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CONTENTS FOR MARCH

456 Suggested Circuits: A Synthetic Bass Circuit for Domestic Amplifiers, by G. A. French

459 In Your Workshop, by J.R.D.

463 Modern Line Timebase Circuits, by S. Welburn

469 Notes on Radio Control, Part 5, Two Simple Transmitting Units, by Quench Coil

475 Book Reviews

476 The "Paragon" Tape Recorder: Pt. 3, by J. W. Walker

480 Can Anyone Help?

481 An Electronic Resistance and Leakage Test Set, by James S. Kendall, M.I.P.R.E.

484 Club News

485 The G3XT Chassis, by G3XT

488 Query Corner

491 Let's Get Started: Pt. 21, Valve Voltmeters, by A. P. Blackburn

496 Radio Miscellany, by Centre Tap

498 Simple Probe Construction, by W. R. Burrows

499 Improving Simple "Universal" Receivers, by F. G. Rayer

503 Notes on the Modification of the 182A Unit to an Oscilloscope, by A. P. Blackburn

504 Trade News

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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.

ALL CORRESPONDENCE should be addressed to The Radio Constructor, 57 Maida Vale, London, W.9 Telephone CUN. 6518
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 great problems incurred when reproducing sound in the home is the difficulty of preventing the attenuation of bass frequencies due to insufficiently dimensioned loudspeaker enclosures. To obtain a note of 50 c/s without noticeable loss it is necessary only 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 center 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 an 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. Also, a full-length article describing a practicable circuit has been published in Wireless World.

The Principles

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

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 function 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 attenua-
tion 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 as this 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 fundamental 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


Wolf Savings Scheme for Handymen

Wolf Accredited Dealers throughout the country are now operating an Easy Stage Savings Scheme for the benefit of prospective purchasers of Wolf Cub equipment. The scheme, which already has achieved high popularity, consists of a special savings card issued to each customer and upon which is entered the amount of money paid in. As equipment is purchased from the funds accumulated the amount withdrawn and balance outstanding can be entered up in columns provided on the card.

I t 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 must 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 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

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 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."

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

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 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 plugs 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 kcs 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 overextensively 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 harmonics.

I dare say 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 stabilizing condenser and treat the circuit as an AM detector for initial alignment.](image)

**MODERN LINE TIMEBASE CIRCUITS**

by S. WELBURN

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." 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 homeconstructed televisions. (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 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 regulations are concerned. At the time of writing the direct-drive system is only attractive to those home-constructors who have a reasonable
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 manufacturers2 have introduced the transformer3 not only to make their home-constructors 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-constructors practice. A point of interest is given by the fact that the metal base of the transformer is fitted to the television chassis by means of grommets, this assisting considerably in the reduction 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.

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 is therefore also available, this having the same frame impedance as the yoke it supersedes. Thus, the new line output circuit may be built into existing televisions 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 special 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 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-constructors use.

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

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2 Allen Components Ltd. 3 Lo 352

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

- **ENJO**

- **Feedback 9**

- **Width Control**

- **Efficiency diode cathode**

- **Line output anode**

- **EHT**

- **Ferroxcube core**

- **Anti-cross-talk condenser**

- **Line deflector coils**

- **C1**

- **EY51 or PY81**

- **R12**

---

**Fig. 2.**

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
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.

Whether it is fitted or not in individual televisions 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 television). 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.

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 0.002uF, may be varied between this certain 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
FM COMPETITION

The Radio Constructor is offering prizes of (1) 2 guineas, (2) 1 guinea, and two consolation of 10s 6d 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:

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 tinmed copper wire and sleeving, keeping all wires as short as possible.

For key, see page 475

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
Fig. 2 and 3. Photos show front and rear view of twin transmitter. Unit on left (year view) 200-watt two-valve transmitter, output from 90 volt HT. Note metal case enclosing unit and holes for adjusting tuning condenser. Note front view, showing lead and clear line of panel. Note aerial mounting. See distance of 1500 yards.

Both transmitters are operated over a distance of 1500 yards.

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Fig. 4. Two small portable transmitters. (Left to right) Two-valve using 90 volt HT and LT 1½ volt, both batteries carried in bottom part of case. Extra small transmitter using two DL70 valves. Batteries carried in small battery pack in pocket.
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 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 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...
operator. If he should have a good short-wave receiver which is accurately calibrated, he can use this by selecting 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.

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. The tube used for the first driving stage is the type 1Q5GT. This circuit uses two tubes instead of one only as in the first transmitter, and the design will give first results for the "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 not follow 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 polythene, paper 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 coil in Fig. 2b, a pushing-on insulator, 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 terminal tap connection can be taken as shown, if required.

Variable condensers should be mounted as near as 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 the terminal to which the wire is connected, a 1, with a rubber stopper. Where an "RFC"—radio frequency choke—is specified, this can be made up of 30-40 turns of thin wire with a 1-inch diameter piece of polythene 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 35v transmitter. Here, two separate windings are connected in parallel. Each coil is kept separate from the other electrically, as insulated wire is used, but the turns are physically in touch if described as "closed-wound." If described as "open-wound" or spaced, then they should not touch.

The general arrangement of the various components and wiring is left as 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.

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 Moulton Ltd., 18 Melville Road, Edgaston, 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 attention and the characteristic impedances of the different arrays quoted so freely.

The methods of construction are simple yet sound, though-wound wire, or the wire may be specified as for their own purpose.

Matching of aerial to feeder, and feeder to receiver, is given due attention and the characteristic impedances of the different arrays quoted so freely.

The methods of construction are simple yet sound, though-wound wire, or the wire may be specified as for their own purpose.

The first deals with attenuators; the second comprises a series of tables which give the dimensions 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-hexagonal and kindred types of aerial might have roused off an already wide coverage of modern antennas.

MARCH 1955
THE Paragon TAPE RECORDER

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 component parts, 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 Truxox 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 possible 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 Truxox tape-deck such shielding should be fitted between the heads and their covers, 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
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.

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 "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.

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 level for 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, as I would gladly repay any expenses.—J. C. G. C. Granville. 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 Responder 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. “Miniscop” Wobulatior 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, Sand, 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 diagram of the AM Unit R3118, Ref. No. 10DB/545 and Unit R-18/APS-3 NXS 11272 425CP? I would gladly pay for any

literature or circuit diagrams.—I. Baldwin, The Dingle, Habberley Road, Bredwley, 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, SW.15.

DEAR SIR,—Could any of your readers be kind enough to let me know where I can obtain cheaper, or on loan or on sale, of the following units: R9/APN/4; ID6/68 APN4; BC-733/D; R3/ARR/2X; BC/229 and Control Box BC231?—Yours truly, E. W. Bell, 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 221? 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 Derrwent 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.

The meter is one which has been specially designed for this instrument by Measuring Instruments (Pullin) Ltd., and it has two scales, one for the resistance and the other for insulation. The cabinet is in polished hardwood, and is both duraue and pleasing to the eye. It is 27 deep at the front, 4 deep at the rear, and takes a metal panel 9 long by 8 deep. This panel is stave 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 5k potentiometer; a Dubilier carbon track type was used in the prototype as it proved smoother to handle than a wire wound one. This 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. If the latter type of 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, is used.

The basic circuit for resistance measurements is shown in Fig. 2. The two resistors are such that the one between HT+ and the other between HT- and the "standard," respectively. These are also employed for the insulation ranges.

Those used in the prototype are Dubilier 1% high stability types, and may, as in the ordinary resistors, be switched separately, in which case the values will be 100Ω, 1kΩ and 10kΩ.
will drop in value by approx. one-hundredth.

The scale of the special meter—obtainable from Kendall and Mousley—is calibrated from 0.05 to 100, and in use the reading 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.

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![Diagram](image-url)
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 = 1 MΩ; with the same "standard" and the smallest scale calibration of one
hundredth the FSD, the "unknown" will be 100 MΩ.

There is little that need be said about the
circuitry. 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 Moseley will supply the panel
ready drilled and finished in stove black
eb alone; alternatively, they can supply a
plain panel for readers who wish to employ
a layout of their own. In the latter case, it is
suggested that readers very well
use Paul 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 sensitivity until the pointer is
at full scale (zero ohms). The instrument is
now ready for use.

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**THE G3XT CHASSIS**

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

Field day is a new venture for this Society and if well
supported will become an annual event. All these
activities will take place in the vicinity of Barnsforth,
Kent.

Programme for March: 4th, Junk Sale: 11th and
25th, Constructional Evening: 18th, "The Voyage
of the M.V. Artes," by E. Skelton (G3IQV).

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. Buvllivant (G3DIC), 25 St.
Filibus Road, Cufford, S.E.6.

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**THE EAST KENT RADIO SOCIETY**

Hon. Secretary, D. Williams, "Llandogo," Bridge,
Nr. Canterbury, Kent. The next meeting will take place on
12th 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
cording, short wave listening, radio control, VHF, and
many other subjects associated 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.

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**ACTON, BRENTFORD & CHISWICK RADIO CLUB**

Secretary, R. G. Hinden, 51 Rushall Avenue,
Beckenham, Kent. At the recent AGM, on
25th January, W. Dyer (G3GEH) was elected President,
The Hon. Secretary, K. G. Hinden (G3GUM), and Treasurer,
R. Baker (G3IRB), were re-elected. The Committee for
1965 is: G3LQ, G3HF, and G3WV. The Treasurer
reported a marked improvement in the Club's financial
position. The Club is now active on 160 metres phone
each Tuesday night.

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**CLIFTON AMATEUR RADIO SOCIETY**

Plays have now been made for this summer's outdoor
events and it is proposed to hold three D.E. competitions
and a portable transmitting field day. The transmitting

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**THE RADIO CONSTRUCTOR**

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**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 the usual 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" × 8½"
will bend into a finished chassis about 7½".)

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

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**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 CE 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

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**Fig. 1**
formed very easily over the straight edge of a hard piece of wood or a metal right-angle girdle. This bend greatly improves 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 it 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 valve-holders 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 valve-holders.

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 separate power packs 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!
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, the 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 interface bad. Unless both these features are above reproach the addition of the wobbling oscilator will only further degrade the picture definition.

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.

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 1½-in. Each coil is carefully slid off the former and the turns tied together with
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
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 EF80 or EP91 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

**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.

**Let's Get Started 21:**

**VALVE VOLT METERS**

*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.

As shown in the figure. The voltmeter has a sensitivity of 1,000Ω/volt.

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 R2, which also has a resistance of 100kΩ, the resultant resistance of R2 and the voltmeter is 50kΩ. The actual voltage across the voltmeter (and R2) is:

\[
\frac{50}{100} \times 200 = 66.7 \text{ volts.}
\]

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

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, R1 and R2 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 R2 as shown in the figure. 

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

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 value of hundreds of megohms. Such a high resistance as this, placed across R2 in Fig. 1, would have such a small effect upon the circuit that the reading it would give would be accurate.

The slide-back VVM

The improvement to be had from the slide-back VVM 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 1mA, which means that M should be a 50Ω 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 1mA again. The new bias voltage is noted.

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 30mA, and capable of reading 0.5mA. 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" 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 V1 rectifies the AC and the valve V2 operates the indicating meter. Range changing is carried out by switching the value of R1. This resistor produces negative feedback, and its value determines the gain of the valve, and therefore the sensitivity.

The resistance chain R2 R3 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 the source potential. The meter will therefore read zero. Fine zero adjustment is made by setting the grid potential with the potentiometer R4. It is also necessary to switch the grid potential as the range is changed, because a change in R1 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 R1, so the potentiometer is arranged to be switched simultaneously with R1 to maintain the zero from range to range.

This instrument may be used on either AC or DC. For DC 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 10MV 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 held on a particular range, the meter will be deflected by the difference in potential between A and B.

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

![Diagram of the Bridge VVM circuit]

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 occurs, the meter would be deflected from zero. The circuit is as shown in Fig. 5a. Fig. 5b illustrates the way in which V2 is used as a resistance, of equal value to the "resistance" of V1. The operation of the circuit is otherwise the same as 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 effects tly to find any explanation for this phenomenon at the moment, but its effect on the 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.

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**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. Dooling, 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.

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**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 10uF.

There are, however, 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 that the audio variations from the output stage may bounce 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 0.001uF.

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

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 commercials, 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 rate 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 prosaically to watch ballet, table tennis, crooning sisters, swimming races, old-fashioned films, incomprehensible plays, foolish parlour games with smiling ladies and inscrutable 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 our continent. Most of our readers 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. He 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 meteorological 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 in his line. The meteorologist was, however, an AM afficionado.

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 "tweezer." 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 arrangement is quite a problem, and apparently a lot of bother is caused by their getting out of orientation while winding.

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. I had called him to think of any other important country in the world where vertical polarisation is used. Even in Russia it is horizontal. Do all 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 wants to know how he can test 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 3" dental mirror for "round-thecorner" 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 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 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 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.

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

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.

![Diagram of AC/DC receiver circuit]

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 500F 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 rewiring 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. So, a SG dropper should certainly be added, about 50kΩ being most generally suitable.

It is also worth noting that the aerial condenser, preset 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 impaired 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 feedback 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 0.1μF 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
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 at 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 2524 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 chassis 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 (or neutral) 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-reversable (e.g. 3-pin) mains plug, neutral going to chassis and line terminal going to mains dropper.

**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, R19 and C17 are shown as connected to C14 on tagboard H (Fig. 17). Reference to the circuit diagram (May issue, Page 588, Fig. 2) shows R19, C17 is connected in the cathode circuit of V3 and C16 in the anode circuit. The circuit diagram is, of course, correct.

In Fig. 17, R19, C17 should be shown as being connected to the spare tags between C16 and R9, on the upper edge of the tagboard. This tag is then connected to the cathode of V3, 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:

**Top row**
- Y1 plate and input to attenuator
- X1 plate and output from attenuator

**Second row**
- Y2 plate one spare (small terminals)
- Bottom row X2 plate one spare (small terminals)

Queries

One reader has asked if a VIU120A valve can be used to replace the specified VIU120. 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 length longer. Amplitude controls are normally fitted to oscilloscopes when the timescale is expanded and may sweep two or three times the diameter of the tube. If, for some special reason, an amplitude control is imperative, the simplest way is to make the anode load R6 of V1 a potentiometer. The trace would be wired between anode and HT + and the slider connected to R9.

One reader who is using the circuit, but not the 182A unit, has requested further details of the compensating coil L4 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, 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:

**Gain** = \( \frac{2 \times 1.41 \times \text{input voltage (KMS)}}{\text{output voltage (peak to peak)}} \)

Although they were not available at the time the author converted, 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

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 1F 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.

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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.

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

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 CP3/F. This pack, in addition to covering the normal short, medium and long wave bands, has the 185-6 Mc/s (50 to 160 metres) portion of the spectrum provided for as a separate band.

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 O.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 handswitched exciter, and the VFO is provided with a full vision calibrated dial. The transmitter covers all the low frequency bands from 3.5 Mc/s to 28 Mc/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 novel 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.
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