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The Radio Constructor
Incorporating THE RADIO AMATEUR

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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.

Queries. We regret that we are unable to answer queries, other than those arising from articles appearing in this magazine; nor can we advise on modifications to the equipment described in these articles.

All Correspondence should be addressed to The Radio Constructor 57 Maida Vale London W9

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Suggested Circuits

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. 68. AN ACCURATE CAPACITY METER FOR LOW-VALUE CONDENSERS

Now that F.M. and Band III television receivers have become commonplace equipment in this country, an additional complication has been added to the work undertaken by service engineers and amateur constructors. The complication is due to the fact that the circuitry needed for Band II and Band III reception involves the use of components which are not normally encountered in conventional radio and amplifier practice. This point is especially applicable to fixed condensers, these components frequently having values as low as 1 or 2 pF when employed in v.h.f. equipment. The capacity of condensers with values as small as this cannot be measured on most existing bridges, with the result that v.h.f. servicing and construction is liable to become a matter of guesswork when components of this nature are encountered.

To offer a solution to this problem, the Suggested Circuit in this issue depicts a simple test device for checking condensers having very small values of capacity. The circuit can be built with readily obtainable components, and it employs a laboratory technique which obviates any necessity to guard against long-term drift. All that is needed is a low short-term drift; and even this has to be maintained only over the period during which a reading is being taken.

The Circuit

The circuit of the meter is shown on the opposite page. It consists essentially of two r.f. oscillators, both of which are capable of being tuned by means of varying capacities in parallel with their tuned coils. The two oscillator circuits are screened from each other to prevent "pulling." This screening does not need to be extensive, however, and, under certain conditions could be dispensed with. The question of screening is discussed in greater detail later.

Readings are taken from the instrument when the two oscillators function at the same frequency. This state of affairs is indicated by beating the two oscillator outputs together with the aid of a detector, zero beat indicating oscillator synchronisation. In this circuit a leaky-grid detector is employed, and it is assumed that sufficient coupling to its grid is obtained by running a probe wire near the coils or wiring of the two oscillators. Although the coupling from the oscillators to this probe wire is capacitive, a further series condenser (C6) is still inserted at the grid of the detector. This condenser obviates the possibility of the probe wire passing hum picked up from heater circuits, etc., to the detector.

The detector should be capable of operating a pair of phones directly. Alternatively, it may be coupled to an a.f. amplifier stage which will then drive a loudspeaker. It is feasible that, with some versions, there may be sufficient a.f. amplitude at the anode of the detector to drive a loudspeaker directly, without the aid of an additional a.f. stage.

Operation

The operation of the meter is quite straightforward. After the equipment has been switched on and allowed to warm up, switch S1 is thrown to the "Test" position. The unknown condenser is then connected across the test terminals. Condensers C1 and/or C2 are then adjusted to give zero beat in the phones (or speaker). C3 and C4 are then left alone, and S1 is thrown to the "Lo-C." or "Hi-C." position as applicable. C5, or C6 (whichever has been switched in by S1) is then adjusted for a similar zero beat, whereupon the basic technique ensures that the value of the unknown condenser is compared with that of C5 or C6. Drift or inaccuracies in any other circuits or components is, in consequence, ignored completely, with the result that a very high degree of accuracy can be obtained. Since the time factor between comparisons can be reduced to that needed to adjust S1 from one position to the next, the effect of any drift in the device is reduced to negligible proportions. The second advantage is the fact that, apart from the comparison condensers C5 and C6, no other components need be classed as being "critical" at all.

Components

With the exception of the tuning condensers and coils, all components have their recommended values designated in the diagram. So far as valves are concerned, any triode valve capable of reliable oscillation at short-wave frequencies may be employed for V1 and V2, whilst any conventional low-mu triode can be used in the V3 position. It would be unwise to combine V1 and V2 in a single double-triode, although it should be quite permissible to so combine V3 and one of the oscillator valves.

The main requirements of the oscillator coils L1, L2, and L3, L4 are that they should have low self-capacity and are capable of functioning over a wide range of tuning
THE TRANSISTORETT

Osmor Radio Products Ltd., of 418 Brighton Road, South Croydon, Surrey, inform us that, as they have received several good reports on the performance of the "Transistorette," they are making available a set of punched chassis to the drawings given in this magazine. The price will be 12s. 6d. for the set.

THE RADIO CONSTRUCTOR

JULY 1956

IN YOUR WORKSHOP

This month J.R.D. continues with his description of the "Challenger," a high-performance f.m. tuner designed especially with the home-constructor in mind.

Readers may remember that, last month, I altered the nature of the monthly contribution somewhat by devoting it to the initial discussion of an f.m. tuner which had aroused the interest of readers. I would now like to continue with the description of this unit, concentrating this month on constructional details.

The Chassis

The first thing which has to be made for the "Challenger" is the chassis, and the dimensions of this are given in Fig. 2. The chassis may be made of aluminium of any reasonable thickness.

The dimensions shown in Fig. 2 are those before bending. The four side aprons should be bent upwards, towards the rear. The two short half-inch aprons are intended only for strengthening the chassis across its width. It would be advisable to bend up the two long aprons first, after which the two short half-inch aprons may be bent with the aid of a conventional vice fitted with short bending clamps. Many constructors will, of course, prefer to drill out the chassis after bending.

Three holes in the rear apron are given for conventional dimensions only. These holes are intended for the power lead grommet (hole "X"); the aerial input socket (hole "Y"); and the audio output socket (hole "Z"). Further dimensions are not given for these holes as the constructor is free to employ whatever type of socket or grommet he desires. However, care should be taken to ensure that the sockets chosen do not project too far back into the chassis, where they might make the process of wiring more difficult.

All the holes marked "A" in Fig. 2 should be drilled out 6BA clearance; whilst those marked "B" are intended to be 4BA clearance (the same applies to subsequent diagrams). Part of the front of the chassis is cut away to allow clearance for the tuning drive mechanism.

Two brackets are also required, these being needed for the tuning condenser and for its drive. The first of these is shown in Fig. 3. The half-inch section of this bracket should be bent up through 90 degrees. As this bracket has to hold the tuning condenser, it is rather important to see that it is not made of too flimsy a material. Aluminium of 16 s.w.g. would, in practice, be a good choice. The second bracket, intended for the tuning condenser drive, is illustrated in Fig. 4. After bending, the two sections of this second bracket should be at 90 degrees to each other.

Mounting the Components

To assist in understanding the layout given in the wiring diagrams, Fig. 5 shows the top layout of the principal components in the tuner unit. After the chassis has been prepared, the valveholders, tuning condenser,
tag-strips and coils may be mounted. The dial and drive are not fitted at this stage. Two three-inch lengths of 14 to 16 s.w.g. tinned copper wire should be soldered to the frame and the rear fixed vanes of the tuning condenser before it is mounted, as these points become inaccessible later. (Wire of this thickness is only necessary for the tuning condenser circuits. Thinner wire may be employed elsewhere, if desired.)

Fig. 6 gives a detailed view of the underside of the chassis and should be studied with some care, since it shows the manner in which the valvholders are mounted, together with the tag positioning of the various coils. (The relative layout of each valvholder is shown by indicating its pin No. 1.) The way in which the two tuning condenser leads are taken through the chassis is also shown in this diagram. These leads are not connected yet.

Fig. 6. Above-chassis layout, showing the positions of the principal components

It will be noted, from Fig. 6, that two of the five-way tag-strips employed in the tuner unit have been "cut down" to make them three-way. The process of cutting down the tag-strips can be carried out quite easily with the aid of a pair of nippers. One of the cut-down tag-strips is secured under a mounting bolt of the oscillator coil, L1. Since this bolt is inserted into the bakelite of the coil former and cannot consequently be fastened as tightly as it could be with a nut, the particular tag of the tag-strip concerned is not employed for earthing purposes.

The Power Wiring

The wiring may now be commenced. The heater and h.t. wiring is illustrated in Fig. 7. Note that a small clamp holds the three-way power cable under the chassis after it has passed through its grommet. The heater choke, L4, is also mounted at this stage; as are the individual heater decoupling condensers. In this and succeeding wiring diagrams, it may be necessary to show rather long component leads for reasons of clarity. In practice all components should be mounted very close to their appropriate tags. This applies especially to decoupling components.

The r.f. and oscillator stages may now be wired up, this process being carried out as shown in Fig. 8. All component leads shown in this diagram must be kept short. The tuning condenser wiring deserves special mention at this point. It was recommended, previously, that fairly thick tinned copper wire should be used for the tuning condenser connections. This is done in order to reduce losses in the variable tuned circuits. However, the relatively thick wire employed should be handled with care during wiring since, otherwise, undue strain may be placed on the tuning condenser tags. The lead from the tuning condenser frame connects to the chassis solder tag immediately adjacent to the grommet through which the wire passes, after which it travels direct to the centre spigot of V2 valvholder. Another piece of heavy tinned copper wire then connects the chassis solder tag to tag 3 of L4. The lead from the rear fixed vanes of the tuning condenser travels through the large chassis hole under the tuning condenser direct to tag 1 of L3.
The fact that thick wire is used for these connections is not shown in Fig. 8.
Fig. 8 also illustrates the positioning of the Philips trimmer in the large hole in the chassis under the tuning condenser. The stem at the lower end of this trimmer is soldered direct to the tag of the front fixed vanes of the tuning condenser, this being the only mounting method required. The process of soldering the trimmer to the condenser tag is quite simple, the best method consisting of applying the soldering iron bit to the condenser tag above the chassis. The lead from the trimmer to tag 1 of L2 should be of the same relatively heavy gauge wire which is employed for the other tuning condenser connections.

In Fig. 8, C10 is shown as a conventional condenser. It is possible, however, to use a "twisted pair" here instead, the procedure required being illustrated in Fig. 9. As may be seen, all that is done is to twist one lead half a dozen times around the sleeving of the other. After this, a soldering iron is run very quickly over the turns of bare wire in order to solder them together without melting or damaging the sleeving. The "condenser" thus formed is quite adequate in practice for oscillator coupling. If any polystyrene varnish is available, this may be painted over the "twisted pair."

The I.F. Strip
The i.f. strip can now be wired up. This is carried out as shown in Fig. 10. Again, all component leads must be kept short.

---

Fig. 6. Under-chassis layout, illustrating in particular the relative positioning of valveholder and coil tags. Fig. 7. The initial h.t. and heater wiring. Fig. 8. Wiring up the r.f. and oscillator circuits.

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Fig. 9. How a "twisted pair" may be made, to replace C10. Fig. 10. The wiring of the i.f. strip. Fig. 11. Wiring and component layout of the discriminator stage.
**TELEVISION for the HOME CONSTRUCTOR**

**PART 1.**  

by R. G. YOUNG and S. WELBURN

This month our regular writer on television topics joins forces with another author, R. G. Young, in introducing the first article in a new series—this series being devoted to home-constructor television in all its aspects.

The obvious solution to this problem consists of fitting a flywheel synchronisation circuit to the receiver. Many commercial manufacturers employ such circuits in their "fringe" models as a matter of course, but the use of such synchronisation by amateur constructors is not very widespread. This is rather a pity as the advantages to be gained are quite considerable. Also, given an intelligent approach, the additional circuitry required is neither very expensive nor very complicated.

This article describes one of the simpler types of flywheel synchronisation arrangement, and gives details of a typical practicable instance in which it has been used.

Some readers may, perhaps, be a little hazy concerning the working of flywheel sync circuits. It would be to advantage, therefore, to devote a few explanatory paragraphs at this stage to the theoretical aspects of the circuit.

With normal sync circuits, every line of the television picture is kept in its position by means of the transmitted line sync pulses. These pulses initiate the flyback period, after which the line timebase commences to scan the next line in the picture. As the flyback period is only a few microseconds long, it occupies the same amount of normal time; in the case of normal channel 2, it can be seen that each successive line of the picture takes up its proper position on the screen. To obtain proper synchronisation, using sync pulses, it is necessary to set the "line hold" control such that the line timebase oscillator runs at a slightly lower frequency than the synchronised frequency. Thus, when the sync pulse arrives, the oscillator is itself almost on the point of going into the flyback period. The sync pulse

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**HI-FLY**

**THE CLAIM IN A RECENT ADVERTISEMENT of Hi-Fi equipment, stating "Capture the true range sounds in the very high frequencies of the sound spectrum," brings to mind an amusing story of an In Town Tonight broadcast some years ago.

When the writer was doing material for the B.B.C. Variety Department, he met an inventor, who said he was about to market a most unusual fly catcher, which he called "The Flyte." He claimed that flies, when mating, call to one another on a "super-aural frequency" of a very high order. So he designed this contraption which consisted of a reed, vibrating at this high, inaudible note. The reed itself was encased in an upright metal tube and both were connected to a dry h.t. battery. The whole stood in a small trough of water.

The theory was that the fly, on hearing the attractive note, was supposed to alight on the metal tube, no doubt expecting to find a "winged siren" or beau, as the case might be, then become electrified and fly up into the own came, not one fly had been trapped.

The writer was so staggered by the wonderful arrangement that word was passed to the late Bill Hanson, then in charge of

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**IN TOWN TONIGHT**

by F. NEVILLE HART

In Town Tonight, and the inventor was invited to describe the instrument in a Saturday night broadcast. To make the feature more amusing, Heath Robinson, whose famous cartoons of crazy inventions have never been surpassed, was interviewed at the same time, and he declared that it quite equaled his best. The script was slightly spoiled, for at that time the B.B.C. was having one of its prudish fits, and all mention of "mating" and "sex-appeal" was blue pencilled, and we had to stick to a purely technical description.

However, a few days later the inventor took the "Flyte" into the kitchens of the Savoy Hotel, and in the evening, when all the cooking had finished, it was set in operation.

All night long the inventor and his friends sat watching, in the hope that unsuspecting flies would be fatally attracted by the seductive call.

Unfortunately the party met bitter disappointment for, when the cold light of dawn came, not one fly had been trapped.

Perhaps, since no human car could hear it, the frequency was too super super aural for the flies as well!
knocks the oscillator "over the edge," as it were, just shortly before it would have done had it been left on its own.

If, however, the sync pulse did not arrive, or had insufficient amplitude, the flyback period would occur at the moment chosen by the timebase in its free-running state. In consequence, the next line would be scanned incorrectly. So also, probably, would a number of succeeding lines until the timebase oscillator got into step again.

The Coincidence Detector

One of the simplest methods of comparing the frequencies of the two pulse sources just mentioned, is by obtaining the control voltage therefrom, by means of a coincidence detector.

A typical example of such a detector is shown, in simplified form, in Fig. 1. In this diagram a conventional pentode is employed, the two pulse waveforms whose frequencies are to be compared being applied to its control grid and screen grid respectively. Fig. 2(a) illustrates the positive-going part of a differentiated transmitted line sync pulse, as obtained from the sync separator of the receiver. It is assumed, in this case, that this pulse has sufficient power to effectively modulate the screen-grid of the coincidence detector of Fig. 1. Fig. 2(b) illustrates a positive pulse obtained from the line timebase during the flyback period, and which is to be applied to the control grid of the coincidence detector of Fig. 1. An excellent place to obtain this pulse would be at the line output anode itself; in which case it could consist of a scaled-down version of the positive pulse appearing at this anode during the flyback period.

The cathode of the coincidence detector in Fig. 1 has a high positive potential, due to R2 and R3. In consequence, the valve normally passes little or no anode current during the period when its grid is at chassis potential. Also, due to the fact that a relatively high-value resistor, R1, is connected in series with the.t.h. feed to the screen-grid, the anode current passed by the valve is still not very high even when the control grid has a potential which is close, or equal, to that at the cathode. If, however, a pulse is applied to the screen-grid which makes it go positive at the same time that the control grid goes positive, then the valve passes a relatively heavy anode current.

The best relative position, for accurate scanning, between the two pulses of Figs. 2(a) and (b) is shown in Fig. 2(c). As may be seen, the flyback pulse occurs just slightly after the appearance of the transmitted sync pulse, this being just what is required in practice for good synchronisation. The shaded portion in Fig. 2(c) illustrates the amount by which these two pulses coincide. Remembering the operation of the coincidence detector of Fig. 1, it will be readily seen that the area of this shaded portion will be proportional to the anode current of the detector which occurs when both pulses coincide.

Let us now see what happens if the line timebase oscillator suddenly commences to run at too high a frequency. When this happens, the positive pulse from the timebase will appear earlier than it did in Fig. 2(c), giving the effect illustrated in Fig. 2(d). As will at once be obvious, the area of the shaded portion now becomes larger. In consequence, the current passed by the anode of the detector becomes larger also. To take the reverse instance: when the line timebase commences to run at too low a frequency we get the effect shown in Fig. 2(e). This time the shaded area has become smaller and, as a result, the anode current passed by the detector becomes smaller as well. The varying anode currents passed by the coincidence detector for the pulse relationships shown in Figs. 2(c), (d) and (e), are not steady. They consist, themselves, of pulses of varying amplitude. If, however, these pulses are applied across a resistor so that a proportionately varying voltage is built up, and this voltage is subsequently "smoothed," we have immediately available a steady voltage capable of controlling the frequency of the timebase. In Fig. 1, the anode voltage is built up across the resistors R4 and R5 in series. This voltage is then applied to the R.C. circuit R6, C3. The values of R4 and C3 are such that a steady voltage appears across C3. R4 and C3 also provide the time delay needed to give the arrangement its "flywheel" action. R4 is made variable in order to adjust the amplitude of the control voltage and it can, in fact, become the "line hold" control of the television receiver.

Control Circuits

The arrangements required at the timebase oscillator for flywheel synchronisation are quite simple. One of the most easily controlled types of circuit is the blocking oscillator, as shown in Fig. 3. It is possible to control the frequency of this oscillator by returning its grid lead to a positive potential. If this potential is increased, so also does the frequency of the oscillator.

In Fig. 2(d) we saw that, when the line timebase oscillator ran at too high a speed, the current passed by the coincidence detector increased. In consequence the control voltage obtained from its anode decreased. If, therefore, we connect the grid leak of the oscillator of Fig. 2 to the "control voltage" given in Fig. 1 we have a workable flywheel system.
knocks the oscillator "over the edge," as it were, just shortly before it would have done had it been left on its own. If, however, the sync pulse did not arrive, or had insufficient amplitude, the flyback period would occur at the moment chosen by the timebase in its free-running state. In consequence, the next line would be scanned incorrectly. So also, probably, would a number of succeeding lines until the line timebase oscillator got into step again.

**FIG. 1.** A simple coincidence detector

The reverse happens when an interference pulse triggers the line timebase. In this case the timebase is triggered before the arrival of the transmitted sync pulse. The result, however, is the same: one, or more, of the subsequent lines is misplaced until the line timebase oscillator settles down to its correct frequency again.

When a flywheel synchronisation circuit is employed, the transmitted pulses are not used to trigger the line timebase in the same manner as they do with direct sync arrangements. Instead, the frequency at which the transmitted pulses occur is compared with the frequency at which the timebase is running. If these two frequencies happen to differ from each other a control voltage is set up, this being applied to the timebase oscillator in such a manner that it either reduces or increases the timebase frequency, as the case may be. The control voltage is delayed in time by means of an R.C. filter, with the result that the circuit responds relatively slowly to changes in control voltage. Hence the "flywheel" effect, and hence the fact that the timebase oscillator maintains its correct speed over a period of time, even when the sync pulses are absent or if there are heavy interference pulses.

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sync circuit. What now occurs is that, when the time-base frequency increases the control voltage drops, whereupon the time-base frequency becomes automatically lowered towards its original value. Alternatively, if the time-base frequency drops the control voltage becomes raised, thereby increasing the time-base frequency.

Fig. 3. A simple blocking oscillator. Frequency control is achieved by returning the grid leak to a varying positive potential

A Practical Circuit

Fig. 4 shows a practical circuit which has been used very successfully by one of the writers. This diagram consists, in essence, of a conventional line timebase to which the flywheel sync circuit has been added in the form of an external unit. This unit is shown within the area enclosed by the dotted line.

In Fig. 4 the video signal, as applied to the c.r.t., has positive-going line sync pulses. These appear at the anode of V1, as negative-going pulses. Since their polarity is incorrect and they may not have sufficient power to modulate the screen-grid of the coincidence detector, V4, phase inversion at some power is required. This is provided by V5, which is a 6AM6 triode-connected. The positive pulses at the anode of V5 are then applied to the screen-grid of V4.

Positive pulses from the line timebase are also required. These are obtained in Fig. 4 from the anode of the line output valve itself. Unfortunately, however, the pulses present at this point have a very high positive peak potential with respect to chassis (possibly up to 5 kV) and considerable care has to be taken to prevent such high potentials reaching the coincidence detector. In this instance the pulses are applied to the fixed potentiometer given by R25, R25 and R22 in series (condenser C11 merely isolates the h.t. voltage appearing at the line output anode), the reduced voltage appearing across R23 being finally applied to the grid of V4. If taps had been available into the line output transformer anode winding, a more elegant method of obtaining the positive pulses would have consisted of connecting the control grid of V4 via a suitable fixed potentiometer, to one of these taps. However, this was not possible in the particular case being described, and the arrangement used functioned satisfactorily in practice. When the method of connection shown in Fig. 4 is employed, it is most important to ensure that R3 and R4 have the wattage indicated in the diagram, and that they are kept well clear of metal parts. Otherwise flashover, with consequent damage, may occur.

Resistor R25 is inserted in series with the pulse drive to the control grid of V4 in order to limit any positive grid current that may flow. This resistor tends to form a low-pass circuit with the capacity existing between grid and cathode of V4, but the consequent integrating effect is largely overcome with the aid of the small-value condenser C11. C11 helps to ensure that the original sharp front of the pulse appears on the control grid.

The varying voltage at the anode of V4 is "smoothed" by C10 and C12. In the prototype C12 was a paper condenser; but there is no reason why a modern electrolytic condenser with a low leakage current should not function equally well in its place. The positive control voltage appearing at the anode of V4 is next applied direct to the grid leak, R19, of the line blocking oscillator, V6. The flywheel sync loop is thereby set up.

Although, in theory, the control given by a flywheel sync circuit gives perfect locking over the whole of the transmitted picture, in practice this does not always occur. It is usually desirable to employ some additional stabilising device to ensure that the long-term frequency stability of the arrangement is held during the period of slight drift which occurs in the first hour or so of running and during changes in mains voltage. One method of obtaining this stabilisation consists of injecting a small proportion of the transmitted sync pulses into the oscillator section. This process is carried out, in Fig. 4, by applying the transmitted sync pulses to the blocking oscillator via R16 and C8. The pulses given by this arrangement are too weak to trigger the time-

Fig. 4. The practical circuit described in the text.

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base, but are sufficiently large to provide a useful reference frequency.

**Practical Points**

There are one or two further points concerning the circuit shown in Fig. 4 which deserve a little extra comment.

![Image of a circuit diagram]

The valves employed in the additional unit, V₃ and V₄, are not all at "critical." 6AM6's were used in the prototype because they were to hand. Later tests showed that almost any medium to low-mu triode would cope in the V₃ position, and most r.f. pentodes in the V₄ position.

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**From Our Mailbag...**

**Dear Sir,**

I wish to correct the information given by Mr. F. C. Judd regarding the relationship between recorder tape speeds and musical pitch in the June issue.

He states that the speeds of 6in, 7.5in and 12in per sec, give respectively, keys of C, F and B flat. This is incorrect, for if the tape speed is doubled, from 6in to 12in/sec, the pitch will rise exactly an octave, or C to C not C to B flat.

Also, the ratio 7.5/6 (or 1.25/1) is exactly a major third in "just intonation" which corresponds to the inverval C to E, not C to C. (For the "equal temperament" system to which pianos etc., are tuned to-day, the ratio is actually 1.25991 not 1.25/1. This slight difference in pitch is quite noticeable to a sensitive ear).

In order to obtain the musical ratios stated by Mr. Judd, i.e., C, F and B flat, the three speeds (taking 7.5in/sec as standard) should be 5.62, 7.5 and 10in/sec.

I would add, from experience, that the pulleys must be very accurate in diameter (to within a few thousandths of a millimetre) if the correct musical intervals are to be obtained. In the "equal tempered" scale the octave is divided into twelve equal semi-tones. The ratio of frequencies between each semi-tone is therefore \( \frac{125}{125} \) or 1.0595/1. Thus the correct ratio for any interval can be worked out, for example, if there is an interval of 8 semitones, the ratio is therefore \( \sqrt[3]{\frac{125}{125}} \) or \( \sqrt[3]{1.0595/1} \). The correct ratio for any interval may be worked out, for example, if there is an interval of 8 semitones, the ratio is therefore \( \sqrt[3]{\frac{125}{125}} \) or \( \sqrt[3]{1.0595/1} \). The correct ratio for any interval can be worked out, for example, if there is an interval of 8 semitones, the ratio is therefore \( \sqrt[3]{\frac{125}{125}} \) or \( \sqrt[3]{1.0595/1} \). The correct ratio for any interval can be worked out, for example, if there is an interval of 8 semitones, the ratio is therefore \( \sqrt[3]{\frac{125}{125}} \) or \( \sqrt[3]{1.0595/1} \). The correct ratio for any interval can be worked out, for example, if there is an interval of 8 semitones, the ratio is therefore \( \sqrt[3]{\frac{125}{125}} \) or \( \sqrt[3]{1.0595/1} \). The correct ratio for any interval can be worked out, for example, if there is an interval of 8 semitones, the ratio is therefore \( \sqrt[3]{\frac{125}{125}} \) or \( \sqrt[3]{1.0595/1} \).

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**THE RADIO CONSTRUCTOR**

**Effects With a Tape Recorder**

**Part 2.**

by F. C. Judd

General effects and sounds. Echo effects. Splicing and editing. Multiple recording.

With suitable equipment (see Part 1) multiple recording becomes a fairly simple problem. The writer's electric guitars have lent themselves well in this respect, as no microphones are used and the instruments are coupled directly to the recording amplifier. Because of this, room echo and microphone distortion are eliminated. The system may, of course, be used with non-electrical instruments and voices, in which case a microphone must be used.

Successful multiple recording and the production of effects can be increased by the number of recording heads, the flexibility and number of amplifier channels and tape speeds. The technique to be described, however, will be confined to the use of one additional recording head and a two-stage amplifier. (See circuit of Fig. 2, part 1).

As an example, take a recording of piano and two voices by the same singer. The first recording, of piano and one voice, is made at normal level and the tape run back to the start of the recording. The second recording head is connected via the auxiliary amplifier to a low gain stage for the singer's next part. Erase and recording head bias units are switched off, and for the purpose of monitoring rehearsal, the main recording head is also switched off. A headphone monitoring position must be available from the output of the recording amplifier. The tape may now be run through and checked for the new recording level and balance with the singer's second voice part.

The singer may also make use of one or two dummy runs for practice. When satisfactory, the live recording may be completed by switching on bias and recording head.

It will be seen from the diagram of Fig. 1 that the first recording is picked up by head No. 2, mixed with the second voice through the recording amplifier and the whole recording completed a little further along the tape. It will be appreciated that head No. 2 and the auxiliary amplifier must be capable of delivering good quality reproduction to the network. Make the initial recording with as little distortion as possible, and preferably at a lower level than normal. Special care to be taken to avoid picking up hum from stray fields, and careful screening of all jacks and sockets, switching and leads, is essential if good quality recordings are to be made.

Flexibility is the keynote of successful multiple recording, and this simply means extra switching and jack facilities so that amplifiers and recording heads may be interconnected ad lib. All the writer's equipment is interconnected by means of standard telephone jacks and sockets for amplifier connections and co-axial connectors for recording heads. Three or four tape speeds are also desirable.

Perhaps a brief account of how this equipment is used may be helpful; for example, a recording to give the effect of two or three pianos and two guitars plus echo chamber, etc. Three microphones were installed inside the piano, two of the crystal variety having a good overall frequency range and a third with a very limited bass response. A two-way foot-operated volume control was used to fade in either of the two crystal microphones or the one with the low bass response. The latter microphone was cut in, a pre-amplifier with plenty of treble boost so that the piano was made to record with a very high pitched sharp tone. At the same time, the pre-amplifier was being rapidly cut on and off with a free-running multi-vibrator to give a fast tremolo effect. Thus, by operating the foot control, highly contrasting tones could be obtained ad lib from one instrument.

By using different recording speeds, high...
speed arpeggio runs were superimposed on the original recording together with a bass-guitar background obtained by using an electric guitar playing the bass and chord sequence of the melody. A change over from one instrument to another is very effective and easily made by splicing separate recordings. The tempo, however, must be constant or it should be taken from the original recording.

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in line. A commercially made splicing block (the Bib) is available and this is recommended. Splicing should always be made with a diagonal cut and with the overlay on the outside of the tape when it runs from left to right, and on the inside when it runs from right to left. Temporary splices may be made with adhesive tape (cellophane) but this method of joining is not permanent. After a while the adhesive presses out from under the tape and spreads along adjacent layers. The result is tape sticking on guides and heads. The most successful method is that of cutting on the diagonal and overlapping as above and making the joint with E.M.I. joining compound. Strong, noiseless joints may be made by this method.

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**BOOK REVIEWS**

The eight sections deal with (1) diodes (rectifiers and detectors), (2) triodes (double-diode and double-diode-triode), (3) transistors and pentodes (including double-diode-pentodes), (4) output valves (triodes, pentodes and triodes), (5) frequency changers (harmonics, heterodyne, oscillators, and mixer valves containing triode oscillator sections), (6) combination valves (triode-pentodes, etc., for r.f. I.F., and a.f. use) (7) thyatrons, crystal diodes and transistors, and (8) cathode ray tubes (magic-eye indicators, and c.r.t. tubes for television and oscilloscopes). Each section gives details of alternative or near-equivalent types.

A good index enables one to ascertain quickly details of a particular valve, its service or CV No., and so on.

This very useful book covers a considerable number of current American, British and Continental valve types, although it is priced somewhat higher than most books of its type, the additional cost seems justified in many ways.

One criticism can be made: The difference between International Octal and Mazda Octal bases is not mentioned.

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**AN INTRODUCTION TO AMATEUR TELEVISION TRANSMISSION.** By M. W. S. Barlow, G7CVO. 30 pages, 34 diagrams and illustrations. Published by the author, and obtainable from him at 10 Barlow Place, Finch Avenue, Gl. Baddow, Essex. Price 3s. 6d., post free.

Michael Barlow needs no introduction as an authority on amateur television transmission, and this booklet he has produced reveals the great strides that he and other enthusiasts have made in their particular field of activity.

The booklet consists of reprints of articles that have appeared from time to time in the R.S.G.B. Bulletin. The circuit diagrams show that considerable simplification of circuitry has been achieved, which brings a complicated technique within the understanding of those who may not be familiar with the complex technical problems of picture transmission.

Although this absorbing field of development may be beyond the financial resources and technical ability of many amateurs, Barlow’s record does at least show that it is a subject that can interest professional and amateur worker alike. On reading this booklet through, one is left with nothing but profound admiration for the results achieved, and the enormous amount of work that has been devoted to the project.

W. E. THOMPSON

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**July 1956**

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**THE RADIO CONSTRUCTOR**

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Although this is but a small book in card covers, it contains a considerable amount of information and many graphs concerning germanium diode types OA71, 53 and 74. The book is of Dutch origin, but the diodes are the same types as those obtainable from Mullard, Ltd., in this country.

Three short chapters describe briefly the underlying principles of the device and some manufacturing processes, the characteristics, and general properties of diodes. Further chapters deal more extensively with applications such as rectification or demodulation. There is one chapter devoted to brief descriptions of several other applications such as rectifiers for high and low impedance sources, measuring instruments, video detectors, rf. filters, limiters, mixers, ratio detectors, pulse-shapers, interference suppressors, etc.

A fair amount of space is given up to very useful graphs concerning the diodes mentioned above, and there is an Appendix which deals with diodes for special applications, i.e., types OA81, 83 and 86.

Presented in the usual high standard of the Philips Technical Library, this book provides all the information likely to be needed on the diode types around which it is written.

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Not the least attractive feature of this rather unique valve data book is the manner in which the information for each valve type is presented in diagram form instead of the more usual tabulated data. The brilliantly-coloured edges to the pages in the eight sections into which the information is divided are not only nice to look at, but facilitate reference to data one is seeking.

The Introduction, printed in nine languages, reveals that a fair amount of thought has gone into the compilation of all the valve data.

The method adopted to present information is to show a typical circuit diagram for each valve type. On this diagram there are symbols, consisting of small circles, triangles and rectangles, in which are shown the usual values of currents and voltages, while associated components are given typical practical values. A base diagram is also shown.
A PORTABLE RADIO-TELEPHONE

by A. C. GEE G2UK

THE 160 METRE AMATEUR BAND HAS MUCH to recommend it as a "local net" frequency, whether as part of an R.A.E.N. organisation or solely for keeping in touch with one's local colleagues. The simplicity of equipment for this purpose gives it a big lead over that needed for the higher frequencies. The equipment described here was designed with a number of such uses in mind. As it was intended for R.A.E.N. service, operation from accumulators was essential. This feature also meant that the equipment could be used as a portable from the car or aboard a motorboat. Such use would undoubtedly mean that a variety of aerials might have to be used, so provision was made for this contingency. Long range was not required, neither was the ability to work weak stations through QRM, so a simple t.r.f. receiver appeared to be all that was required. The final circuit decided on was, therefore, a single stage crystal oscillator modulated by a three-stage modulator for the transmitting section, using an aerial coupling system which would resonate a wide variety of aerials, and a three-valve "straight" receiver.

Economy of battery consumption was desirable, and it was felt that operation from a 12-volt d.c. supply was likely to be the most useful. Accordingly, the valves and pilot light have been so chosen that they can be wired in series-parallel, i.e. only being supplied from a small rotary converter. Total d.c. consumption has thus been reduced to 1.5 amps at filament only on, 4.5 amps in the "receive" condition, 3 amps at "monitor" and 5.3 amps at "transmit." These ratings are all well within the capacity of a normal size 12-volt car battery.

Mullard miniature valves are used throughout, the transmitter line-up consisting of an EL41 as crystal oscillator, modulated by a second EL41, which in turn is driven by an EL91 and an EF40 as pre-amplifier for a carbon microphone. The receiver uses an EF91 as r.f. stage, an EF92 as detector and an EL91 as audio amplifier.

The various controls on the front panel are as follows: Two knobs between the meters are for the oscillator anode tuning and aerial tuning variable capacitors. Above them is the aerial socket. Beneath the right hand meter is the second/monitor/receive switch, and immediately underneath is the crystal selection switch control. On the left, just above the receiver tuning dial, is the knob controlling the potentiometer P, which determines the depth of modulation. The left of the two lower knobs is the receiver volume control, and that at the right controls the reaction. The microphone lead is connected directly to the appropriate terminals on the microphone transformer, passing through the panel via a rubber grommet.

The general construction and layout can be seen from the photos, and a detailed description seems unnecessary, as the location of the various components is not critical. In the model built by the author, a war surplus microphone type No. 4A is used. This is a carbon type and thus must be used with a small energising battery. After some experimenting, 1.5 volts was found to be all that was required, so a Vidor type No. L5040 battery was fitted as shown. A switch is provided in the handle of the microphone so that the battery can be permanently fitted at the back of the equipment and forgotten.

The transmitter-receiver removed from its case.

The complete radio telephone, with rotary generator power supply.

The Receiver

A persual of the appropriate circuit diagram will show that the receiver is, as already stated, a straightforward t.r.f., detector and audio amplifier line-up. Maxi-Q coils are used. Range 3 covering the frequency band required. In the author's model the octal plug-in types are used, and the figures shown in the circuit diagram indicate the appropriate pin connections. The blue colour coded coil is required for the r.f. tuning circuit, and the green type for the detector and reaction circuits. The two-gang variable capacitor of 370pF maximum capacity is a J.B. Miniature type. The I.F. choke in the anode of the audio amplifier valve is a midget 10H, 40mA type. The two variable potentiometers are also of the latter to be monitored. In this position the I.F. is applied to both receiver and transmitter and the aerial removed from the receiver. This monitoring facility is very useful for checking the modulation.

The complete unit is housed in a cabinet 8in wide, 7in deep, and 12in high, supplied by Philpotts Metal Works Ltd., Loughborough. Two aluminium chassis 6jin by 7in by 2in deep are also required. The layout of the front panel is clearly shown in the photographs and the lettering is done with "Panel Signs" transfers supplied by Data Publications Ltd., which much enhance the appearance of the completed transmitter/receiver.

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the midget type. The tuning dial is an Eddystone type 843 Vernier Slow Motion dial, which is coupled to the variable capacitor by a small Eddystone flexible coupler. The r.f.c. in the detector anode circuit is an Eddystone type 1066. The values of the other components are shown in the circuit diagram. Layout follows the usual practice. A small metal screen should be placed between the r.f. stage and the detector stage components, between the chassis, but no above chassis screening is necessary, as all valves and both coils are covered by cans.

The EL91 and the EF92 both take a filament current of 0.2 amps, so that they can be wired in series. The EF91 has a filament current of 0.3 amps and this should be wired in series with a 6.3 volt 0.3 amp pilot lamp. Both sets of filaments are then wired in parallel to the filament supply, so that the 12-volt battery supply can be used for filament heating.

The Transmitter

The transmitting section is also quite straightforward. The microphone transformer is fixed to the panel below the transmitting section chassis, the microphone battery being carried in a small clip-holder made up from strip aluminium. A metal screen divides the modulator section components from those of the oscillator on the underside of the chassis, but no above-chassis screening is needed. The oscillator anode coil L1 is wound on a 1/4 in diameter former. Approx-
mately 45 turns of enamelled wire of 22 or 24 s.w.g. tuned with a 250pF variable capacitor should tune to the 160 metres band.

Whilst this transmitter was built primarily for use as a local radio telephone, it can, of course, be used for c.w. and with a good aerial normal long-distance c.w. communication can be effectively carried out if the oscillator is keyed. Provision is, therefore, made for keying in the cathode circuit; a key click filter being wired in around the key jack J, which is of the closed circuit type. The modulation choke is a small receiver type of 10H, 90mA rating.

It is advisable to screen the lead from the potentiometer P to the grid of the EF91, and the 4.7kΩ resistor should be soldered right up close to the grid pin.

The EF40 and the EL91 both have a filament current of 0.2 amps, so they can be connected in series, leaving the two EL41's to be wired in series, thus enabling the 12-volt battery supply to be used for filament heating.

Aerial Arrangements

The only other point which needs mentioning is the aerial arrangement. In the writer's equipment, what amounts to a loading coil is mounted on top of the anode coil as shown in the photos. This consists of about 100 turns of 34 s.w.g. enamelled wire on a 1 in former, spaced to give a 300pF variable capacitor. With this, any length aerial from a 12ft whip to a fifty to sixty foot length of wire can be resonated. It is advisable to spend a

little time experimenting with the number of turns on L2 and the distance of the two coils from each other, using the length of aerial which will most frequently be used. The arrangement shown is that most convenient in the writer's case, but other readers may find a more conventional link coupling to a centre loaded whip or antenna tuning unit more convenient, in which case, of course, all that is required is a two-turn coupling link over the end of L1.

Send/Receive Switch Connections

A three-wafer, three-position switch is required for the transmit/monitor/receive switching mechanism. The aerial section has the first and second contacts joined and taken to the transmitting unit aerial connection. The third contact is connected to the receiver aerial.

The second switch section has the first and second contacts joined and connected to the

transmitter h.t. connection; the third contact is left blank. The third switch section has the first contact not connected, with the second and third strapped and connected to the receiver h.t.

Power Supply

As previously stated, the equipment is intended for operation from a 12-volt d.c. supply. The filaments are wired up in series/parallel so that they can be connected directly to the battery. The h.t. requirements are supplied by a small rotary converter. That used by the writer is a Type ZA 1517 (HT 31 Watt No. 1 Rec.). Input 11.5V, output 250V, 125mA. It is mounted on top of a small metal box 5in × 5½in × 3½in deep, which houses the smoothing components. It is worth while taking some trouble over this smoothing, for if well done, no hash whatever will be audible in the receiver. As can be seen from the circuit diagram, chokes and capacitors are provided in each h.t. lead and also in each h.t. lead, together with, in the latter case, a pair of 16μF electrolytic capacitors—a single double-section type being used in the design shown, together with a smoothing choke. The smoothing choke, together with the chokes and capacitors in the leads, were obtained from a type 104 Power Unit (10K/238). These are, of course, designed specifically for this purpose. Similar components from any other small surplus rotary would do just as well. The general

arrangement of these components and the rotary itself is well shown in one of the illustrations. Two double-pole on/off toggle switches are provided, one acting as "main" switch to rotary and filaments, the other switching on the rotary itself.

With an h.t. supply of 250 volts, the equipment draws about 25mA in the oscillator anode circuit, thus giving quite a reasonable input for "top band" use.

The two meters shown are surplus voltmeters reading 0–20 volts d.c. and 0–40 volts

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removing the internal resistor and replacing with a shunt across the terminals; the shunt being wound up from a short length of resistance wire, the exact length of which was chosen by experiment, so that the meter reads mA instead of volts. The original "volts" marking on the dial was blacked out with India ink and the new "volts" and "mA" signs put on the meter glass with "Panel Signs" transfers (Set No. 3).

This small portable radiotelephone has been extensively used by the writer for a year or more, and has given the greatest satisfaction in all respects. It has been operated portable from a car and also aboard a Broads motor cruiser, when good contacts on both phone and c.w. were achieved. It is regularly used for local "top band" schedules, running off a 75 amp hour accumulator which is trickle charged, the whole thus making an ideal emergency communications unit.


The new part should be read in conjunction with the recommendations for all electronic valves contained in Part 1 of the Code of Practice which was published in 1954 together with Part 2.

Part 3 gives information, additional to that in Part 1, on photo-cells, transmitting valves and cold-cathode gas-filled valves; and on the more common aspects of the use of electronic valves, such as: ratings, mountings and temperature.

Specific aspects of the subject of which the following are examples, are also dealt with: modulation-frequency response and relative spectral-response for photo-cells; means of ventilation and cooling for transmitting valves; and ionization and de-ionization in cold-cathode gas-filled valves.

Reference is made in the document to the possibility of danger arising from X-radiation from valves operating at high voltages.

Copies of the standard may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. Price 3s. each.
From Fig. 1 and the above short description, it will be noted that the whole aim of the design has been to produce an efficient but, at the same time, a simple receiver capable of being built by the average home constructor in a few hours and with the minimum of trouble.

Construction Details

Before dealing with these in detail, it would be as well to consider several points which are of some importance if the best possible final results are to be achieved.

When handling the Ferrite rod aerial, great care should be taken at all times—one sharp tap is sufficient to fracture and break the rod.

Component wiring should be kept as short as possible and all components should be neatly placed, as shown in the various drawings featured herewith.

The construction of this receiver is divided into four parts, the last part also including the alignment instructions. It is assumed in the following that the kit of parts has been obtained from a dealer and the reader is ready to assemble and construct the receiver.

Stage 1

Mount all components as shown in Figs. 3 and 5, ensuring that all nuts and screws are tightly fitted.

Mount potentiometer R6 on the right-hand side of the chassis.

Fit the four valveholders, taking care that pins 1 and 7 are correctly positioned, and at the same time fitting 6BA solder tags under the valveholder screws.

Insert the three grommets G1, G2 and G3. Next fit the 5-way tag strip. Mount the output transformer T1 on the top of the chassis.

View showing layout of chassis, etc., in cabinet

It is advisable for the home constructor to use resin cored solder throughout and to ensure that all soldered joints are carefully made. Most manufacturers of kits have found by experience in the past that some 90% of the failures of equipment built at home are caused through badly made joints—and very dry ones at that!

Fit two ¾ in 4BA screws through the chassis for the trimmer block and secure in position with two nuts on each. Join the four tags of the trimmer block marked “60” together and leave about 2in of wire free. Having done this, secure the trimmer block to the two screws with 4BA nuts and one solder tag as shown in Fig. 3. The side of the trimmer
block marked “69” should be nearest to the edge of the chassis.

Mount the two i.f. transformers (the pin numbers are clearly marked on the bases [see Fig. 1 for these connections]) and, at the same time, fit 6BA solder tags as shown in Fig. 3.

Fix the Medium Wave coil (red) on left-hand side and the Long Wave coil (blue) on the right-hand side, the slots to be orientated as shown in Fig. 2.

Next fit the gang condenser C1-C2 to the bracket as shown in Fig. 2, with 4-in 4BA screws, and follow this by fixing the bracket to the chassis with 6BA nuts and screws.

Position and secure the wavechange switch S1.

Wiring Instructions

Connect pin 7 of V1 to pin 7 of V3 and thence to tag 4 of the tag strip. From the same tag, connect to pins 1 and 7 of V4 and to pin 7 of V5.

Solder the metal centres of V1, V2 and V3 to pins 1 of their corresponding valveholders and from thence to the earthed solder tags fitted under the valveholder screws. Wire the centre of V4 likewise to pin 5 and to the solder tag of V4. Connect tag 4 of S1 to tag 3 of the Long Wave coil.

Connect tag 6 of S1 to TC1 and tag 5 of S1 to TC2. Wire pole C of S1 to C1 (rear section of ganged condenser), via grommet G1. Pole D of S1 is next wired to C2 (front section of ganged condenser), via grommet G2.

Next, tag 2 of the Medium Wave coil should be wired to TC3 and pole A of S1 to tag 2 of S1. Follow this by soldering tag 2 of the Long Wave coil to TC4 via a length of wire. Continue by connecting pin 2 of V1 to tag 4 of IFT1. Pin 6 of V2 now goes to tag 1 of IFT1.

Connect R1 between pin 6 of V1 and tag 1 of the tag strip. Solder C9 between tag 1 of the tag strip and tag 3 of the same strip. Connect pin 2 of V2 to tag 4 of IFT2.

Wire R4 between tag 3 of IFT2 and tag 3 of IFT1, and connect C8 between tag 3 of IFT2 and the metal centre of V5. Connect R2 between tag 3 of IFT2 and pin 2 of V3. R2 is now wired from pin 6 of V3 to the solder tag on V3. R8 is next connected between pin 4 of V3 and tag 6 of IFT3.

C4 is next fitted between pin 4 of V3 and the solder tag on the near side of V4. The next step is to connect R3 from tag 6 of IFT1 to pin 3 of V2. Follow this by soldering pin 2 of V2 to the right-hand tag of R6. Next, connect the left-hand tag of R4 to the solder tag of V4 and follow this by connecting the loose lead from the trimmer block direct to the solder tag under the fixing nut.

Solder pin 3 of V3 to tag 1 of IFT2.

This now completes stage 1 in the construction of the receiver. Below are listed the component parts for this stage.

**COMPONENTS**

**Stage 1**

**Resistors**—all ½ watt

| R1 | 470KΩ |
| R2 | 12KΩ |
| R3 | 2.2MΩ |
| R4 | 100kΩ |
| R5 | 1MΩ pot with D.P. switch |
| R6 | 4.7MΩ |
| R7 | 4.7MΩ |

**Capacitors**

| C1 | 0.1µF, 250V wkg |
| C2 | 0.1µF, 250V wkg |
| C3 | 75pF, SM or Ceramic |
| C4 | 100pF, 63V or Ceramic |

**Repanco punched chassis**

**Repanco I.F. Transformers type MSE**

**Repanco Miniature O.P. Transformer**

**Repanco oscillator coils types RO1 and RO2**

4-pole, 2-way switch

**B7G Valveholders**

**Twin-gang 500pF variable condenser, Jackson type "L" (C1 and C2)**

4-band trimmers, Cyldon (TC1, TC2, TC3 and TC4)

Nuts, Screws, Solder tags, etc.

**Stage 2**—Wiring Instructions

Having carefully checked the wiring of stage 1, we now proceed to wire up stage 2 as follows, carefully comparing the instructions given below with Fig. 4.

Solder tag 3 of the Medium Wave coil to tag 3 of S1, and pin 3 of V1 to pole B of S1. Connect C8 between pole D of S1 and pin 4 of V1; follow this by wiring C9 between pole C of S1 and pin 6 of V1.

Carefully solder R2 between pin 4 of V1 and pin 1 of V1. Next, wire into position C3 between tag 1 of the Medium Wave coil and the earthed tag of the trimmer block (see Fig. 4).

Insert and solder C4 from tag 7 of the Long Wave coil to the earthed tag of the trimmer block. Connect tag 2 of the Medium Wave coil to tag 7 of S1. Wire tag 2 of the Long Wave coil to tag 8 of S1 and follow this by connecting tags 6 of IFT1 and IFT2 together.

Solder tag 6 of IFT1 direct to tag 2 of the tag strip, tag 3 of IFT1 then being connected to tag 1 of the tag strip. Wire C6 from pin 3 of V5 to the earthed tag of IFT2. R8 is now being connected from tag 6 of IFT2 to pin 5 of V5.

Between pin 5 of V5 and pin 6 of V4 solder C12 into position, following this by wiring C11 between pin 5 of V5 and the earthed solder tag of the same valve. Connect pin 3 of V4 direct to tag 2 of the tag strip, following...
Can Anyone Help?

W. J. Temple, 56 Oakfield Road, Altrincham, Cheshire, asks if anyone can give him a source of supply for a 3/4-watt neon indicator lamp, candleabra base (screw) used in a Supreme Tube and Battery Tester, model 504A, made by Supreme Instruments Corporation, Greenwood, Mississippi, U.S.A.

B. N. Wade, 408 High Road, Chilwell, Nottingham, wishes to buy or borrow the circuit and details of the Murphy V110 12in.t.v. receiver.

J. Bailey, 38 Consort Avenue, New Malden, Surrey, wishes to obtain, on sale or loan, the circuit of the Puratone television model T-14 on the Raymond chassis F60.

G. A. Maclachlan, c/o 14 Mannfield Avenue, Ballybride, Sliringshall, would be very grateful for any information on a transformer coded AC724-10K/975, from a 62 Inch Unit.

J. E. Brown, c/o Brookhouse Farm, Doxey, Stafford, requires a service sheet or circuit details, which he is willing to purchase, of a Baird portable a.c. t.v. receiver.

Cpl. J. Chinnick, R.A.M.C. Billet, Porton Camp, nr. Salisbury, is in need of the circuit of the Test Set 31, ref. 10SB/57.

G. Norton, 14 The Flats, Wiltshorpe, Bridlington, asks if anyone can supply any details of the circuit, modifications etc., of the Amplifying Unit type 445, serial 10J16575.

J. R. Blackburn, 58 Pen y Dre, Rhivhns, Cardiff, asks if anyone can supply servicing data for a Ferguson 272RG.

W. Hurford, 120 North End House, West Kensington, London, W.14, wishes to buy the circuit and data of a polyphonic electronic organ.

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

BRIAN V. TEECE, "Tryphena," Pen-y-Maes Avenue, Rhyll, N. Wales, would like any information regarding the conversion of any ex-WD apparatus to use as radio, t.v. or oscilloscopes, especially the RDF1 and 62 Units.

G. F. Walker, 19 Burrelgh Avenue, Wallingford, Surrey, wishes to buy or borrow the circuit of the Stromberg-Carlson "Command" Receiver type CFC-46104, 1.5-3.0 Mc/s.

T. Park, 28 West Lane, Middlesbrough, will willingly pay for the circuit and details of the Philco TV receiver model BT.1753C, especially on the valve line-up and on the width controls.

Alec M. Jones, Ashville College, Harrogate, Yorks, wishes to obtain the circuit of the Beethoven Major SG4.

C. Harrington, 9 Sheldon Avenue, Vicars Cross, Chester, requires information on the ex-Govt. receiver R1448.

L. G. Hutton, 29 Elmstead Avenue, Marston Green, Birmingham 33, will gladly reward anyone who can supply information, circuit data and, if possible, modifications for the Stromberg-Carlson aircraft radio Tx type CFC.52211, frequency 7.91 Mc/s.

M. H. Hague, 36 Gladstone Terrace, Grantham, Lincs, wishes to buy or borrow the circuit and information on the Kolster Brands 12-in T.V. model E.V. 30B.

J. A. Cusden, Hillcrest Nurseries, Polegate, Sussex, desires the circuit of the Invicta T.V. model 815, particularly details of the line sync separator (EFO), frame sync separator (EFO) and h.t. rail voltage.

W. R. Williams, 31 Alexandra Street, Ebbw Vale, Mon, urgently needs service data for the Alba D.C.56 receiver (SP20, VP20, SP20, PEN3520 and Barretter).

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USING V.H.F. ACORNS

by F. G. RAYER

ACORN VALVES ARE AVAILABLE FROM many surplus stockists at very low prices indeed. This, combined with their small size, high efficiency, and particular suitability for H.F. operation, makes them exceedingly useful for a number of purposes. The 955 triode and 954 pentode are most suitable, and have 6.3V, 0.15 amp heaters. They can thus be operated from a 6.3V heater transformer, in parallel with other 6.3V valves, or in series, for 0.15 amp circuits, as in normal a.c./d.c. procedure.

Pin connections for the 955 are shown in Fig. 1, the valve being viewed from the top, or larger end. Stray capacities are exceedingly low, and the central position of the cathode pin also helps in reducing induced hum to a very low level, even on high frequencies. The 955 has a maximum anode voltage of 180V, maximum anode current of 7mA, and amplification factor of about 25. Primarily intended for detector or oscillator positions, it can be pressed into service in 1st a.f. stages, in small sets, or may be employed in b.f.o. stages, or as detector or oscillator in small S.W., V.H.F., or all-wave receivers.

The 954 pin connections are given in Fig. 2. This valve has maximum anode and screen grid ratings of 250V, 2mA, and 100V, 0.7mA, respectively. A negative control grid voltage of −3V is usual.

The valves can be fitted into ring type holders, but these are not easy to obtain (Paxolin holders may be obtained from R.C.S. Products Ltd.—Ed). It would be feasible to make such holders, or an alternative is to use small wire clips, taken to the pins, the valve being supported in the wiring. These methods avoid soldering.

It is also practicable to solder the valves directly to the circuit wiring, but care is essential or the glass seal will be broken by the heat. To solder the valves successfully, a really hot iron is necessary. An electric iron that has been allowed to reach full temperature is suitable. Connecting leads should not be stouter than 20 s.w.g. and a small loop should be clipped to the extreme end of the valve pin. Thin core solder of the kind intended for radio connections (i.e., relatively low-melting point) can then be applied to the end of the pin, simultaneously with the heated iron, and removed immediately the joint is made. It should not be necessary to keep the iron in contact with the live pin for longer than one second. Long glaciation will render the valve useless for the reason above. If the pin is held between joint and valve by thin-nosed pliers, this will help to keep heat travelling to the seal. Once leads have been soldered on, they can be suitably cut and shaped, and no further soldering at the valve pins is required.

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Circuits

Though the valves will operate well down to half a metre or so, this naturally does not mean they are unsuitable for normal frequencies. They can be used successfully upon any frequency, provided the power to be handled is small.

A simple v.h.f. detector is shown in Fig. 3. A dipole is most suitable, but a short wire aerial of unspecified length, with earth connection as indicated by the dotted line, can be used. Exact frequencies tuned will naturally depend greatly on stray capacity, but the following coils will be approximately correct for the bands given:

- 2-3½ metres, 6 turns 14 s.w.g. 1½ in diameter.
- 3-5 metres, 7 turns 14 s.w.g. 1½ in diameter.
- 5-10 metres, 12 turns 14 s.w.g. 1½ in diameter.
- 10-15 metres, 16 turns 14 s.w.g. 1½ in diameter.

A tuning condenser with low minimum is required, and very short direct wiring. The 100kΩ potentiometer is for regeneration control.

The use of an r.f. stage reduces radiation of interference, and maximum efficiency arises when this stage is also tuned. A suitable circuit is shown in Fig. 4. With home-wound coils, separate tuning condensers are best, to avoid ganging difficulties and possible inefficiency from lack of alignment.

Standard type S.W. coils can also be used, for wavelengths down to 10 metres. In this case, it is best to use a conventional detector circuit for these frequencies, not the super-regenerative type shown in Fig. 3. The circuit in Fig. 4 is also satisfactory in all-wave sets. The valve is not very suitable for later circuit positions, such as in an i.f. stage, because of the ease with which it may be overloaded.

A B.F.O. Stage

The small size of an acorn, and its low current consumption, makes it suitable for inclusion in an existing receiver, for such purposes as a beat frequency oscillator. Here, the valve and all components may be included in a small i.f. transformer can, and a circuit is shown in Fig. 5. This can use the triode, or pentode type wired as triode, or operated as a pentode, this being unimportant.

L₁ is the b.f.o. coil, and can consist of one winding from an i.f. transformer of the same frequency as found in the i.f. amplifier—usually 465 kc/s. The cathode tap will require to be only about 3 turns from the earthed end, and can be made by winding on a few extra turns of thin insulated wire. If oscillation does not arise, the winding must be reversed. With some i.f. coils a tapping can be made on the existing winding, though this is not always easy.

For a note of 1,000 cycles, the b.f.o. is tuned above or below the i.f. to this extent. C₁ may be the usual i.f. coil trimmer, fixed if the component used has an adjustable core. C₂ can be a small variable condenser, panel operated through an extension spindle, of about 25 or 50pF maximum capacity. Once C₁ is suitably adjusted, the note can be modified by operating C₂.

Very tight coupling is not helpful, and may increase background noise, so that the coupling capacity to the detector diode needs to be very small. A 0-4pF air-spaced Philips concentric pre-set is suitable, here. If the note is unsatisfactory, the stage is oscillating too strongly. The number of coil turns between cathode and earth may be reduced, or the 50kΩ resistor increased in value, to correct this.

Complete Circuit

A circuit particularly suitable for 10-100 metres is shown in Fig. 6. It may operate phones direct, or an output stage can be added, for speaker reception. As with the other circuits, an h.t. line voltage of about 150 to 250V is satisfactory. If the circuit is used as it stands, battery operation is
possible, though these valves are not primarily intended for the purpose, so that a 6V accumulator is desirable for filaments, the total of 0.45 amp being a little heavy for dry cells, except for intermittent use. In such cases, a 120V h.t. battery is satisfactory. For mains operation, a small mains transformer, with half-wave rectifier, will be suitable.

For short wave purposes, 160pF tuning condensers are satisfactory. With this value, the following coils can be wound:-

9-17m. 4 turns. Cathode tap at ½ turn.
16-31m. 7 turns. Cathode tap at ¼ turn.
30-61m. 16 turns. Cathode tap at ½ turn.
60-105m. 31 turns. Cathode tap at 1 turn.

These are all on 1in dia. formers, with 24 s.w.g. wire except for the smallest coil, which is of 20 s.w.g., and occupies ¾ in winding length, the other coils occupying 1½in. The r.f. stage tuned winding will be exactly similar, but with no cathode tap. For aerial and anode coupling, 2, 4, 6, and 12 turns respectively can be used on the coils, interwound with 32 s.w.g. silk-covered wire at the earthed end of the tuned section.

For v.h.f. purposes, tuning values of 15 to 25pF will be more satisfactory, with small self-supporting coils soldered directly to the tuning condensers, or inserted in pin connectors fitted thereto. If the set is to be used on M.W. and L.W., then the by-pass condensers should be increased from 0.01μF to 0.1μF. The variable screen grid control for the first stage is optional. For speaker output with modulated valves, it is highly desirable to replace the a.f. stage by a type more suitable for the purpose in view, such as a 6V6, with 240 ohm bias resistor, 50μF bias condenser, and output transformer for 5,000 ohms at 50mW. This will give sufficient volume from the more powerful stations.

In service types, the 954 is designated the VR95 and V121, the 955 being the VR59 and VT121. The 957 triode requires special mention, as it has a 1.25V, 0.05 amp directly heated filament, and would be at once damaged if used in error in a 6.3V, 0.15 amp heater circuit.

In a circuit with plug-in coils and r.f. stage, it is usually convenient to have a vertical screen between stages, and the r.f. valve can be arranged with its grid pin projecting through a hole in this, when high stability can be expected. On wavelengths below 15 metres, a condenser of about 0.005μF may be wired from each heater circuit to chassis, to by-pass r.f.

The Radio Constructor

**RIGHT**—From the Start

**INTERFERENCE**

*by A. P. Blackburn*

**PART 7.**

Anyone who has gone "station hunting" on their radio receiver will be familiar with the interference between stations. Those annoying strains of music breaking into the programme are one of the thorns in the side of the perfect radio communication. Although familiarity with the effect may now have made it seem a matter of common sense, the reasons for it are seldom suspected.

In the last article, we saw that a particular signal could be selected by a tuned circuit. The question of how well that tuned circuit rejects all the unwanted signals was not touched upon.

This is a very important question, particularly nowadays, when all wavebands are so crowded. As always, before we come to the point, another aspect must be introduced first.

**Sidebands**

The first question is: why should two stations interfere? If station A has a frequency of 200 kc/s, and station B a frequency of 202 kc/s, why should one of them not be completely rejected by a tuned circuit tuned to the other? The reason is twofold.

First, a modulated signal of frequency, say, 200 kc/s, has other frequencies associated with it which are dependent upon the modulation, and second, the amount of acceptance or rejection of a tuned circuit depends upon how close in frequency the wanted and unwanted signals are.

To deal with the first point first, a modulated signal contains "sidebands," the frequency of which depend upon the modulating frequency. For example, if our 200 kc/s carrier were modulated with a steady 500 c/s tone, two other "signals" would appear, 500 c/s either side of the carrier, their amplitude depending upon the depth of modulation, i.e. how much the carrier amplitude was varied by the modulation.

The three frequencies would, therefore, be 200 kc/s minus 500 c/s, or 199.5 kc/s, the carrier at 200 kc/s, and 200 kc/s plus 500 c/s (or 200.5 kc/s). The first of these (199.5 kc/s) is called the "lower sideband" and the last (200.5 kc/s) the "upper sideband." Fig. 1A illustrates this diagrammatically.

Now, a complex musical sound, such as an orchestra with many instruments producing many frequencies simultaneously, will give rise to a large set of sidebands. The highest frequency present in the sound will produce the pair of sidebands displaced furthest from the carrier frequency. Fig. 1A illustrates a possible sideband group for such a sound. Audible sounds may have frequencies up to 16 kc/s or so. To transmit such a sound, a pair of sidebands 16 kc/s either side of the carrier will be produced. This means that no other station can operate nearer than 16 kc/s to the first station without danger of interference. If the second station also has sidebands of up to 16 kc/s, it cannot operate closer than 32 kc/s to the first station.

In practice, broadcast stations limit the highest frequency they transmit to somewhere in the region of 8 kc/s.

**Selectivity**

The second point concerns the operation of the tuned circuit. If it is to accept the signal with all the sidebands and no other signal. Unfortunately, the natural law of things has not made tuned circuits very efficient in this respect. Fig. 2 shows a signal and sidebands and the shape of the ideal tuning "response." The term "response" here means what happens to the output of the tuned circuit at various frequencies. The response just fits nicely to the sidebands and lets them all through, but immediately outside this range, nothing is passed through the circuit. Also, within the response area all frequencies receive equal treatment; that is, all are passed with their original amplitude. Fig. 3, however, shows the sad state of affairs really is. Curve A is a highly "selective" tuned circuit which just passes the outer sidebands and increasingly favours those nearer the centre or carrier frequency.
This means that the higher sidebands, and therefore the higher frequencies, will suffer some attenuation relative to the lower sidebands nearer the carrier. Curve b shows a relatively unselective circuit. Here the higher sidebands are not attenuated so much as before, but any unwanted signal occurring at A or B will also be passed through. The sharpness of this type of response curve shows the "selectivity" of the circuit.

This then is the choice. With a single tuned circuit, if high selectivity is used as in Fig. 3 curve a, the high frequencies in the modulation will suffer (the upper octave on a piano, for example, would be lost); and if a low selectivity circuit is used, there is a danger of interference from other transmitters.

Now to examine the coil itself a little closer. The wire with which it is wound must obviously have some resistance. The resonant L and C circuit operates by storing energy in the coil, passing it to the capacitor, which in turn passes it back to the coil and so on, back and forth. The frequency with which the energy is transferred is the resonant frequency of the coil. Every time the energy passes from coil to capacitor, current flows around the circuit, and some energy will be lost in the resistance of the coil. If there were no losses, such as resistance anywhere in the tuned circuit the energy would oscillate back and forth for ever, once it had been excited.

The operation is very much like a pendulum. If it is swung in air it will continue to oscillate for a considerable time, but due to air resistance and so forth it will finally come to rest. If the pendulum were now placed in treacle, it would come to rest very much sooner. The former case is analogous to a high-Q circuit and the latter to a low-Q circuit.

It is clearly desirable to keep the resistance of the coil in the tuned circuit to a minimum. It is not the resistance alone which decides the Q of a coil, however. The inductance comes into it also, as can be seen from the expression for the Q of a coil:

\[ Q = \frac{f_0}{f_2 - f_1} \]

To take an example, if \( f_0 \) were 1 Mc/s, \( f_1 \) 0.995 Mc/s and \( f_2 \) 1.005,

\[ Q = \frac{1}{1.005 - 0.995} = 100. \]

This is a fairly high Q circuit. What this signifies is that the response of the circuit is 0.7 times that at resonance when a signal 5 kc/s away from the resonant frequency is applied to it. The higher the Q value, of course, the better the selectivity obtainable.

\[ Q = \frac{2\pi f L}{R} \]

where \( f \) is the frequency, \( L \) is the inductance and \( R \) the resistance.

So much for the tuned circuit on its own. Unfortunately, it is not much use on its own; other things have to be connected to it. These limit the useful Q of the circuit. In Fig. 4, for example, the aerial and crystal are connected, and these introduce extra losses into the circuit. The aerial is always less, therefore, than the theoretical value of the circuit on its own.

\[ Q_{\text{value}} = \frac{2\pi f L}{R} \]

"regeneration." A circuit which uses this is shown in Fig. 6. Basically, the circuit is a leaky grid detector fed from the tuned circuit L1C1. The aerial is coupled into L1. So far this is a normal detector. We saw when dealing with detectors that some r.f. "ripples" is still left on the audio after detection. This will, therefore, appear in the anode circuit of the valve and the coil L2 will couple some of it back into the tuned circuit. The variable capacitor C2 controls how much is fed back, and therefore controls the selectivity. This scheme has the advantage that it improves the selectivity at the same time as it improves the sensitivity of the receiver. If too much energy is fed back into the tuned circuit, oscillation will occur. This is the condition that occurs when sufficient energy is fed back to cancel the losses in the circuit completely. To revert to the pendulum for a moment, oscillation is analogous to giving the pendulum a little tap every now and again, so that
it will swing for as long as you care to tap it.
If reaction has to be applied too close to the point of oscillation, it becomes very
difficult to control, so it is still desirable to
have a fairly good tuned circuit even with
reaction.

A typical straight receiver may consist of a
detector alone, or a detector and output stage,
and very frequently an r.f. stage, detector and
output stage.
The latter two types make very satisfactory
receivers. The sensitivity of a receiver with
only a detector and output stage is limited,
but is quite suitable for listening to the three
B.B.C. medium wave stations. If reaction is
used, the selectivity is adequate.
Generally, a fairly good aerial must be
used, but this depends to some extent upon
location.
With an r.f. stage added, the sensitivity is
sufficient usually for Continental stations,
only a detector and output stage is limited,
but is quite suitable for listening to the three
B.B.C. medium wave stations. If reaction is
used, the selectivity is adequate.

The Straight Receiver
There are two types of receiver in common
use today—the straight and the superhet.
The straight is what we have been leading up
to so far, the superhet will come later.

Long Waveband Addition for the
High-Q Pre-set Push-Pull Two

by J. E. BLOOMER

I

constructed this receiver from the
article by Mr. J. W. Bagwall in the Decem-
ber issue of this magazine, and must
congratulate the designer on a really remark-
able little set.
The coil was home-

wound on a Neosid
former with 36/47 Litz
wire and a "Q" of about
400 was obtained, which
accounts for the wonder-
ful performance. There
was one snag, however,
when using the set in the
Midlands Area, and this
was that the Light Pro-
gramme on Medium
Waves tended to fade
badly and was a very
unreliable signal.
Consequently, I de-
cided to incorporate a
loading coil to bring the
Light Programme in on
the Long Waveband,
which is a very good sig-
nal here. The diagram
shows how this was done
with the minimum of trouble and expense.
All that is needed is a single-pole make
and break switch and a coil covering the
Long Waveband. The end of the Medium
Wave coil is broken where it joins the
reaction winding, and the two ends are
joined to the switch which is shunted by
the Long Wave coil.

It is not essential to have a high-Q loading
coll, and any long wave coil can be used
for the purpose.
The operation of the switch will bring the
coll into circuit on either of the trimmers
1 and 2.
I now have my trimmers set for the Long
Wave Light programme, Medium Wave
Midland programme, and Third Luxembourg.
All these stations come in at great
volume, and the quality amazes all who
listen to it.
**Radio Miscellany**

The number of readers who have written on points in connection with small wind-driven generators came as quite a shock, but I have finally got round to answering them all individually. Unfortunately, as far as I know, there have been no constructive articles dealing with any specific design as all the mechanical components are not normally available. It is a case of improvising with whatever bits and pieces can be scrounged or otherwise acquired. Even if suitable parts were ordinarily available, the price would be almost prohibitive. All the amateur-built wind-generators I have seen, or heard described, have been constructed from ex-car or motorcycle generators picked up from the breaker’s yard at bargain prices, plus sundry bits of ironmongery to provide the motive power. The wind-wheel can easily be cut from sheet metal, as can the “tail” required to keep it heading into the breeze.

**Centre Tap**

<table>
<thead>
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<th>Talk about</th>
</tr>
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<tbody>
<tr>
<td><strong>Wind-driven Generators</strong></td>
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<td><strong>Radio Terms</strong></td>
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</table>

The arm and mast can readily be made up from light tubular metal, but to bring the drive down from the wind-wheel to the generator it is necessary to calculate the amount of mechanical ingenuity and skill. It would, of course, be a comparatively simple job by means of pulleys and an endless belt if it were not for the fact that the head has to revolve with the wind. True, the generator could be mounted on a platform designed to rotate with the mast, but this would involve virtually frictionless bearings requiring all-weather protection.

Fortunately, the drive required by a small generator can be lightened and made more reliable by flexible cable, sheathed and regularly greased; but, again, extensive weather protection is essential. The construction of such an arrangement calls for more than average mechanical knowledge and workshop facilities.

The design of a wind-driven generator thus boils down to individual experiment according to the material available, but if any reader has discovered a simple method of getting round the difficulties with parts the average man might obtain with reasonable luck, I shall be pleased to hear from him.

**Personality**

A popular weekly recently contained an article analysing the personalities of followers of six major hobby interests. Working on the premise that our characters guide us to the hobby, we are apparently easily “typed.” As I read it I began to wonder about my fellow hobbyists, not only those I meet but also the occasional correspondent. The rough and ready division—the musical

Philatelist were found to be the best adjusted and happiest of fellows, so if you collect stamps as well as possessing a leaning for music and radio construction your wife (or girl friend) is a lucky woman. Personally, I haven’t collected stamps since my school-days although I was once a keen collector of QSL’s, but that was before years ago. I get hot under the collar when I didn’t get a 100% response, so even at my best I wasn’t out of the top drawer—and I must have deteriorated since then, as nowadays I don’t collect anything much at all.

**The Name’s the Same**

The London Evening News has for a long time held on to a reputation for its coverage of news of the amateur radio movement. Perhaps it has not been so noticeable in recent months simply because there has been a dearth of “hasty” news in that line, but at all times the reportage (despite the garbled accounts on technical items which one often finds in the popular Press) has been accurate. Amateurs must therefore have been surprised to read that following the visit of B. & K. Russian amateurs were now using the “OC” call (a mistake for CQ, appearing three times) instead of the mysterious WSEM which they have been using for a number of years now.

No one seems to have discovered what the letters WSEM stand for—and I have still not heard a plausible guess.

In an RFC paper recently carried a story of GJWJ’s colour t.v. transmissions. A reference in the headline re “T.V. Hams” mentioned that the form Ham waylay’s discouraged. Indeed, an appeal was included for suggestions for a better term—apparently without response. The word Ham implies clumsiness, awkward amaturism, bad-acting, ham-fistedness or worse. Years ago I campaigned for its discontinuance, a campaign in which I was vigorously supported by Dr. Arthur Gee, G3UK, then Editor of the Short Wave News. Our campaigning had some good effect and the term was rarely dropped.

There is, of course, no harm in speaking amongst ourselves or even of one another as Hams, but it seems quite another connotation when disparagingly used to describe the follower of a scientific hobby by outsiders. Amateur radio has already lost enough of its prestige without being further cheapened by a name which infers a slight.

**Flock Spraying**

My appeal for the experiences of readers who have sprayed the insides of radio and speaker cabinets with flock as a means of damping out resonances, brought in several interesting letters. They are unanimous in agreed that it has proved effective in cases where the volume level is limited to a few watts, such as in the normal domestic receiver. Even a thick spraying is inadequate for levels of about six watts upwards.

Mr. P. Inho of Chingford Road, Waltham- stow, E.17, in writing and confirming this opinion mentions a helpful 84-page book on various types of spraying published by Leonard Brooks Ltd., of 25 Harold Road, Rochester, Essex. It is post free.

Mr. Inho also praises the efforts of The Radio Constructor Staff and reports that he built an amplifier recently described in current publications. It is intended for use with Audion 60 and the performance is equal to the costlier commercial amplifiers. His good wishes to the staff have been passed on to those concerned. It is nice to know your work is appreciated, and it provides the incentive to put just that extra bit into it that keeps your magazine lively and as fresh as a new coat of paint.

**Hints on the Use of Perspex**

*by J. A. CUSIDIN*

Where the decorative appearance of any piece of home constructed “gear,” whether electronic or otherwise, is a matter of high expenditure entailed in the use of Perspex, then it is worth the energy of proper finishing. Those amateurs who have not experienced of this material may be interested to learn that in addition to being clear it is also available in many colors, including delicate pastel shades, and in sheets of varying thickness.

It is easily worked with light hand tools, the normal way of cutting a straight edge being with a sharp hobby knife or the specially made-over popular miniature version, but taking care to use a blade with the least number of teeth per inch. The rough edge so left is cleaned up with first a fine file, and then with the finest grade of emery or glass paper. This leaves the edge with a very smooth but matt surface which may be polished if desired, or else the polished surface is regained by repeatedly polishing with ordinary metal polish used in the customary manner. The polished surface will not scratch vigorously whilst the polish is still wet, allow to dry, and then rub off. This will also remove any scratch marks to a deep.

In both the cutting and the polishing operations, due care and attention is exercised that excessive heat is not generated, as this can start melting the Perspex.

The small pieces left over are very useful for insulators for power and audio frequency circuits and even for the lower radio frequencies; but it is advisable to use test instruments where losses could not be tolerated, in spite of the outward similarity between colourless Perspex and Polystyrene.

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JULY 1956
The rather unusual title this month may come as a surprise in the middle of the summer holiday season, when it is to be hoped that fine weather has put snow very much out of mind. But when applied to a television picture this term, which originated in America, is used to describe the scintillating noise pattern which is frequently seen to mar t.v. pictures. With the increasing number of t.v. sets in use, the service areas of both the B.B.C. and I.T.A. transmitters have been stretched to their utmost, with a result that many sets are expected to operate on a very low signal level for at least one of the two signals. Under these conditions the general background noise becomes apparent on the picture as the signal-to-noise ratio is low. This noise appears as a very fine discontinuous pattern on the screen, and gives the impression that the scene is being enacted in a very fine snowstorm. This unwanted interference is usually generated within the set, and is equivalent to the hiss which is heard from a sensitive radio receiver when it is operated at maximum gain. The trouble is yet more pronounced in a colour television receiver when noise appears as a speckled pattern of coloured dots, for which the word "confetti" has been chosen in America.

The noise generated within the circuit of a television receiver may be divided into two categories, Shot noise and Johnson noise. The former starts within the valves and is due to the high velocity electrons which form the anode current actually striking the surface of the anode. This may be likened to the noise produced by allowing sand to fall upon a tin plate. The magnitude of this noise naturally depends upon the current Ia which is flowing in the valve and is given by the equation:

\[ i = \sqrt{2eaI_bk^2} \]

where \( e = 1.59 \times 10^{-19} \) being the charge in coulombs of an electron
\( B = \) bandwidth over which the noise is effective in cycles per second
\( k = \) a constant whose value depends upon the proportion of the total available cathode emission which reaches the anode. \( k^2 \) is usually about 0.05.

The second type of noise which we are concerned is Johnson noise, which is present in all resistors. It is sometimes known as thermal agitation noise because it is due to the random movement of electrons in the resistive elements. Its magnitude depends upon the value of the resistance and the temperature of it, and is given by the formula:

\[ e = \sqrt{4kTB} \]

where \( K \) is a constant and equals 1.38 \times 10^{-23} \( T \) is the temperature (absolute scale) and \( R_\text{N} \) is the resistance in ohms.

It will be seen that both noise formulae take into account the bandwidth of the receiver. This is because the noise is distributed over an infinitely wide band so that the more narrow the pass band of the set is made, the less the noise which will be accepted.

Now let us consider which are the resistors in a t.v. set which can cause the noise. Under the worst conditions the noise level will be in the region of a few microvolts, so we are only concerned with that which appears in the grid circuit of the first valve. In other parts of the circuit the signal level is sufficiently large to completely swamp locally generated noise. Figure 1 shows the resistors which appear in the grid circuit of the first valve, but as they are not all actual resistors they require some explanation. The aerial circuit has a fixed resistance, usually about 80 ohms, which after a noise level at the anode which is equal to the shot noise. The values of \( R_\text{A} \) and \( R_\text{E0} \) depend upon the type of valve chosen; lately it has become common practice to employ a triode in the first stage of a t.v. set because it enables the best results to be obtained over a large number of channels. The values for \( R_\text{A} \) and \( R_\text{E0} \) depend upon circuit and coil design and require very careful attention.

Summary
Before concluding this short discussion upon the factors which govern the generation of noise, it is worth while considering the practical application of the information given above. These may be summarised as follows:

1. Choose a suitable valve for the first stage. The chief requirements are low noise level and high mutual conductance. Double triode valves such as the PCC84 and 6807 are frequently used nowadays in the cascode type of circuit such as indicated in Fig. 2.

2. The design of the aerial transformer requires careful consideration. For example, if the turns ration of \( L_1 \) and \( L_2 \) (Fig. 2) is made too large the reflected resistance \( R_\text{A} \) will be high and consequently the noise will be increased. Also, because of mismatching the signal level will be decreased. On the other hand, if the turns ratio is made too low, the
TRADE REVIEW

The latest TC-431 Ediswan Clix Crocodile Clip offers something new in such components. Brass-plated for easy soldering, it is made of single-piece spring steel for strength, adaptability and maximum electrical contact. The Clip has been designed so that plugs and pins both English (3mm) and Continental (4mm) can be plugged into the respective rings, leaving the jaws free for clipping. In the double-folds, spade plugs can be slipped in easily when required; again leaving the jaws free. Behind the teeth, wide jaws allow clipping over the valve caps.

NEXT MONTH: Miniature Crystal Frequency Standard
by W. E. THOMPSON, A.M.I.P.R.E.

The sensitivity of the receiver will be adversely affected.

3. Input circuit losses must be reduced to a minimum to keep the value of $R_L$ down.

4. Noise is generated by all stages in a receiver, but by virtue of the low signal level only that in the first stage is generally troublesome. However, in a receiver which has a sensitivity control varying the gain of the first stage, it is advisable to work with the gain set as high as possible and the contrast control down to avoid trouble with second stage noise. In observing this the signal level at the second stage is kept reasonably high, thus providing a good signal-to-noise ratio.

5. If a receiver is operated at the limit of its sensitivity but still gives a weak noisy picture, a pre-amplifier may improve matters. The required improvement will only be obtained, however, if the noise factor of the pre-amplifier is better than that of the receiver. This point is frequently overlooked and accounts for the disappointing results which are occasionally reported in the use of pre-amplifiers. In the next issue we hope to describe the method usually used to measure receiver noise, as only by the direct comparison of figures can the performance of one set be assessed against that of another.

DESIGN CHARTS FOR CONSTRUCTORS

No. 7 INDUCTANCE-CAPACITY-WAVELENGTH CHARTS
MEDIUM AND I.F. RANGES

by HUGH GUY

CONTINUING with the series of four design charts for interpreting wavelength in terms of the required values of inductance and capacitance and vice versa, we come this month to two charts which can conveniently be covered in the one issue. They are charts dealing with the Medium Wave band, from 150 to 700 metres, and the I.F. band, from 450 to 1,500 metres.

All the charts in this series operate on the same principle, and this was covered in full detail in last month’s issue. It will suffice here, therefore, to give examples on the use of the charts only, and to assist in this respect on each chart dashed lines appear outlining the steps involved in getting from a value of wavelength to the appropriate values of inductance and capacitance.

(4) To determine the value of capacitance with which a known value of inductance will tune to a specified wavelength.

The first use and last two uses are almost identical in operation, while the second is merely the reverse of the first.

Now a word about the individual charts.

Medium Wave Chart
The capacity range covers values from 30pF to 2,000pF on the inner scale and 300pF to 0.02µf (i.e. 20,000pF) on the outer scale. The inductance scale reads from 100µH to 1mH (i.e. 1,000µH) on the inner scale and 10µH to 100µH on the outer scale. Note that the inner scales should be read in conjunction with one another, and similarly the outer scales.

<table>
<thead>
<tr>
<th>Chart</th>
<th>Waveband Coverage</th>
<th>Frequency Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Waves</td>
<td>1 – 20 m</td>
<td>300 – 15 Mc/s</td>
</tr>
<tr>
<td></td>
<td>10 – 200 m</td>
<td>30 – 1.5 Mc/s</td>
</tr>
<tr>
<td>Medium Waves</td>
<td>150 – 700 m</td>
<td>2 Mc/s – 428.6 kc/s</td>
</tr>
<tr>
<td>I.F. Band</td>
<td>450 – 1,500 m</td>
<td>666.7 – 200 kc/s</td>
</tr>
<tr>
<td>Long Waves</td>
<td>450 – 6,000 m</td>
<td>666.7 – 50 kc/s</td>
</tr>
</tbody>
</table>

Each and every chart has four uses:
(1) To determine suitable values of inductance and capacitance for a specified wavelength.
(2) To determine the wavelength to which a tuned circuit comprising known values of inductance and capacitance will tune.
(3) To determine the value of inductance with which a known value of capacitance will tune to a specified wavelength.

The “Key Line” on this chart occurs at the bottom of the graph, coincident with 10 and 100µH.

The example in dashed outline will now be used to illustrate the operation of the chart.

Example 1
Determine suitable component values for a circuit to tune to the Light Programme on 247 metres.

JULY 1956
The intersection of the value of wavelength corresponding to 247 metres with the "Y Line" is dropped vertically to the "Key Line." Through this point a diagonal line is drawn parallel to the printed diagonal lines. Any values of inductance and capacitance crossing on this line will give the required component values. For example, actually on the "Key Line" itself we see that 100μH and 173μF could be used; alternatively, at the same point the outer scales show that 10μH and 1730μF, would produce the same wavelength.

Similarly it is seen that 300μH and 57.5μF would also produce the same result. This then covers the first use. The third and fourth uses follow quite naturally from this point.

If the value of capacitance being used to tune the wavelength to 247 metres was fixed at, say, 100μF, then the required inductance is seen to be 173μH.

If instead an inductance was available of value, say, 250μH, then the necessary capacitance value is seen to be 69μF.

The second use is given in the next example.

<table>
<thead>
<tr>
<th>Unit</th>
<th>microfarads</th>
<th>millimicrofarads</th>
<th>picofarads or micro-microfarads</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYMBOL</td>
<td>μF</td>
<td>mμF</td>
<td>pF's or μμF's</td>
</tr>
<tr>
<td>QUANTITY</td>
<td>1 =</td>
<td>1000 =</td>
<td>1,000,000</td>
</tr>
<tr>
<td>0.001 =</td>
<td>1 =</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>Henrys</th>
<th>millihenrys</th>
<th>microhenrys</th>
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<tbody>
<tr>
<td>SYMBOL</td>
<td>H</td>
<td>mH</td>
<td>μH</td>
</tr>
<tr>
<td>QUANTITY</td>
<td>1 =</td>
<td>1000 =</td>
<td>1,000,000</td>
</tr>
<tr>
<td>0.001 =</td>
<td>1 =</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

**Example 2**

Determine the wavelength to which an inductance of value 300μH and a capacitance of value 100μF will tune.

The intersection of these two values is located, and a diagonal line traced through this point back to the "Key Line." In this example the two values intersect on an existing diagonal line, making the task easy. Invariably, however, this does not occur and the reader may either draw the required diagonal line lightly in pencil, or interpolate the appropriate intersection at the "Key Line." Having got this far, a vertical line is drawn (or visually traced) to intersect the "Y Line," the point of intersection being referred to the wavelength scale where the resulting value may be read.

In this example, which is not shown in print on the chart, the wavelength is found to be 325 metres, an error of less than 1%.

**I.F. Band Chart**

Since the use of this chart is exactly the same as that of the Medium Wave chart, it will suffice here merely to use the "dashed" example as a guide. This chart covers the range 450 to 1,500 metres, all of which will be included in next month's chart covering the Long Waves.

**Example**

Determine suitable component values for an intermediate frequency of 465 kc/s.

**Hints and Tips**

**Reducing Hum in Midget Sets**

In midget sets there is often a considerable background hum produced by the output stage. This may easily be checked by shorting the grid of the output valve to chassis. If the hum is still there, it is almost certainly being fed into the screen grid (gs), which in this case is acting as a control grid. The source of this hum is the h.t. line, and the hum may, of course, be removed by decoupling. However, the most economical method is to take this feed from the decoupling circuit of the previous stage. The circuit diagram gives typical values.

**A Useful "Breadboard" Chassis**

The illustration shows a method of making quick tests on circuits. A number of valveholders of various types are mounted upside down, so that all wiring is easily accessible. The heater circuits and various earthing points are wired carefully and the chassis is then ready for a "hook-up." The following valveholders could be usefully mounted:—two octal holders with pins 7 and 8 connected to the heater circuit; two octal holders with pins 2 and 7 connected to heaters and pin 1 earthed; two B7G holders with pins 3 and 4 connected to heater circuit and pin 6 earthed; and two B9A holders with pins 4 and 5 connected together to one side of the heater circuit and pin 9 to the other side.

The chassis should be made of tinplate so that wires may be soldered directly to it.

A few tag panels should be mounted at convenient points, and potentiometers may be fitted to the sides. A convenient size is 7in square for the top and 4½in for the height.
Scottish Insurance Corporation Ltd

62-63 CHEAPSIDE LONDON E C 2

Television Sets, Receivers and Short Wave Transmitters are expensive to acquire and you no doubt highly prize your installation. Apart from the value of your Set, you might be held responsible should injury be caused by a fault in the Set, or injury or damage by your Aerial collapsing.

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ADDRESS (Block letters) ____________________________ /JB
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First published in the March and April 1956 issues of this magazine, this high quality tuner-receiver has aroused considerable interest. In this reprint the text has been revised and enlarged, and additional diagrams, including a map of present and projected coverage areas, have been included as a result of suggestions by readers.

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