high stability types is recommended here, as there will be less drift with these. The balance control is a 5kΩ potentiometer; a Dubilier carbon track type was used in the prototype as it proved smoother to handle than a wire-wound one. The latter type is, however, quite satisfactory for the sensitivity control (500Ω).

The action of the balance control is to so adjust the anode loads that the same potential is present on each valve anode; when this condition obtains, there will be no current flow through the meter.

When the potential of the control grid of V1 is varied, this will in turn affect the potential at V1 anode, and current will flow through the meter; the sensitivity control is, in effect, a variable shunt which is so adjusted, on the resistance ranges, as to prevent the maximum current flow through the meter exceeding the full scale value.

The basic circuit for resistance measurements is shown in Fig. 2. The two resistors are such that the one between HT+ and the "standard" is exactly 100 times the value of the "standard." This means that if a resistor of equal value to the "standard" is connected in parallel with it, the deflection of the meter will fall to half scale (if previously set to full scale). On the other hand, if a resistor of 100 times the value of the "standard" is connected in parallel with it, the reading

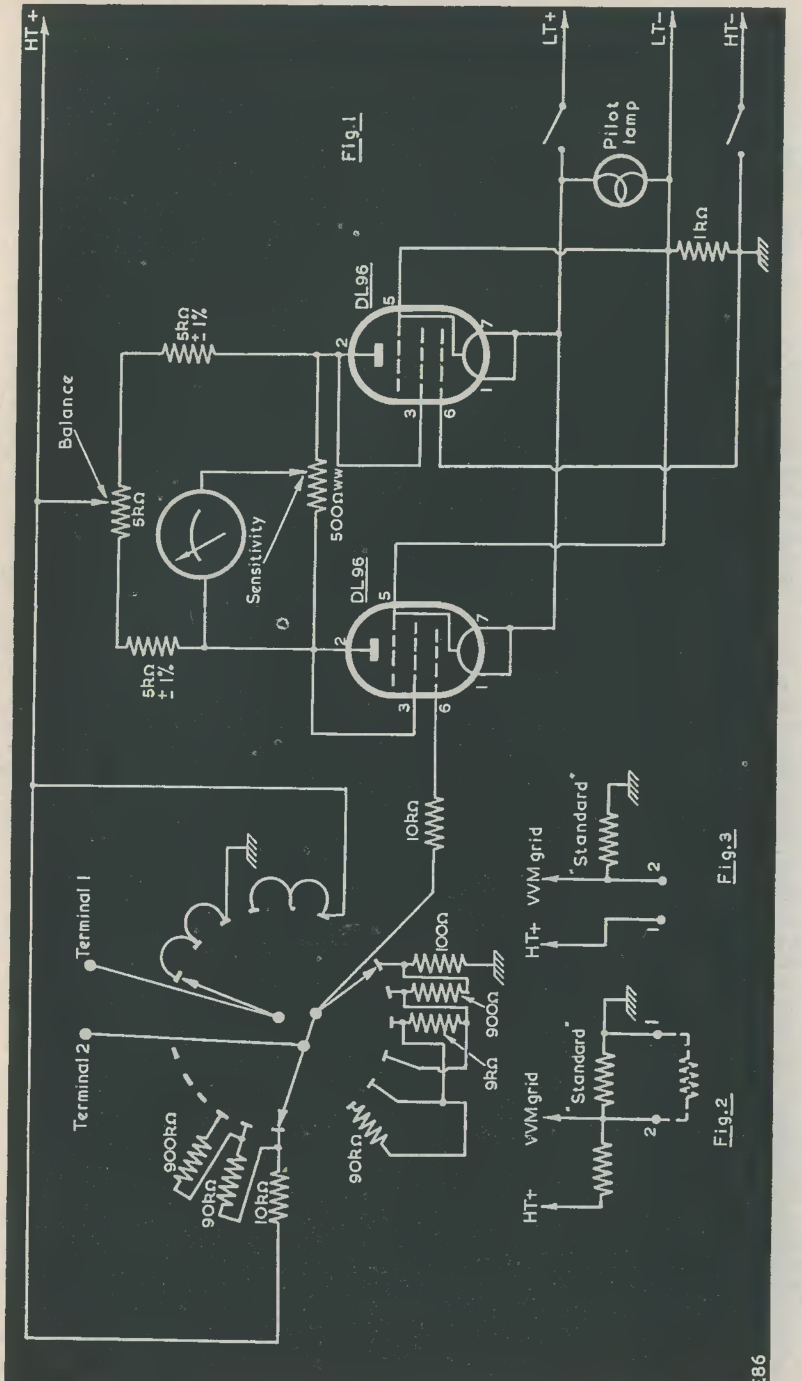


Fig. 1 shows the circuit of the complete instrument.

Figs. 2 and 3 show respectively, the basic circuits for measurement of resistance and leakage.

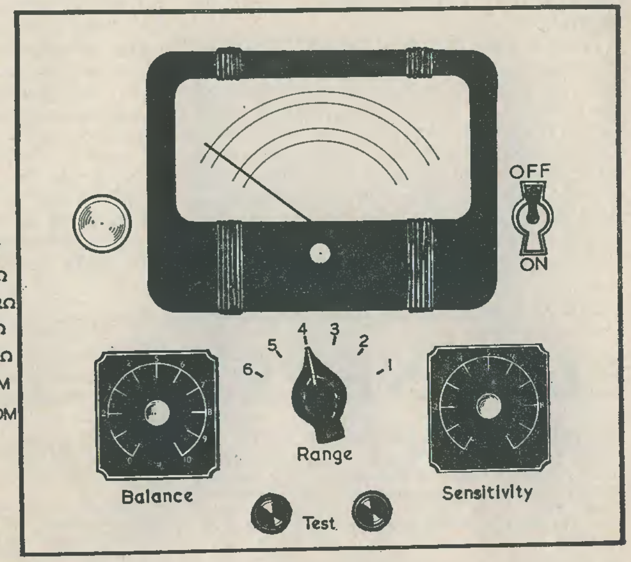
will drop in value by approx. one-hundreth.

The scale of the special meter—obtainable from Kendall and Mousley—is calibrated from 0.05 to 100, and in use the reading indicated is multiplied by the value of the "standard" on the particular range being employed. Thus, a reading of 0.05 with a "standard" of 100Ω will give a value of 5Ω; a reading of 50 and a "standard" of 10,000Ω will give a value of 500kΩ; and so on.

Fig. 3 shows the basic circuit employed for the measurement of insulation, with an applied voltage of 67.5. The effect is to connect a resistance of unknown value between HT+ and the top end of the "standard"; the voltage dropped across the "standard" is then "measured" and read off the scale as the value of the insulation resistance. As on the resistance ranges, an "unknown" of 100 times the value of the "standard" will result in a full scale reading on the meter; doubling the value of the "unknown" to 200 times the "standard" will result in the voltage drop across the latter being halved,

Fig.4

Range	min	centre	max
1	5Ω	100Ω	10kΩ
2	50Ω	1k	100kΩ
3	500Ω	10kΩ	1MΩ
4	100k		10MΩ
5	1MΩ		100M
6	10MΩ		1000M



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Component List
Set out for easy reference to Fig. 1

1 specially calibrated 100μA Pullin meter, Kendall and Mousley
1 Instrument box and panel, Kendall and Mousley
2 B7G valveholders, McMurdo
2 DL96 valves, Mullard
3 type K107 Knobs, Bulgin
1 type D/430/RED/A Indicator Lamp, Bulgin
1 type S/437 Switch, 3-pole 6-way, Bulgin
1 type S300 Switch, 2-pole on-off, Bulgin
1 500Ω wire-wound potentiometer, Colvern
1 5kΩ carbon potentiometer, Dubilier
1 100Ω ½W 1% high stability resistor, Dubilier
1 900Ω ½W 1% high stability resistor, Dubilier
1 9kΩ ½W 1% high stability resistor, Dubilier
1 10kΩ ½W 1% high stability resistor, Dubilier
2 90kΩ ½W 1% high stability resistor, Dubilier
1 900kΩ ½W 1% high stability resistor, Dubilier
2 5kΩ ½W 1% high stability resistor, Dubilier
1 10kΩ ½W 20% high stability resistor, Dubilier
1 1kΩ ½W 20% high stability resistor, Dubilier
2 Terminals, Belling-Lee
1 B114 Battery, Every-Ready
1 Panel-Signs, either Set 1 or Set 2.

and the meter will read half scale. With a "standard" of 10,000Ω and a full scale reading, the "unknown" will be 100× 10,000=1MΩ; with the same "standard" and the smallest scale calibration of one-hundreth FSD, the "unknown" will be 100MΩ.

There is little that need be said about the construction. In the original the job was split into two sections, the panel holding the majority of components, with a small chassis on which were mounted the valves. Kendall and Mousley will supply the panel ready drilled and finished in stoved black enamel; alternatively, they can supply a plain panel for readers who wish to employ a layout of their own choosing. In the latter case, it is suggested that readers might very well use Panl crackle paint to obtain a finish in keeping with other test gear.

The initial setting-up of the instrument is achieved as follows. Turn the range selector switch to one of the insulation ranges, and set the sensitivity control to zero. Switch on, then increase the sensitivity until the meter pointer moves off the zero mark. Next, set the balance control to the position where the pointer is on zero. Repeat the foregoing procedure until the sensitivity control is at its maximum with the pointer set on zero. The instrument is now balanced.

Next, set the sensitivity control at zero, switch to one of the ohms ranges, and then increase the sensitivtiy until the pointer is at full scale (zero ohms). The instrument is now ready for use.

CLUB NEWS

Details for insertion in this section should reach us not later than the 8th month before publication.

AMATEUR TAPE RECORDING SOCIETY

Asst. Secretary, G. A. Widdup, 92 Halifax Road, Rochdale, Lancs. Are you building the tape recorder now being described in this magazine, or do you already possess one? If so, why not join the above Society? A cordial welcome awaits you. All enquiries to Asst. Secretary.

BIRMINGHAM & DISTRICT SHORT WAVE SOCIETY

Hon. Secretary, R. Yates, 28 Daimler Road, Yardley Wood, Birmingham, 14. The Club have now acquired new headquarters at the YMCA, 20 Soho Road, Hockley, Birmingham, 19, at which site it is proposed to erect and operate the club transmitter. Meetings are held on the second Monday of each month at 7.45 p.m., and new members are welcome. Forthcoming subjects include: March: "Power Supplies," by H. Burdett; April: the Club Station; May: "Aerials," by T. Burton.

THE EAST KENT RADIO SOCIETY

Hon. Secretary, D. Williams, "Llandogo," Bridge, Nr. Canterbury, Kent. The next meeting will take place on 15th March at 8 p.m. Meeting place "The Two Brothers," Northgate Street, Canterbury. Meetings are held fortnightly. The Society has varied interests including transmitting, television, tape recording, short wave listening, radio control, VHF, and many other subjects connected with radio. A cup is presented to the member who constructs the best item of equipment during the year. Frequent lectures, sales, raffles, etc., have been given and are again being arranged this year. The Society welcomes new members and also visitors to the district.

ACTON, BRENTFORD & CHISWICK RADIO CLUB

Secretary, R. G. Hindes, 51 Rusthall Avenue, Bedford Park, Chiswick, W.4. At the A.G.M. on 25th January, W. Dyer (G3GEH) was elected President, the Secretary, R. G. Hindes (G3GIM), and Treasurer, R. Baker (G3IRB), were re-elected. The Committee for 1955 is G5LQ, G3FJT and G3JVL. The Treasurer reported a notable improvement in the Club's financial position. The Club is now active on 160 metres phone each Tuesday (G3IIU).

CLIFTON AMATEUR RADIO SOCIETY

Plans have now been made for this summer's outdoor events and it is proposed to hold three D.F. competitions and a portable transmitting field day. The transmitting field day is a new venture for this Society and if well supported will become an annual events. All these activities will take place in the vicinity of Farnborough, Kent.

Programme for March: 4th, Junk Sale; 11th and 25th, Constructional Evenings; 18th, "The Voyage of the M.V. Aries," by E. Skelton (G3JOQ).

New members are always welcome and details of membership can be obtained upon application to the Hon. Secretary.

Meetings are held every Friday at 7.30 p.m. at 225 New Cross Road, London, S.E.14.

Hon. Secretary, C. H. Bullivant (G3DIC), 25 St. Fillans Road, Catford, S.E.6.

ROMFORD AND DISTRICT AMATEUR RADIO SOCIETY

Hon. Sec., N. Miller, 55 Kingston Road, Romford.

At the recent AGM the officers elected were Chairman, F. Simmons (G2FWJ); Treasurer, E. Boxcer (G3AUG); Hon. Sec., N. Miller, and a committee consisting of G3EBF, G2BVN and G. Creevy.

Future lectures include "Transistors," by J. Missen, B.Sc., of the G.E.C. Research Laboratories, on 22nd March, and TVI" Suppression," by Louis Varney, A.M.I.E.E. (G5RV), on 12th April.

Work has commenced on NFD gear and a workshop is being fitted up at the Club headquarters.

New members and visitors will be welcomed at the weekly meetings held on Tuesdays at 8.15 p.m. at RAFA House, 18 Carlton Road, Romford.

THE SLADE RADIO SOCIETY

Headquarters: The Church House, High Street, Erdington, Birmingham, 23.

4th March, 7.30 p.m., special meeting to consider adoption of amendments to Society's Rules; 7,45 p.m., Display of members' apparatus.

18th March, Lecture by Mr. W. E. Merrill (Member).

Full particulars of the Society and its activities may be obtained from the Honorary Secretary, Mr. C. N. Smart, 110 Woolmore Road, Erdington, Birmingham, 23. Visitors to the Society's meetings, which commence at 7.45 p.m. prompt, are cordially welcome.

The Club Station at the Church House is now completed, and is open every day of the week for the use of members. Transmitting and receiving equipment is being installed, constructional facilities are available, and morse and theory classes are being arranged.

THE G3XT CHASSIS

THE MAJORITY OF CONSTRUCTORS TAKE IT for granted that every receiver should be built on a flat metal chassis. This has now been standard practice for so many years that no one seems to think of improving upon it!

In an attempt to get out of this rut, I have been experimenting for some time with less conventional types of chassis, and have at last evolved a design which offers a number of advantages over the ordinary standard arrangement.

The G3XT chassis is most suitable for the smaller class of receiver, employing one to four valves. It is cheap, light, rigid, easily constructed, readily adaptable to any sort of box or cabinet, and specially designed to give maximum accessibility of components and wiring.

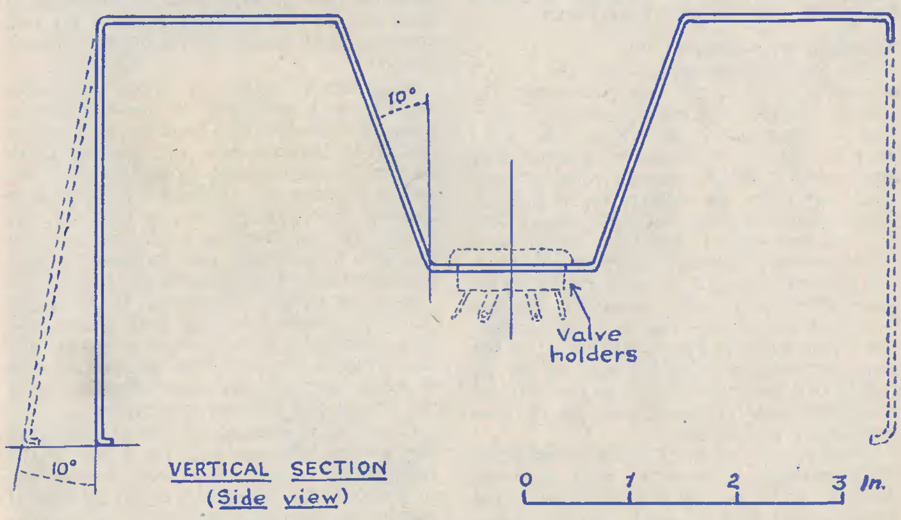
The fact that all the parts of a set built on this special chassis are so easily "get-at-able" is a great asset, not only in the initial construction and wiring but also in testing, fault-tracing and maintenance. A faulty component can be replaced quickly and easily with a minimum of disturbance to the rest of the set.

Easy Construction

Any constructor who is capable of tackling the simplest metal-working should find no difficulty in making this chassis. It is fashioned out of a single, flat, rectangular sheet of suitable metal (aluminium, mild steel, etc.) by simply bending it to the shape indicated in Fig. 1. The exact angles and dimensions can, of course, be varied to suit the individual requirements of any particular set. (As a rough guide, a development sheet 15″×8″ will bend into a finished chassis about 7″×8″).

For example, the front panel (which is separate from the chassis) can be either a vertical or sloping type. There is a good deal to be said for letting the panel have a backward slant of a few degrees, as it makes for much easier dial-reading, when the set is on a table below eye-level. A sloping panel is difficult to fit to the normal standard chassis, but dead easy in the case of the G3XT chassis; all you have to do is to adjust the angle of the front portion to suit the desired slant of the control-panel.

The various bends in the chassis are all parallel to one another and to the front and rear edges of the metal sheet. They can be



01 Fig. 1

formed very easily over the straight edge of a hard piece of wood or a metal right-angle girder. The bends greatly improve the rigidity of the chassis, in much the same way as the corrugations lend strength to a sheet of corrugated iron. The metal can therefore be of thinner gauge than would be needed for an ordinary flat type of chassis.

Small steel brackets, obtainable for a few pence at any ironmongers, can be used if desired to strengthen the chassis and improve rigidity still further. A pair of the metal handles found on many ex-Government surplus sets can be mounted across the ends of the valve trough, to improve rigidity and at the same time serve as lifting-handles for moving the chassis about. They also give a pleasingly professional-looking finish to the job.

The larger holes, such as those for the valveholders, can be cut or drilled before bending the chassis (i.e. while the metal sheet is still in its original flat state) if desired. But although this makes the drilling easier, the holes naturally tend to weaken the metal and make it less easy to bend neatly.

Accessible Valveholders

The outstanding feature of the G3XT chassis is the "trough" which traverses the central part of the chassis from side to side. This accommodates the valves and their holders. When the chassis is turned upside down, this "valley" naturally becomes a "hill," with the valveholders on its "crest." Their numerous soldering-tags (usually 7, 8 or 9 to each holder, involving about three dozen soldered connections in the average set) are thus brought up to a height which places them in a readily accessible position for easy soldering (see Fig. 2). Fault-tracing and testing are also greatly facilitated by the valve connections being so easy to get at, instead of being tucked away in odd corners at under-chassis level amidst a mass of other components and wiring!

The majority of the smaller components (fixed resistors and condensers, for example) are also carried on this trough, those in the anode circuits slanting away from the valveholders on one side of the central ridge, and those in the cathode circuits on the opposite side. Grid condensers and resistors, and midget IF transformers, can be carried on the flat part of the trough between valveholders.

The metal sides of the valve trough form a double screen which helps the stability of the set and reduces any risk of unwanted interaction between components in different parts of the circuit.

Simplified Layout

This chassis makes the task of planning a layout very simple indeed, as most of the components can occupy the same relative positions as their corresponding symbols occupy in the theoretical circuit diagram! This would be difficult to achieve on an ordinary flat chassis without making the whole set unduly large and unwieldy.

The details of the layout will depend, of course, on the circuit and components used, so only a general idea can be given here. The tuned-circuit components (coils, variable condensers, etc.) will of course be located in the front section of the chassis. Valveholders and the smaller components associated with them will be carried on the trough, with suitable tag-boards for mounting the fixed resistors, etc. Output transformer, loudspeaker jack, etc., can best be located in the rear section of the chassis.

It is strongly advisable, for several reasons, to use a separate power pack with any receiver built on the G3XT chassis. (Personally, I think it is always better to have the power pack separate in *every* set.) The power pack chassis can be an ordinary standard type of fairly small dimensions. It need not be in a separate cabinet; the two chassis can be housed in the same cabinet if desired.

If, however, the set is to be used occasionally as a portable, or *non*-built-in car radio, it is far better to have the power pack in a small separate case, with a short multicore cable terminating in safety plug and socket to carry the HT and LT supplies to the set. For portable use, or in a car, the mains unit can then be unplugged and put aside, its place being taken temporarily by a small car-radio type power pack running off a 6-volt or 12-volt car battery. If the output circuit of this pack is fitted with a cable and plug identical to that used for linking the mains unit to the set, two alternative sources of supply are instantly interchangeable without having to make any alterations.

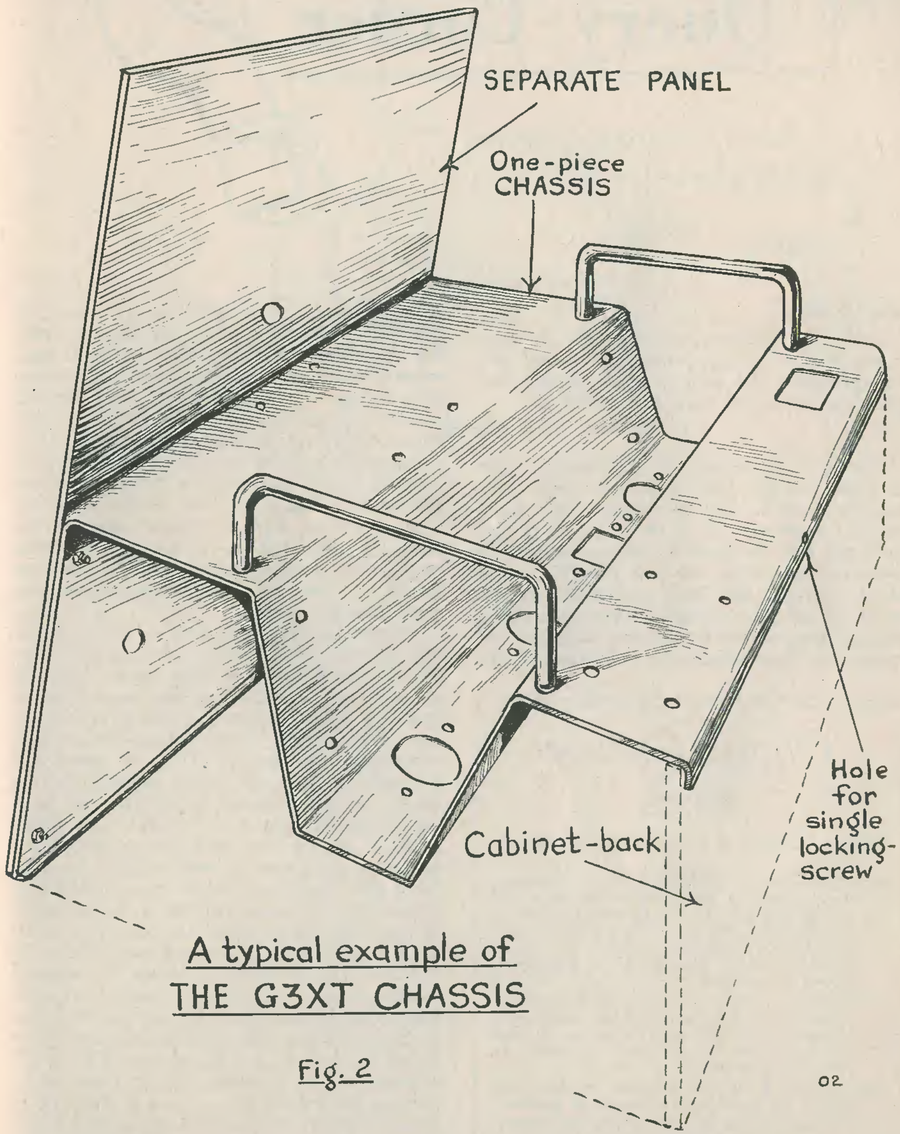
One word of warning! Some of the wiring connections will pass over the bends of the valveholder trough. Insulated connecting-wire should be used; but as an additional precaution against short-circuit to chassis from any bare wires (such as the wire ends of fixed resistors), it is advisable to stick a length of insulating tape along the bends on the underside of the chassis.

Limitations!

This chassis, like everything else, has its limitations! I have used it successfully for about ten different sets up to the time of writing; but all of these have been relatively small ones, employing one to four valves in straight or superhet circuits of fairly simple type. I would not recommend the G3XT chassis for more elaborate sets, such as complicated communication receivers. (There is, however, some scope for experiment in this field with the basic principle of a bent or corrugated type of chassis as opposed to the usual flat type.)

Finally, it should be borne in mind that this chassis is not suitable for beginners who find it necessary to follow a published layout plan in every detail. Being such an unconventional type of chassis, it does not lend itself to the average orthodox layout designed for an ordinary flat chassis.

In all other respects, I have found this novel chassis entirely free from snags, and I would be very reluctant to return to the ordinary standard type!



A typical example of THE G3XT CHASSIS

Fig. 2

Query Corner

A *Radio Constructor* Service for Readers

Spot Wobble

I find the scanning lines on my 17″ television tube very distracting and would like to experiment with some form of spot wobble. Can you suggest a suitable circuit?

L. Mayhew, York

The idea of employing an elliptical spot in a cathode ray tube is by no means new. Such a spot having its major axis in the vertical direction could be adjusted in size until the gaps between the scanning lines of a television picture are just filled in. This would prevent the illusion that the picture is being viewed through a venetian blind, and, providing the horizontal width of the spot is not increased, the definition of the picture would not be impaired. However, to design a tube having a spot size which meets the required specification is not practical, and some other means must be used to fill in the gaps between the scanning lines. The method usually adopted is known as spot wobble, and consists of vibrating the scanning beam of the picture tube in the vertical direction, whilst it is being deflected in the usual manner to form the raster. The amplitude of the vibration is adjusted so that the gaps between the lines are just filled in. It is important that no overlap occurs, as this has the effect of producing another line pattern along the overlapping portions.

This additional movement or vibration of the spot is achieved by placing an extra pair of small deflector coils on the neck of the tube and applying a sine wave current to them. The frequency of vibration is made very high when compared with the line repetition frequency. This is necessary because a low frequency would merely cause the spot to traverse the tube face in a wavy line of sine wave form. The upper limit is set by the difficulty of providing adequate deflection at very high frequencies from the small amount of power which is economically available from a normal type of receiving valve. The minimum frequency used with a sharply focused spot is around 8 Mc/s, and a value of about 12 Mc/s is often chosen. Some adjustment of the frequency is usually required to prevent a harmonic of the spot wobble frequency from being picked up on either the RF or IF channels of the receiver, thus causing a beat pattern on the screen. There is little point in adding spot wobble to a receiver in which the overall focus is poor or the interlace bad. Unless both these features are above reproach the addition of the wobbling oscillator will only further degrade the picture definition.

Query Corner RULES

(1) A nominal fee of 2/6 will be made for each query.

(2) Queries on any subject relating to technical radio matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like. Queries relating to ex-W.D. surplus or commercial equipment cannot be accepted.

(3) Complete circuits of equipment may be submitted to us before construction is commenced. This will ensure that component values are correct, and that the circuit is theoretically sound.

(4) All queries will receive critical scrutiny and replies will be as comprehensive as possible.

(5) Correspondence to be addressed to "Query Corner," Radio Constructor, 57 Maida Vale, Paddington, London, W.9.

(6) A selection of those queries with a more general interest will be reproduced in these pages each month.

The complete circuit of the spot wobble oscillator is shown in Fig. 1. A single high slope pentode is employed in a conventional circuit. In order to obtain the highest degree of efficiency the deflector coils are made part of the oscillatory circuit, the frequency of oscillation being adjusted by means of a 3–30pF Philips concentric trimmer. The amplitude of oscillation is varied by controlling the HT supply voltage to the valve by means of a series resistor. Bias for the valve is provided by a combination of grid leak and cathode resistors; an arrangement which has the advantage that should the valve cease to oscillate because of some circuit fault it will not be ruined by passing excessive current. When setting up the wobbler it is important to first ensure that the tube focus is set to optimum. For this purpose the HT switch S1 is provided to cut the oscillator out of circuit to permit of accurate setting of the focus control.

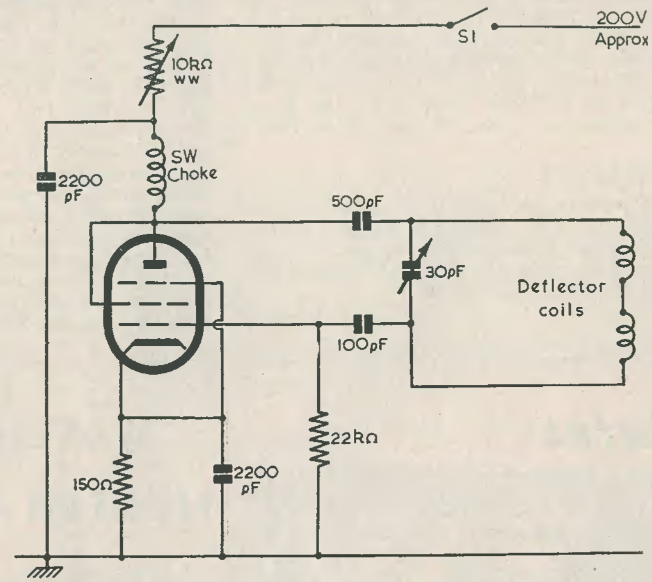


Fig. 1. Circuit of spot wobble oscillator. Suitable valves are EF50, EF91, EF80, 6AM6, Z77, VR91, etc.

The only components which must be made are the small saddle type deflector coils. These are positioned as close behind the main deflector coils as possible, and as space on the tube neck is limited the width of the coils has been restricted to 1-in. Reduction in the width will decrease the sensitivity of the coils and may result in insufficient deflection. Each coil consists of five turns of 26 swg enamelled copper wire wound on a former 1-in by $1\frac{3}{4}$-in. Each coil is carefully slid off the former and the turns tied together with cotton. They are then bent round the neck of the tube with the short side parallel to its axis. Having thus formed the coils they are dipped in wax or coated with glue and allowed to harden. The coils are then connected in series so that the direction of turns on each is the same, that is, with the magnetic fields assisting each other. Fig. 2 shows the

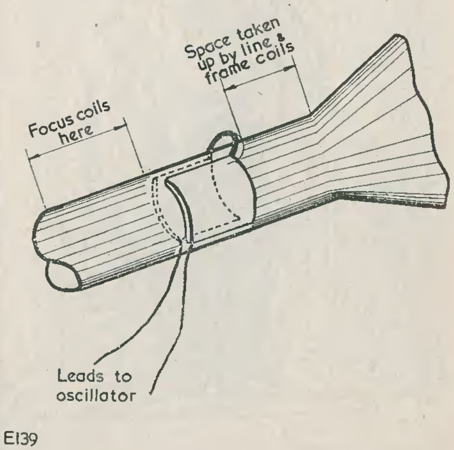


Fig. 2. Shows method of bending deflector coils around tube neck.

manner in which they are finally positioned on the tube neck, where they are held in position by two turns of insulating tape.

The leads connecting the coils to the oscillator form a part of the oscillatory circuit and should be kept as short as possible, preferably less than 6 in. in length. An H.T. supply voltage of 200 is adequate if a valve of the EF80 class is employed. Should an EF50 or EF91 be used it will be found preferable to increase the voltage to 250.

Glow in CRT

I recently purchased a 14" television tube and am a little alarmed to notice a pinkish glow which appears within the neck when the tube is in operation. Does this indicate that the tube has a poor vacuum?

J. Blackley, Bradford

Should the vacuum of a CRT become slightly impaired a very faint light blue glow may be detected coming from within the electron gun assembly. This glow will completely disappear when the tube is biased off, so that no beam current flows, and it will gradually reappear and increase in intensity as the bias is reduced. If the tube is slightly gassy the focus may also become less sharp. The important point to notice is that the glow appears from within the gun, actually right in the path of the main electron stream. If, however, the glow only appears on some outer part of the gun, or on ceramic or mica supports, then this is simply fluorescence caused by bombardment of the glowing part by stray high velocity electrons. This form of glow varies in colour from blue to light pink, and is a phenomenum which in no way detracts from the normal life of the tube.

Rufus

"*What clot crossed the fast-forward belt on my tape-recorder!*"

WATCH YOUR HEATER CURRENT

A possible but little-known cause of premature cathode ray tube failure is the over-running of the heater with consequent undue rise of cathode temperature. Cases have been known, in which such an increase has impaired the interelectrode insulation of the tube, ultimately resulting in either a heater-to-cathode or grid-to-cathode short.

Replacing the tube will, of course, form a temporary cure of the trouble, but unless the cause has been removed the replacement tube may in due course fail in a similar manner.

Over-running of the heater can be the result of many possible causes. The use of the receiver on an incorrect mains tapping is one obvious cause, but in those types of receivers designed for series operation there is another possibility which should be checked. Such receivers almost invariably have a surge limiting resistor in series with the heater chain, and failure of this component may result in a short circuit with consequent rise of voltage throughout the chain.

It is therefore highly advisable to check the cathode ray tube heater *voltage* in a parallel operated receiver, or in the case of a set in which the valves and tube are series operated, to check the heater *current*, when replacing a faulty tube in a receiver, in order to guard against a repetition of the trouble.

It is recommended that the heater *current* of a series connected tube should be within 5 per cent of its nominal, and for a parallel connected heater the *voltage* should be within 7 per cent of the nominal. Measurements should be made with the nominal supply voltage connected to the appropriate tap.

(Courtesy Mullard *Outlook*)

Let's Get Started 21: VALVE VOLTMETERS

By **A. P. BLACKBURN**

Having considered very briefly some of the sources of signals used in receiver and amplifier testing last month, the next step is to detect this signal at any point in the system under test, and to estimate what the system has effected. Don't be put off by the use of such a pedantic word as system, since it only means "receiver," "amplifier" or "transmitter" in a shorthand form.

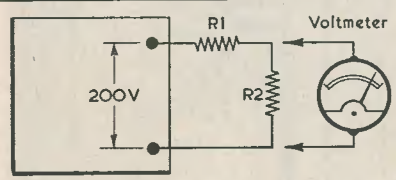


FIG. 1. G123

In order to carry out this estimate, it is necessary to be able to measure, with a reasonable degree of accuracy, the parts of the signal. It may, of course, be necessary to know the frequency, or the amplitude, at that point in the circuit.

First of all, however, we shall attempt the measurement of amplitude, or more recognisably, voltage.

Voltage

The methods for normal measurement of AC and DC voltages are well known. A previous article in this series* was, in fact, devoted to this very subject. In that article it was mentioned that the impedance of the source of voltage to be measured had some bearing on the accuracy of the reading. The time has now come when a closer look into this matter would be useful.

Fig. 1 shows a power supply which produces 200V at its terminals. Now if we wanted to step down this voltage to 100V, R_1 and R_2 must be of equal value. For a start we will make them 100kΩ each. Having rigged this up, naturally we just check the voltage by applying the voltmeter to R_2 as shown in the figure. The voltmeter has a sensitivity of 1,000Ω/volt.

* P.538, April 1954

Incredibly, the voltmeter reads 66.7 volt, and not 100, as we had expected. The reason is, of course, that the voltmeter on the 100V range has a resistance of 100kΩ. Now when it is connected in parallel with R_2, which also has a resistance of 100kΩ, the resultant resistance of R_2 and the voltmeter is 50kΩ. The *actual* voltage across the voltmeter (and R_2) is:

$$\frac{50}{100+50} \times 200 = 66.7 \text{ volts.}$$

If the voltmeter had a sensitivity of 10,000Ω/volt, the reading would be 95.2 volts, which certainly is nearer to the 100 volts that we should expect, but the error is still nearly 5%.

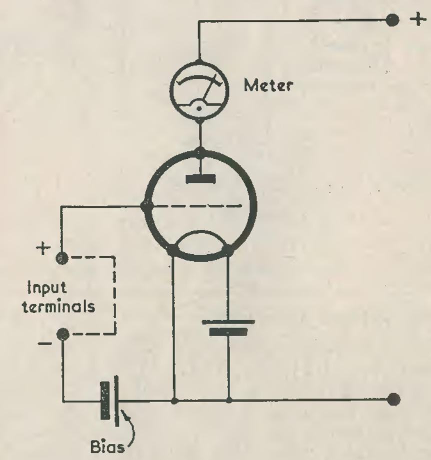


FIG. 2. SIMPLEST VALVE VOLTMETER G124

We can see, then, that the higher the resistance of the voltmeter (in the latter case it was 1MΩ on the 100 volt range) the more accurate becomes the reading. It is not possible, however, to go on increasing the sensitivity of the meter indefinitely without increasing its cost and delicacy. Our first meter was a 1mA movement (1,000Ω/volt) and the latter 100μA (10,000Ω/volt).

Ideally, we want a meter of infinite impedance (and minimum cost) so that it does not load the source at all. The nearest practical approach to this is the valve voltmeter.

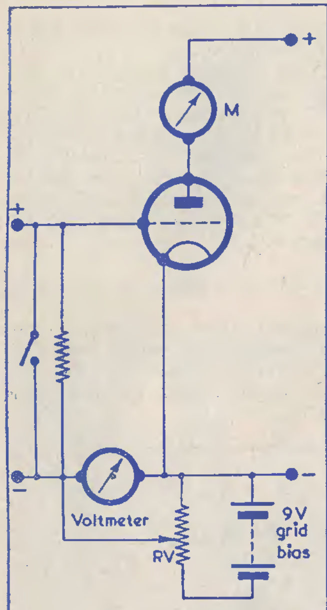


FIG. 3. "SLIDE-BACK" VALVE VOLTMETER

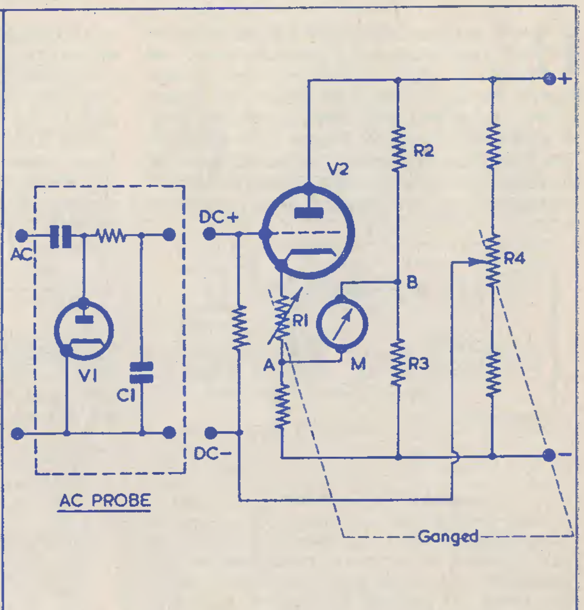


FIG. 4.

G126

The Valve Voltmeter

The basic idea behind all valve voltmeters is shown in Fig. 2. The grid bias battery voltage has such a value that the current through the valve is almost entirely cut off. The meter in the anode circuit, therefore, reads almost zero when the input terminals are connected together. Connecting the input terminals to an unknown positive voltage will cause the current through the valve to increase. The anode current meter will take up some new reading, and if the scale of the meter has been calibrated, a measure of the unknown voltage is obtained.

The input resistance of the voltmeter is the resistance of the valve base, between the grid and cathode pins, and may have a value of hundreds of megohms. Such a high resistance as this, placed across R_2 in Fig. 1, would have such a small effect upon the circuit that the reading it would give would be accurate.

The simple circuit of Fig 2 has many disadvantages, however. One is that the meter will not read zero unless the valve is exactly at the bias value required for anode current cut-off. The non-linearity of the Vg/Ia characteristic would make the calibration very non-linear, and at measured voltages below 2V the instrument would be very insensitive. Changes in the valve characteristics would invalidate the calibration and frequent re-calibration would be necessary.

Various methods have been adopted to overcome these disadvantages. One is to use a value of bias that would bring the valve to the straight portion of the Vg/Ia characteristic and then back off the standing current reading of the meter with a battery. This, however, does not overcome the objection that the calibration depends upon the valve characteristics.

The Slide-back VVM

The improvement to be had from the slide-back principle is that the circuit is arranged in such a way as to enable comparison to be made between the unknown voltage and a known one. A circuit is shown in Fig. 3.

The principle is much as before, but with one important difference. To begin with, the anode current is adjusted to a very low value by adjustment of the bias potentiometer, Rv. The anode current should not exceed 1μA, which means that M should be a 50μA movement. It will be noticed that an ordinary voltmeter has been introduced to measure the bias voltage. When the valve has been set almost to cut-off, the reading of this voltmeter should be noted. The unknown voltage is now connected to the input terminals and the anode current will increase, as before. The bias is again adjusted until the anode current meter reads 1μA again. The new bias voltage is noted.

As the valve has been brought back to its original condition by an adjustment of bias voltage, this voltage must be equal to the applied voltage. Subtracting the two bias readings, therefore, gives us the value of the unknown voltage. Compared to the far more elegant direct-reading technique, this method seems cumbersome and complex, but it has the saving grace that the accuracy is unaffected by valve characteristics. The purpose of the switch on the grid circuit is to short the grid resistor in order that no hum pick-up or other effects upset the initial setting of the anode current.

This circuit has another important advantage over Fig. 1. It can be used to measure AC voltages. This facility comes about because the valve is biased well back, beyond the "knee" of the Ia/Vg curve. In this condition, rectification of the AC grid voltage occurs, so producing a change in the mean anode current.

As in the DC case, the anode current is adjusted to a very small value. The AC signal is then applied and the bias re-adjusted until the meter reads the initial value once again. The difference in grid voltage readings is then equal to the peak value of the applied voltage.

If two meters are not available, it is possible to arrange switching to transfer the anode current meter to the grid circuit, where, with suitable multipliers, it may be used to measure the grid voltage. Alternatively, the potentiometer controlling the grid bias voltage could be calibrated in voltage, and the calibration checked occasionally to ensure that the battery had not run down.

The slide-back type of valve voltmeter is not very popular today, for a number of reasons. It requires a very sensitive meter for the anode circuit, with a full scale deflection of no more than 50μA, and capable of reading 0.5μA. Such a luxury is not to be found, of course, in every radio amateur's shack.

Its great advantage is that the calibration does not depend on valve characteristics, etc., and the "reading" meter need not be monopolised by the instrument.

Direct Reading Types

In more general use today are the many forms of direct-reading valve voltmeters These are used like any normal multi-range meter—just apply the volts and read off the result on a meter. The first type described above is direct-reading, but is rather too crude for serious work.

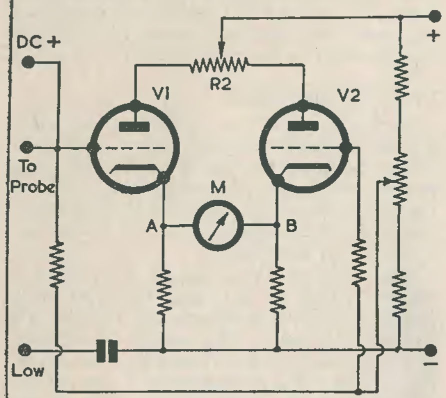
One type of direct-reading instrument is shown in Fig. 4. It is split into two parts. When an AC measurement is required, the "probe" is used. The diode V_1 rectifies the AC and the valve V_2 operates the indicating meter. Range changing is carried out by switching the value of R_1. This resistor produces negative feedback, and its value determines the gain of the valve, and therefore the sensitivity.

The resistance chain R_2 R_3 is used to set the zero on the meter. In the "no signal" condition, the voltage at point A is arranged to be the same as at point B. The meter will therefore read zero. Fine zero adjustment is made by setting the grid potential with the potentiometer R_4. It is also necessary to switch the grid potential as the range is changed, because a change in R_1 produces a change in the standing potential at point A. In order to get a zero reading on the meter, the potential at point B must be changed also. The grid to cathode potential is also changed with R_1, so the potentiometer is arranged to be switched simultaneously with R_1 to maintain the zero from range to range.

This instrument may be used on either AC or DC. For AC measurements, the diode probe is connected. The probe is normally made as small as possible, with the input lead either very short, or in the form of a rigid prod. If care is taken in the construction of this probe, voltage readings can be obtained up to 10 Mc/s or more with fair accuracy. The R-C network associated with the diode is a filter for removing any residual AC after rectification.

The actual operation is quite straightforward. When a DC signal is applied to the grid, the anode current changes. This change produces a change in potential at point A. As point B is fixed on any particular range, the meter will be deflected by the difference in potential between A and B.

Although this type of valve voltmeter can be quite sensitive, one limitation to its sensitivity is the zero drift.



— FIG. 5 (a) —

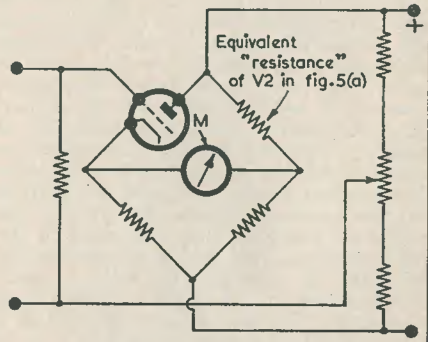


FIG.5(b) REDRAWN EQUIVALENT OF FIG.5(a) SHOWING BRIDGE ARRANGEMENT

G127

The Bridge VVM

The "bridge" circuit has been developed in an attempt to obtain a stable zero. Drift in the zero setting is caused by small changes in the valve. If, for example, a small change in the current flowing through the valve occurred, the meter would be deflected from zero.

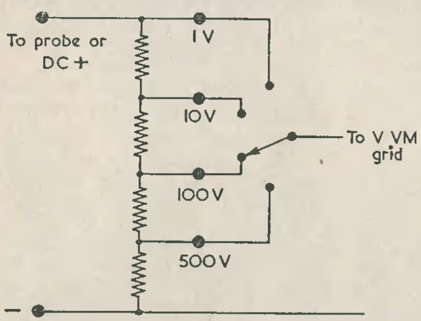


FIG.6. POTENTIOMETER METHOD OF RANGE SETTING

G125

The circuit is as shown in Fig. 5a. Fig. 5b illustrates the way in which V_2 is used as a resistance, of equal value to the "resistance" of V_1. The operation of the circuit is otherwise the same as Fig. 4.

If the circuit of Fig. 5b were used, there would be no improvement, from the zero drift point of view, on the circuit of Fig. 4. If, however, a valve is used in place of R_1, the two valves would tend to heat up together and the change in valve characteristics with temperature would be minimised. You will notice particularly that no signal is applied to V_2—it is used purely as a "resistance."

Further improvement can be brought about by making V_1 and V_2 a double triode. Both valves would then be under very similar thermal conditions. Zero setting is achieved by the use of R_2. Dissimilarity between V_1 and V_2 is cancelled by varying the current flowing through the valves by use of this control. The potentials of the points A and B in Fig. 5a can be made equal, giving zero reading of the meter.

Ranges

There are many ways of range setting in valve voltmeter design. One of the most popular is to arrange a potential divider to deliver a certain fraction of the unknown voltage to the valve voltmeter. This is shown in Fig. 6. It can be seen that it resembles a volume control, except that the steps are fixed.

When measuring DC, this type of range setting has the advantage that only one switch is required. It is not necessary to alter grid potentials, etc., as with the negative feedback arrangement in Fig. 4.

In the measurement of AC however, the diode probe will be connected. A strange feature of the diode is that if the heater is switched on, and a high resistance connected between anode and cathode, a small negative potential will appear at the anode, despite the absence of any external source of voltages. We will not try to find any explanation for this phenomenum at the moment, but its effect on the valve voltmeter is obvious. The instrument will read this small DC voltage. But why not adjust the zero set? That, of course, is the answer, but if a network like Fig. 6 is in use, changing the range will change the value of the diode "contact potential," as it is called, applied to the voltmeter.

It is necessary, therefore, to gang another switch to this one, and automatically reset the zero when the range is changed.

There is still much that could be said about valve voltmeters. Their accuracy, the strange effects they can have on RF circuits, their many uses in measuring AVC voltages—the list is a long one.

And, of course, the range of test gear only begins with valve voltmeters. It includes a great number of other instruments, some highly specialised, and these, too, will be covered in succeeding articles.

PRINCESS ROYAL TO OPEN NORTHERN RADIO SHOW

H.R.H. The Princess Royal has consented to open the Northern Radio Show, City Hall, Manchester, on Wednesday 4th May next.

This has been announced by the organisers, the Radio Industry Council, whose director, Vice-Admiral J. W. S. Dorling, said: "Her Royal Highness has a double interest in radio. She is a music lover and listener and as Colonel-in-Chief of the Royal Corps of Signals closely follows technical developments and training."

All space in the exhibition is taken. The exhibitors include the leading manufacturers of radio and television receivers, and the RIC is to build a studio within the exhibition from which the BBC will broadcast sound and TV programmes.

The Northern Radio Show, which is the second to be held since the war, closes on Saturday 14th May.

The Decoupling Resistor and Condenser

The most usual purpose of the AF decoupling resistor and condenser is, of course, to prevent hum in the HT line from affecting the early stages of an audio amplifier, common values being 50kΩ and 16μF.

There are, though, at least two other functions which are now often seen in the modern television receiver, and which may at first seem a little puzzling. For instance, it is often the output stage of the audio amplifier which is decoupled, and not the first stage. Because other circuits demand a hum-free HT line there is, in fact, often no need to decouple the audio stage, but it is vital that the audio variations from the output stage should not be allowed to affect the HT line, because these variations in turn affect the other stages. One typical trouble is frame "jitter." The frame bounces a tiny amount in time with the audio signal.

Another function of the decoupling may therefore be seen. It not only keeps out hum, but in the last case keeps in the audio variations.

Another function is where the decoupling is necessary to keep out other forms of interference, even though the hum level is low. This is found, for instance, in a television receiver where the audio stage is decoupled to keep out line whistle. It is also found in high gain amplifiers where it is used to prevent low frequency oscillation or motor-boating.

The same function is, of course, seen in a television receiver in the high frequency amplifiers, where every stage will be found to be adequately decoupled. In this case, only high frequency troubles are to be expected, and so the usual values are 5kΩ and 0.001μF.

The same circuit may, of course, be used for dropping the voltage of the supply, and in this case the only object of the condenser is to prevent negative feedback in the valve concerned. Two examples of this are the screen circuit of a video output stage, and the screen circuit of a 470 kc/s IF amplifier. Decoupling, as such, is unlikely to be necessary, but the valve itself demands lower voltages to prevent too great an internal heat dissipation.

Radio Miscellany

CENTRE TAP *talks about* AMERICAN VIEWPOINT AMATEUR RADIO

In my final paragraph last month I mentioned the return of an American radio acquaintance from a short visit to Europe. He certainly made a busman's holiday of it, and as far as I could judge his chief relaxation seemed to be watching our TV programmes. While he was with me the programme timing seemed worse than usual—so much so he became somewhat exasperated with the "interval films" of angel fish swimming aimlessly, potters' wheels, waves breaking on the shore or fingers plucking harp strings. At home he has the choice of some half-dozen programmes, and the idea of losing the customers' attention to other advertisers because of poor timing seemed Bad Business.

The repetition of interval films does not seem to worry our viewers. They have got used to them, and perhaps even look on them with some affection. I once heard of a household where they run a sweepstake on which night of the week a new interval film will turn up. As new ones are so rare I suppose it adds interest to the in-between-times. If the BBC only had a few more of them one could run a pool on the order of the three which get the most showings in any one month!

Pot Pourri

From interval films we got round to viewers and programmes. Accustomed as he is to being able to switch from programme to programme, he found it difficult to understand how British viewers used their receivers so much.

When you come to think of it, it is amazing how people can settle down to promiscuously watch ballet, table tennis, crooning sisters, swimming races, old-fashioned films, incomprehensible plays, foolish parlour games with smirking panel ladies and irascible old gentlemen, snooker, and politicians discussing almost non-controversial affairs, and grow so hypnotised by it all that they become quite incapable of turning the wretched thing off. I can only think it must be due to a strange belief that however bad it is now there is always a chance it might get better later on!

Maybe it is different with American viewers who have the opportunity of switching round to a half-dozen stations. If they are all bad, disillusionment ought to come six times as quickly!

Broad Acres

Naturally, I had questions to ask about the continuing popularity of radio as a hobby. It is, of course, difficult for anyone, however well informed, to give a true picture of a hobby in a country which is the size of a continent. We ourselves can hardly judge the growth or contraction of interest in our own country, let alone a nation of some 3,000 odd "steam" radio transmissions and about 400 TV stations. His opinion, for what it is worth, was that the decline in amateur transmitting radio is about the same as it is over here, and he suggested that the decline in enthusiasm is greater than that in numbers. That is, many amateurs are continuing with their licences but are generally less active. With ourselves, the number is still about three times as many as pre-war, but I think we shall shortly reach the "hard core" and the number will remain fairly constant around that level.

He was diffident about expressing an opinion on constructional radio interest, but was inclined to think it was about holding its own. If the advertising space in magazines catering for the hobbyist is any guide (and it is generally considered a fair indication), any diminution can only be very slight. The love of the American male for gadgets is proverbial, and interest in electronic gear which is closely allied to radio is likely to continue unabated for years to come. I was happy to be able to reassure him that over here there is a regular and continuing influx of youngsters coming into the hobby, and recent correspondence from old-timers proves they still get a lot of fun out of it even after twenty or more years of radio.

Deep Depression

From programmes, our conversation got round to announcers. Direct comparison between the BBC and American TV announcers is quite out of the question. However, I asked him which of ours he preferred. To my astonishment he opted, without hesitation, for one of the meterological experts. I pointed out that he wasn't an announcer, but merely someone borrowed from the Air Ministry to prove to overseas visitors how unpredictable our climate is! Not only did he stick to his choice, but he almost talked me into agreeing with him that the met. man would make a better job of it than those picked by the BBC.

Oddly enough, this particular met. man a few weeks later mentioned he wasn't feeling too happy. Everything had gone wrong. Yesterday's forecast had misfired, the one he was about to read would make everybody feel miserable and on top of it all he had just broken his favourite pipe! I have since been wondering how many viewers sent him a new one.

Simple But Good

Of course, we also talked of technicalities. When he was last in Britain, shortly after the war, our TV service had scarcely got into its stride. He was quite impressed at the picture quality we get from our "low definition" system—they use 525 lines—and the odd hundred is noticeably better on the larger size screens now coming into more general use. He was charmed at the simplicity of our sets. On the sound side, American receivers are necessarily more complicated since they use FM audio which means at least one more "toob." Nor did he think our sound reproduction was in any way inferior to their "hi-fi" FM.

On the video side, too, we get away with less IF stages. He had read of the type of sync circuits popularly used over here, and said he used to wonder if they were really satisfactory. He thought they looked too simple, yet apparently the picture lock on their receivers gives them far more trouble. He scarcely believed me when I told him how trouble-free most of our better-known makes are, and was even more surprised to learn just how many years' use the average viewer expects to get out of them.

I think he was quite converted to our vertically polarised signals. Over there aerial erection is quite a problem, and apparently a lot of bother is caused by their getting out of orientation during windy spells. Quite what would have happened during the recent gales if we had had horizontal aerials over here is anybody's guess. Quite a number of 2-metre beams came down despite the generous use of guy wires.

Incidentally, I cannot think of any other important country in the world where vertical polarisation is used. Even in Russia it is horizontal. Despite what the Left-wing propagandists tell us, much of their TV is still in the planning stage. Twice to my knowledge they have made big changes. They started with 343 line scanning, then to 441, and now they use 625. I can't think what would happen in a democracy if the Big Brother of TV started mucking about like that.

Old Timers' Corner

Reverting back to my recent paragraphs re free gifts, Mr. R. S. Forster of Sea View, Lowestoft, writes to say he still has a number of relics from the earlier days. He also has a set of ST500 coils (canned) which he will pass on to any reader wishing to try out how such a receiver would behave under modern conditions.

An interesting letter also comes from Mr. N. F. Smallwood (Publicity Officer, Southgate Group RSGB), who still has in regular use many of the tools from a kit given under a coupon gift scheme. Among the tools is a $\frac{3}{8}''$ dental mirror for "round-the-corner" inspection. It is a good idea for other readers to make up such a mirror, and a de-luxe version fitted with a small spot light is bound to come in useful on frequent occasions.

I am sorry I haven't yet found time to get round to answering all the letters from old-timers, but I have enjoyed reading them immensely. It is most encouraging to think that our hobby is such a permanent affair for so many of us.

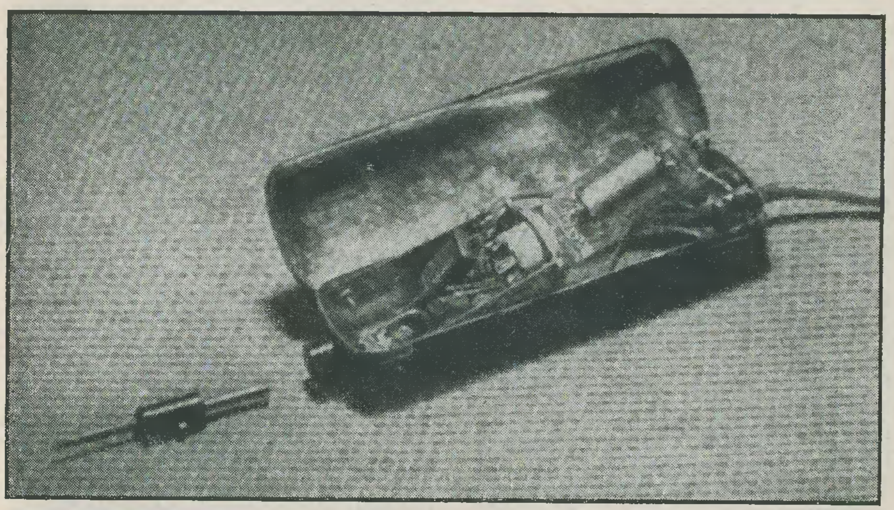
SIMPLE PROBE CONSTRUCTION

by **W. R. BURROWS**

Many good designs for signal tracers have been made available in recent years, but often the amateur constructor with only limited skill is deterred by the difficulty of making the probe itself. Usually a cylindrical container is suggested, and the wiring of a valve and sundry small items in such a small space can be decidedly tricky.

The probe illustrated obviates these difficulties, and is based on one of the narrow valve but makes the wiring of the capacitor and resistors really easy.

The point at the business end consists of a nail with the head cut off, gripped by a single pin plug which in turn fits into a Clix socket fixed into one end of the tin as shown. An additional advantage of this arrangement is that if it is desired to hold the probe on to any particular point of a set under examination, while still leaving both hands free, a tiny length of flex with a crocodile clip at one end



The probe with lid open, showing valve assembly partially raised on its "hinge," and details of the prod

tins used for containing cycle tyre repair outfits. The miniature valveholder is supported by two short strips of sheet metal, which are in turn fixed to the sides of the container by 8-BA bolts and nuts to give a hinge effect. This not only facilitates replacement of the and a plug at the other can be substituted for the "prod" shown.

If the completed probe is given a coat of black enamel it will assume quite a professional appearance and will fit the hand very comfortably.

IMPROVING SIMPLE "UNIVERSAL" RECEIVERS

by **F. G. RAYER**

Of the many AC/DC circuits employed, both in commercial receivers of cheap type and in the less expensive home-construction models, components and circuit complications have been reduced to the minimum. Though such receivers can give good results, a number of modifications can be tried out with comparative ease, and will generally result in an improvement in overall sensitivity. It is also frequently possible to reduce the level of background hum, which is quite high in many of the cheaper receivers.

Nevertheless, the simpler types of AC/DC receiver, especially if home-built from a circuit designed with low cost in mind, can be improved very considerably.

A typical circuit such as usually employed in the type of set in view is shown in Fig. 1, and uses the minimum number of components. Though good results can be obtained, a number of limitations are imposed by the simplified circuit, and these may best be considered individually, together with means of overcoming them.

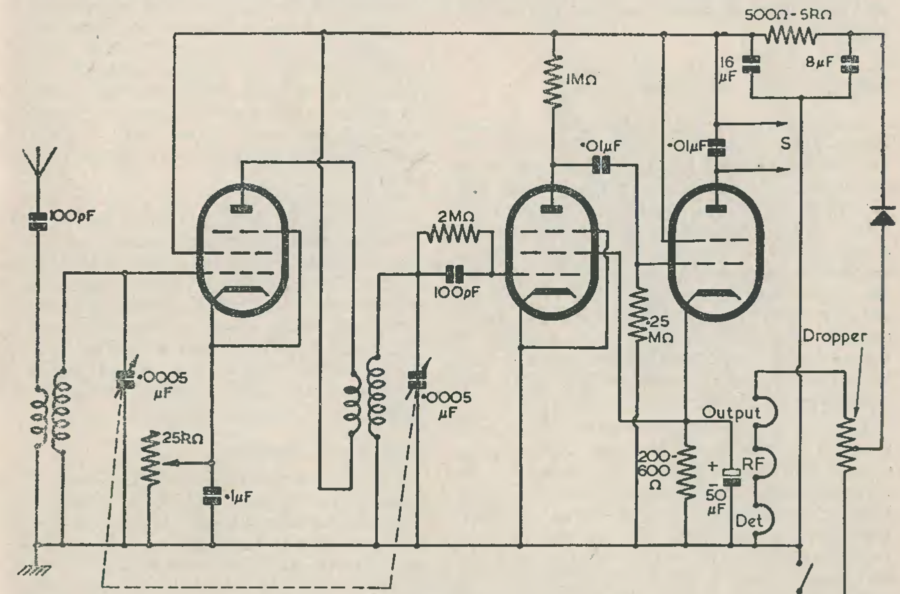


Fig. 1
Typical AC/DC TRF 3

When considering such improvements, and the results to be expected from them, it will be realised that some may not apply to particular receivers as such circuits may already exist. Nor is it suggested that *all* the modifications necessarily be carried out at one time.

Extra Wavebands

Long waves are useful in some parts of the country, while good loudspeaker reception of the more powerful short wave transmitters may be expected from such a circuit. If single-range coils are used, the simplest method of adding a long wave band is to use a 4-pole 2-way rotary switch wired in as shown in the complete circuit in Fig. 2. When this switch is in one position, the existing medium wave coils will operate exactly as before the modification, and any tuning scale fitted will continue to be satisfactory. In the second position, a pair of long wave coils are switched in. These should be of "RF and Detector" type, and may conveniently be the small dust-cored components available from many sources.

If a short wave band is to be used in addition, a 4-pole 3-way switch is necessary, and a further pair of coils for about 19 to 50 metres. Leads to the switch should be reasonably short and direct, and the aerial coils may best be mounted above the chassis, with the detector coils underneath. The switch itself may be positioned near the tuning control, or on the side of the chassis if no space exists for a further knob on the cabinet front.

For maximum results, a 50pF trimmer should be wired across each coil, as shown, and each band separately aligned for highest sensitivity.

Changes in the RF Stage

As reference to Fig. 2 will show, further points arise when maximum efficiency from the RF stage is required. The simple form of volume control shown in Fig. 1 does not always permit of the local station being kept down to the required level, and this can be overcome by re-wiring it as in Fig. 2. Here, as bias is increased, so is the signal input to the first stage reduced, so that control of volume down to zero is possible. A fixed resistor of about 300 ohms is also added in the cathode circuit so that the valve is not left operating wholly without bias when the control is set for maximum volume.

In some simple designs the RF screen grid is wired directly to HT positive. An increase in gain will arise if the anode voltage can be increased, and a SG dropper, as shown, then becomes necessary since valves of the 6K7 type have a maximum SG voltage of 125. In some circuits, this voltage may already be exceeded. If so, a SG dropper should certainly be added, about 50kΩ being most generally suitable.

It is also worth noting that the aerial condenser, present to keep mains voltages out of the aerial wire, should be of high quality with insulation above reproach. As reception of weak stations is usually improved by adding an earth, a further 750V working condenser, of about 0.05μF capacity, may be connected to the chassis for this purpose, as indicated.

Detector Stage

The method of obtaining a low SG voltage from the output valve cathode shown in Fig. 1 is largely used in simple circuits. As the output cathode voltage is not always most suitable, and some forms of feed-back may arise, a separate SG dropper, with by-pass condenser, is preferable. These are shown in Fig. 2. The resistor value of 4MΩ is most generally suitable for the 6J7 valve and similar types.

Fig. 2 also shows the circuit for anode-bend detection, with best values for a 6J7 or similar type. This type of detection generally results in less hum, since the control grid of this valve is now returned to the chassis, as regards hum frequencies. The anode resistor value may require changing to that shown in Fig. 2, and the anode bypass condenser of about 0.001μF should not be omitted.

If maximum possible volume from weak stations is required, especially in an experimental receiver, reaction can be added. It can result in a considerable increase in sensitivity, and standard coils with reaction winding can be used. If the receiver is for general use, however, it is not really necessary.

In Fig. 2 the HT supply to the RF and detector stages is further smoothed and decoupled by the 50kΩ resistor and 8μF condenser. This helps to preserve complete stability, and can prove very helpful in reducing hum caused by ripple in the HT circuit.

If clear-glass valves are used in RF or detector stages, it is frequently worth while enclosing these in screening cans, or adding screens made from aluminium, bolted to the chassis. If the receiver becomes unstable as the volume control is advanced towards maximum, such screening may be essential. The 0.1μF bypass condenser in Fig. 2, wired from the HT end of the coil primaries to chassis, keeps RF currents out of the remainder of the HT circuit.

Output and Rectifier

These are best considered together. With 0.3 amp type valves, a 25A6 or 43 is frequently found in the output stage, and have maximum SG and anode voltages of 135 and 160 respectively. In Fig. 1, the total HT voltage is kept down to about 135V by using a tapping on the mains dropper. It is preferable, however, to increase the HT voltage to the maximum rating of the output valve anode, adding a SG dropper of about 5kΩ. This increases power output and amplification, and also the gain of the RF and detector stages. In 0.2 amp and 0.15 amp heater circuits, a 12A6 is commonly used, and may receive up to 250V on both anode and screen grid.

A simple form of tone control may readily be added as shown, the 50kΩ potentiometer

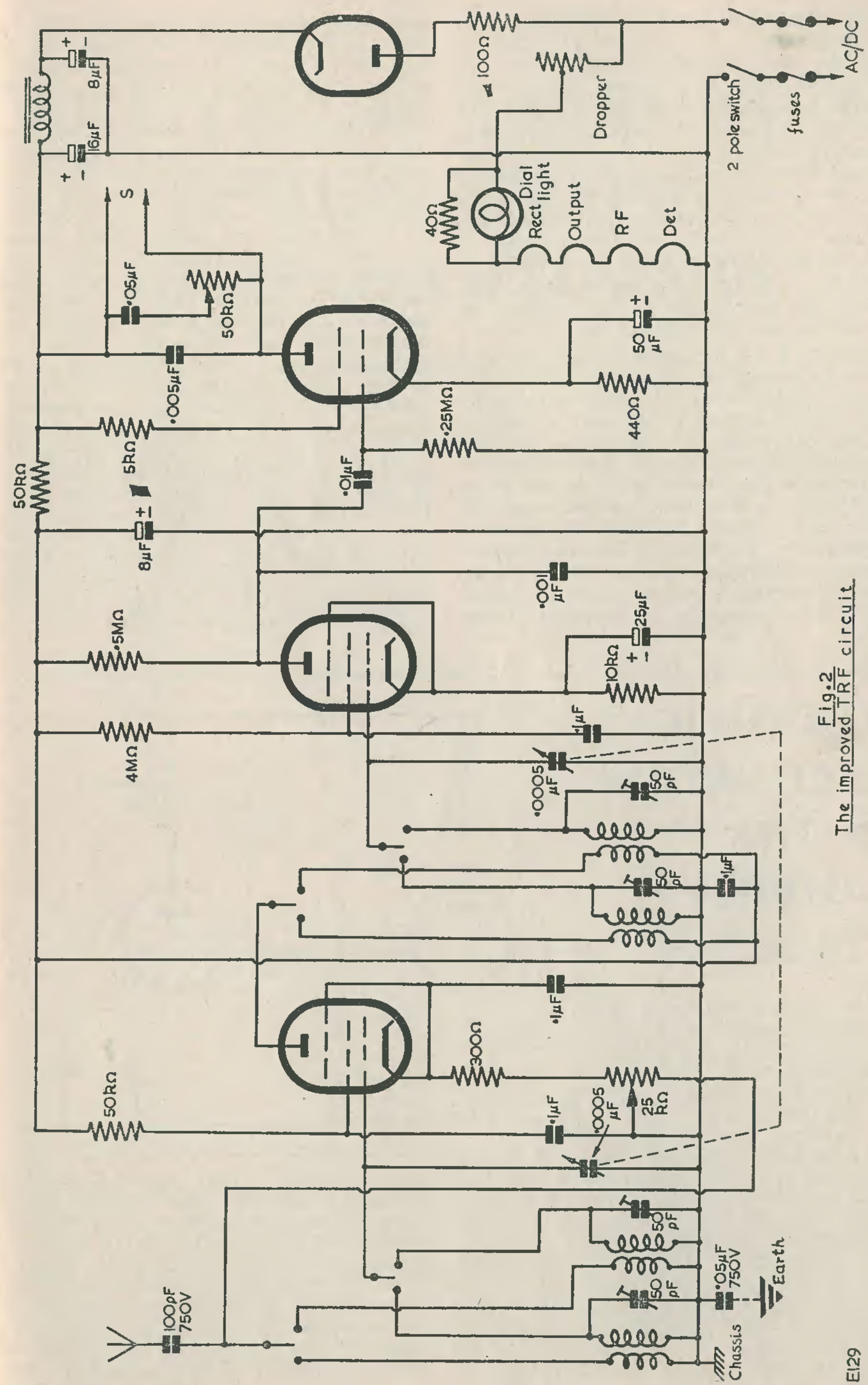


Fig. 2
The improved TRF circuit

being mounted at any convenient position. In order that a fair amount of treble is possible, any condenser already wired in parallel with the transformer primary may require reducing in value, as indicated.

Small receivers of this type frequently use a resistor, as in Fig. 1, instead of a smoothing choke. However, a choke will provide better smoothing and also be of lower DC resistance, so that the receiver HT voltage increases. Any small smoothing choke is satisfactory, its rating being about 60mA.

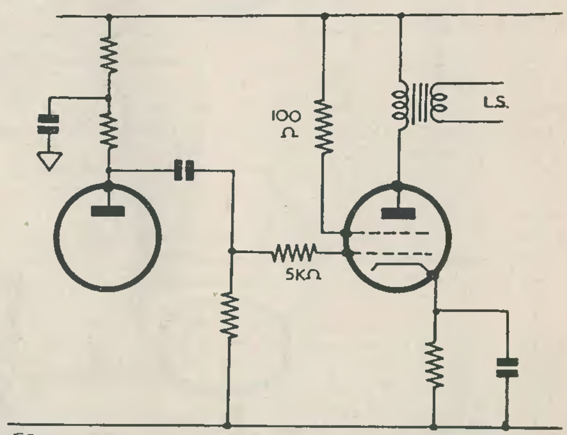
In Fig. 2, a valve rectifier is shown, and gives less hum, with a given degree of smoothing, due to its infinite back-resistance.

The 25Z4 is a good type for this position. If the metal rectifier is in good condition and of good make, it may, of course, be retained. But if a replacement is necessary, a valve is worth considering as a substitute. To limit the peak anode current, a 100Ω resistor is included in the anode lead. At the same time the mains dropper circuit may be adjusted as required to obtain the maximum permissible HT voltage for the output stage.

If no dial light is present, this may be added as shown, a resistor of about 40 ohms being wired in parallel to prevent the initial surge when switching on causing the bulb to blow. Alternatively, a 0.3 amp bulb may be used for 0.15 and 0.2 amp heater circuits, and a 0.5 amp bulb for 0.3 amp heater circuits.

Finally, a single pole switch included in the position shown in Fig. 1 is frequently used, but double-pole switching (Fig. 2) is preferable as the chassis is then safe to touch when the receiver is off. In Fig. 1, when the switch is opened, the circuit to the chassis from one mains lead is still completed, via dropper and heaters. It is also worth while connecting the receiver in such a way that the chassi is at the —ve or neutral side of the mains circuit, with AC mains. (This is a useless precaution with switching as shown in Fig. 1, as when the switch is open the chassis would become at high-potential respective to earth, via the unbroken mains lead.) Two fuses of quite low rating (0.5 amp) may also be included in the input leads, to avoid any fault blowing the main house fuse, and to afford maximum protection in the event of breakdown or leakage into the aerial or earth leads. If possible, it is best to use a non-reversible (e.g. 3-pin) mains plug, *neutral* going to chassis and *line* terminal going to mains dropper.

PARASITIC OSCILLATION IN THE OUTPUT STAGE



F.3

As its name implies, parasitic oscillation consists of unwanted high frequency oscillations in the output stage. High mutual conductance valves are very prone to this trouble if no precautions are taken. The trouble may also be caused by bad layout with, for instance, anode and grid wires too near to each other. The trouble often shows up as a rattling noise in the loudspeaker as though there were an iron filing caught in the speech coil. The fault is difficult to detect without an oscilloscope, and so it is worth while always including these extra resistances. The increase in cost is negligible, the performance of the stage will not be affected, but parasitic oscillation will be most unlikely. The parasitic stopping resistances must be mounted close to the valve-holders to be effective. For instance, when wiring a 6V6 base, the 5kΩ is connected between pins 5 and 6 while pin 1, which is blank, is connected to HT and the 100Ω resistance may be mounted across the holder between pins 4 and 1. Before wiring other types of valve it should be ascertained that there is no internal connection to pin 1. G.B.

NOTES ON THE MODIFICATION OF THE 182a UNIT TO AN OSCILLOSCOPE

by **A. P. BLACKBURN**

SINCE THE ORIGINAL ARTICLES APPEARED in these pages (May, June and July, 1954), some queries have been received which may be of interest to other readers who are attempting the conversion.

Before going any further, it has been pointed out by one reader that an error appears in one of the diagrams. On page 709 of the July issue, R_{19} and C_{17} are shown as connected to C_{16} on tagboard 1 (Fig. 17). Reference to the circuit diagram (May issue, Page 588, Fig. 2) shows R_{19}, C_{17} as connected in the cathode circuit of V_3 and C_{16} in the anode circuit. The circuit diagram is, of course, correct.

In Fig. 17, R_{19} C_{17} should be shown as being connected to the spare tags between C_{16} and R_9, on the upper edge of the tagboard. This tag is then connected to the cathode of V_3, the tag merely serving as a "jump off" or anchoring point for these components.

A point which has worried some readers is the fact that there are twelve terminals on the rear input panel, but the circuit only accounts for ten of them. A layout of this panel was not suggested in the article, because it was felt that each constructor would prefer his own arrangement of the terminals. Two spare terminals were added, in case anyone should need them for a purpose that had not occurred to the author, e.g. a cathode follower probe input, or an additional sync input position in direct connection with the plates.

A suggested arrangement for the use of the terminals is

- Top row Y_1 plate and input to attenuator
- Second Row X_1 plate and output from attenuator
- Third row Y_2 plate one spare (small terminals)
- Bottom row X_2 plate one spare (small terminals)

Queries

One reader has asked if a VU120A valve can be used to replace the specified VU120. The answer is that, in this circuit, they are directly interchangeable.

Another asks if a sweep amplitude control could be fitted. In this circuit the trace length should not exceed the diameter of the tube. There is little to be gained, therefore, in fitting a control which would only make the trace shorter. Trace amplitude controls are normally fitted to oscilloscopes when the timebase is expanded and may sweep two or three times the diameter of the tube. If, for some specialised reason, an amplitude control is imperative, the simplest way is to make the anode load R_6 of V_1 a potentiometer. The track would be wired between anode and HT+ and the slider connected to R_9.

One reader who is using the circuit, but not the 182A unit, has requested further details of the compensating coil L_1 in Fig. 3, "Y amplifier." No winding details are available because the coil used in the author's instrument was modified by unwinding as described, but for anyone in a similar predicament, who requires the correct coil, it can be supplied by the Teletron Company, of 266 Nightingale Road, London, N.9.

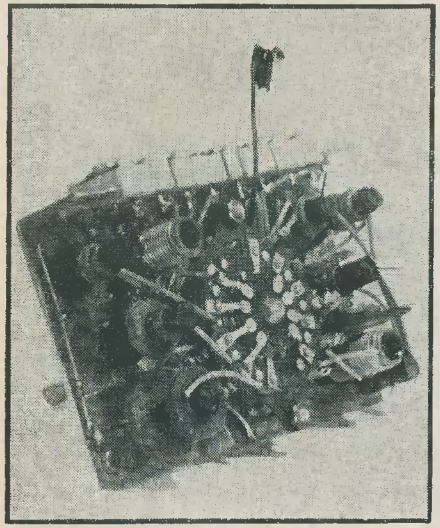
A small omission has been noticed on page 708 of the July issue. Under "setting up," the expression should read:

$$\text{Gain} = \frac{\text{Output voltage (peak to peak)}}{2 \times 1.41 \times \text{input voltage (RMS)}}$$

Although they were not available at the time the author undertook the conversion, the panel signs now being marketed by Data Publications Ltd., are recommended to give a really professional finish to your instrument.

The interest shown by readers in this conversion has been very gratifying, and I am very pleased to hear from the number of readers who have expressed their satisfaction with the operation of this design.

TRADE NEWS



Denco (Clacton) Ltd., 357 Old Road, Clacton-on-Sea, Essex.

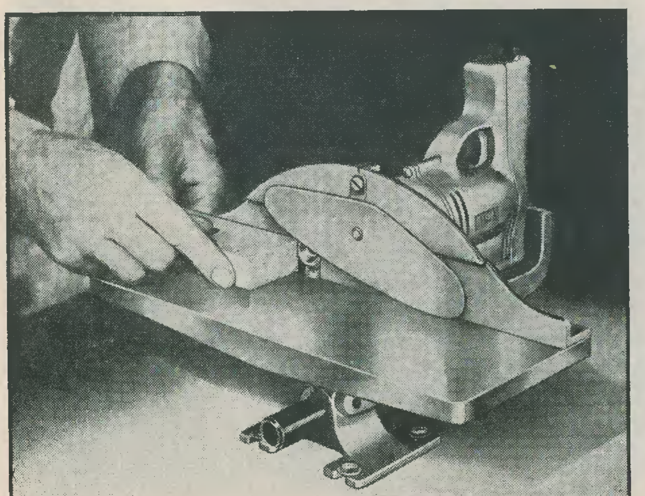
A further welcome addition to the well-known Denco range of coil packs is the Model CP.3/F. This pack, in addition to covering the normal short, medium and long wave bands, has the 1.85—6 Mc/s (50 to 160 metres) portion of the spectrum provided for as a separate band.

This new pack is for use with a two-gang 500pF condenser and is composed of aerial and oscillator coils wound on "Neosid" formers complete with iron dust tuning cores. Both the wavechange switch and the mica compression trimmers are mounted on an aluminium plate. The complete assembly is fixed by an additional nut on the wavechange switch. The IF is 465 kc/s and the pack may be used with any standard frequency changer. The retail price is 49s. plus purchase tax of 16s. 4d., total 65s. 4d.

Wolf Electric Tools Ltd.

Wolf Electric Tools Ltd. are the first to introduce to the field of "home handyman" equipment an electric bench planer of high performance and accuracy. It is powered by the Cub Drill and fitted with a cleverly designed planing head. Continuous cutting action eliminates difficulties of planing against the grain and the patent conical high speed cutters—virtually self-sharpening—should last indefinitely under normal usage. Owners of the Cub Drill can add this useful set to their equipment for the low inclusive cost of £3 9s. 6d., whilst the complete Bench Planer, including the Wolf Cub Drill, Bench Clamp, Pillar and No. 10 Planer Set, costs £10 13s. 3d.

Also introduced is the No. 9 Bench Sander Set at a cost of £1 18s. 6d., or for those who do not possess the Cub Drill the complete Bench Sander, comprising the No. 9 Sander Set, Bench Clamp, Pillar and Wolf Cub Drill, can be had for £9 2s. 3d. Fine accurate finishing is easily obtained at high speed on wood, metal, plastics and similar materials to a depth of 2¼in. To ensure maximum performance, self-adhesive sanding discs are provided in assorted grades to suit different work, and these can be instantly fixed to, or removed from, the faceplate as desired. The set includes a handy bevel attachment which enables mitres and other angles to be sanded with accuracy and speed. Inexpensive conversion packs to convert planers to sanders and vice versa are also available.



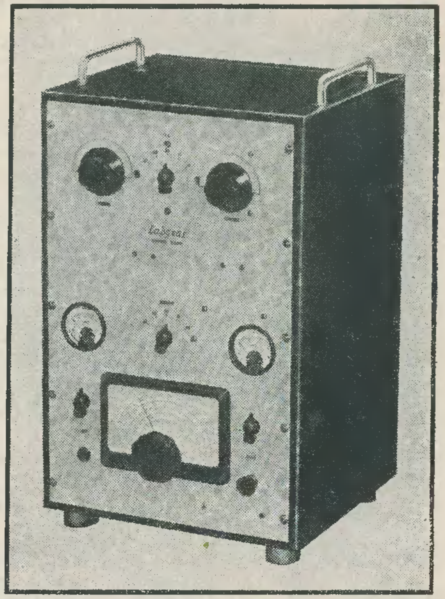
The range now embraces a veritable power work- shop, with facilities for Bench Sawing, Wood Turning, Portable and Bench Drilling, Grinding, Bench Planing, Polishing, Portable and Bench Sanding, Fretsawing, etc.

Fully descriptive literature of the above Sets can be obtained from Wolf Electric Tools Ltd., Hanger Lane, London, W.5.

Labgear (Cambridge) Ltd.

The illustration on the right shows the workmanlike appearance of the new table-top transmitter manufactured by Labgear (Cambridge) Limited, of Willow Place, Cambridge. For all that it occupies only one square foot of table space, excluding power pack and modulator if used, this transmitter is capable of giving the full 150 watts input allowed by the G.P.O. It uses an 813 in the PA, a heater transformer for which is included, and this stage uses a pi-filter tank output circuit to assist in the reduction of harmonic radiation, a matter which has received great consideration in the design. Cooling of the PA stage is by convection, air being drawn through the bottom of the cabinet so that it flows past the 813 and out of the perforations in the top of the case.

5763's are used in the bandswitched exciter, and the VFO is provided with a full vision calibrated dial. The transmitter covers all the low frequency bands from 3.5Mc/s to 28Mc/s. A descriptive leaflet may be obtained from the manufacturers in return for an SAE.

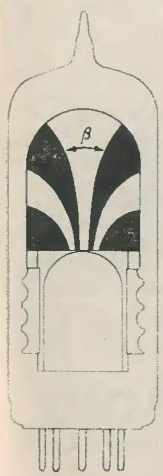


New Mullard Tuning Indicator of Novel Design

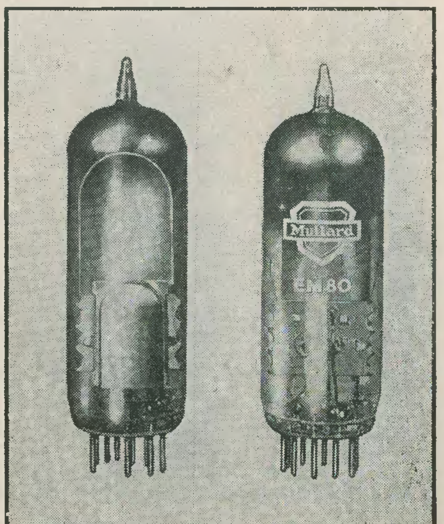
The Mullard EM80 is a cathode-ray tuning indicator ("magic eye") for AC mains-operated broadcast radio receivers.. Unlike conventional tuning indicators, in which the luminescent screen is viewed through the end of the valve, the EM80 is designed for viewing from the side. Thus, although the valve is a miniature all-glass type, the area of the display is quite large (14.5mm wide and 19mm high), and is clearly visible over a wide angle. When a station is being tuned in, alternate bands of light and shadow in the display vary in size, the shadow diminishing as tuning becomes more correct.

The valve is sufficiently sensitive to ensure that small changes in tuning which cannot be detected by ear are nevertheless clearly visible.

The EM80 is on the B9A noval base, and has a heater rating of 6.3V., 0.3A. Mounting position is unrestricted, and the design of the valve makes it easy and economical to mount so as to give a clear indication of tuning, and at the same time be aesthetically pleasing.



On right, two specimens o the Mullard EM80 tuning indicator placed side by side to provide front and rear views. The valve on the left is seen as it would be looking from the front of a set
At left, drawing showing the indicator pattern of the Mullard EM80. B is one of the illuminated "petals".



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SPECIAL VALVE OFFER: TZ40. **35/–**; 6L6G, **10/6**; 5R4GY, **12/6**; 829/3E29, **60/–**; 100TH, **90/–**; 866A, **17/6**, or **30/–** per pair; 807, **10/–** each or **17/6** per pair; 931A, **45/–**; 813, **80/–**.

FISK SOLARISCOPES. Complete with Charts, give World Time, light and dark paths. Invaluable to the DX man. List 21/–. **Our price 7/6** post free.

PANL HOME CRACKLE. Black, brown or green, 3/– tin, p. & p. 8d.

H.S. KEYING RELAYS (*Siemens*). 1700 × 1700 coils, **12/6**.

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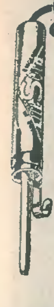

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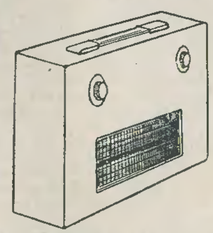

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(continued on page 511

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EQUIPMENT. Engineer forced to sell through loss of workshop, offers for sale—Test Instruments, Components, Radiogram with auto-change, Transformers (Mains and IF), Chokes, Chassis, Cabinets, Speakers, Valves, etc. (many new), over £150 worth. May be viewed Herne Hill. Box No. D145.

FOR SALE. AP sound, vision, BCR97, BC455 receivers. 6″ time bases. BCR97 and 517C. Pye strips. 12V Vibrator Packs. Hosts of R's, C's etc etc., etc. What offers the lot? Vickers, 100 Vicarage Road, Chelmsford.

PRIVATE TUITION given for the R.T.E.B. Radio Servicing Certificate Examination (London). Box No. D134.

TRADE

BUILD YOUR OWN TEST EQUIPMENT. Kits, Circuits, and spares available. SAE for list. Electronic Services, 50 Kelmscott Crescent, Leeds, 15.

BLUEPRINTS. High Gain 10 Metre Converter, with a de-luxe circuit comprising EF91 RF stage, ECC91 double triode mixer and oscillator, EF92 IF amplifier, with stabilised voltage supply via a 7475, 1/8 post free with full instructions. Data Publications, 57 Maida Vale, London, W.9.

KENDALL AND MOUSLEY LTD. Manufacturers of Laboratory Equipment, chassis and instrument cases, also suppliers of B.V.A. valves, Radio and TV components. 18 Melville Road, Birmingham 16.

COILS, COILS, COILS. We can supply coils for all frequencies, RF Chokes, Filters, etc. Coils wound to specification—send details for estimate. Send SAE for circuits and data. The Teletron Co., 266 Nightingale Road, London, N.9

I.P.R.E. PUBLICATIONS. 5,500 Alignment Peaks for superhets, 5/9. Sample copy *The Practical Radio Engineer*, 2/–. Membership examination particulars, 1/–. Syllabus of TV and Radio Courses free and post free. Secretary, I.P.R.E., 20 Fairfield Road, London, N.8.

FREE! Brochure giving details of Home Study Training in Radio, Television, and all branches of Electronics. Courses for the hobby enthusiast or for those aiming at the A.M.Brit.I.R.E., City and Guilds, Telecommunications, R.T.E.B. and other professional examinations. Train with the College operated by Britain's largest Electronic Organisation, moderate fees. Write to E.M.I. INSTITUTES, Postal Division, Dept. RC28, E.M.I. Institutes, London, W.4.

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OSMOR—for efficient coils, coilpacks, etc. Send 5d. stamp for FREE circuits and lists. Dept. RCC, Osmor Radio Products, Ltd., 418 Brighton Road, South Croydon, Surrey, Telephone Croydon 5148/9.

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