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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.

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

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No. 83. A SINGLE VALVE FM TUNER

It frequently happens, in the altering scene which is inevitable in a rapidly
advancing science such as that of electronics, that individual developments are liable to
become relegated to the background even when they deserve especial attention on their
own merits. The circuit which is described this month tends to fall within this class,
insofar that it represents an f.m. tuner which caused some noticeable interest in the United
States in 1947 to 1949, but which, so far as the writer is aware, has since occasioned very
little comment. It is, of course, possible that the particular time when the circuit appeared
may have some bearing on the fact that it is now so little-known. In this period, f.m.
broadcasting in the States was becoming uneconomic under the conditions of commercial
broadcasting which were then applicable. Public interest was swinging towards television, and the demand for high
fidelity reproduction—which could have given a fillip to the f.m. medium—was limited.

At the same time, f.m. broadcasting in Europe was practically non-existent, and the design
received scant publicity outside the States.

Because of these facts, it seems that the one-valve f.m. tuner circuit which forms the basis
of this month’s contribution has been given an undeserved lack of attention. To the
writer’s mind, the tuner employs such ingenious circuitry that it deserves recognition on
this score alone, and the fact that it also provides an intriguing field of investigation
for the more serious experimenter makes its inclusion in this series all the more desirable.

The Circuit

Before proceeding to a description of the circuit itself, some details of its source should be
given. The circuit is due to R. D. Loughlin, and was produced by the Hazeltine
Corporation as the FrEModyne receiver. The circuit employs a single ECC81 (12AT7)
and provides an audio frequency output at a level normally associated with superhet
receivers. There are two references to the design which may be available to readers,
and these are quoted at the end of this article.

The circuit accompanying this article is that of the Hazeltine FrEModyne receiver in
full; with the single exception that the original 300Ω input circuit has been changed to one
more suitable for 75Ω operation. In the 300Ω version the coupling coil, L1, is not
employed. One conductor of the 300Ω aerial feeder connects directly to chassis (at the
bottom end of L2), whilst the other connects to the top end of L2 via a 2pF condenser.

Apart from coils and chokes, which are discussed later, all the components are
standard. It is advisable to commence an examination of the circuit by first considering the oscillator,
V1(a). This triode, which is half of the ECC81, functions as a superhet local oscil-
lator and runs at 22 Mc/s above the input signal frequency. If the oscillator circuit is
analysed it will be found that it is basically a v.h.f. Colpitts, the only difference to the
version normally encountered in such things as television tuners being that the anode of
the valve is at chassis potential so far as r.f. is concerned, and not the cathode. Provided
that it covered the frequencies required and developed sufficient oscillator amplitude, any
other oscillator circuit could be employed in place of that shown. The oscillator voltage
is fed to the grid of V1(a) via the 2pF condenser C9.

A signal voltage, built up across the tuned circuit, L2-C1, is applied to the grid of V1(a)
in addition to the oscillator voltage. As will be seen shortly, V1(a) is switched on and off at
a supersonic frequency, with the result that, for part of the time, the valve operates in a
non-linear fashion and mixing between the

OCTOBER 1957
oscillator and signal frequencies takes place. The oscillator is off-set from the signal frequency by 22 Mc/s, with the result that the amplitude of this value appears at the anode of \( V_{1(0)} \) and also functions as a self-quenched super-regenerative detector. The Off-set 22 Mc/s frequency, then, is the quench frequency. The detector is an off-set 22 Mc/s, with a grid frequency 22 Mc/s, and with a quench frequency of approximately 30 kc/s. In this mode of operation the valve emits electrons. In this case, the tuned circuit, one end of which connects directly to the anode, whilst the other is applied to the grid via the choke L\(_1\). This choke offers a high impedance at the v.h.f. frequency, but has low impedance at 22 Mc/s. The grid of the triode is, so far as 22 Mc/s is concerned, at chassis potential, the cathode being isolated by means of choke L\(_2\). It will be noted that the cathode of \( V_{1(0)} \) taps into the centre of the capacity tuning L\(_c\). Insofar as the super-regenerative action proper of the circuit is concerned, it is rather different to visualise the CR network which causes quenching, due to the various capacities connected to the grid of \( V_{1(0)} \). However, it would probably be valid to consider C\(_9\)-R\(_4\) as the quench CR, the quench frequency being considerably increased by reason of the factor that R\(_4\) is returned to h.t. positive. (This connection to h.t. is probably necessitated by the positive cathode of \( V_{1(0)} \). If R\(_4\) were returned to chassis the super-regenerative would not start.) Working as a super-regenerative detector tuned to 22 kc/s, the i.f. circuit is capable of achieving a very high degree of sensitivity, with a considerable scope for the more experienced constructor.

Discrimination of the 22 Mc/s frequency modulated i.f. signal is achieved by its conversion to a.m. on the side skirts of the i.f. response curve and subsequent detection. The response curve given by the Modyne circuit has skirts which are very linear when considered in terms of db against frequency deviation, and which give a selectivity of the order of 20 db per 100 kc/s. In consequence, a relatively high level of amplitude modulation, at frequencies above those of the i.f. frequency deviations normally encountered in v.h.f. transmitters.

The a.f. output of the super-regenerative detector is taken from the cathode of the triode, it being built up across the detector load R\(_1\). This a.f. is then filtered by R\(_9\) and C\(_{10}\), and is finally passed on to the subsequent amplifiers. The response curve of the circuit with the feed to the a.f. amplifier is desirable if the latter is likely to be affected by the small d.c. component present.

Experimental Details

As was mentioned at the beginning, the Hammarlund has considerable scope for the more experienced constructor. At first sight the coils would appear to present some difficulties, but closer examination shows that they need not be so. Examining the aerial input circuit, it will be noted that all of the L\(_4\) and L\(_5\) is that they allow a signal voltage of good amplitude to be built up across the tuned circuit. The input coils could, therefore, very probably consist of reasonably high-grade components. The selection of the frequency deviations is achieved by the choke L\(_2\) to be dispensed with.

L\(_5\), the super-regenerative coil, is also not so "awkward" as might be thought at first, the theory being that any 262 kc/s, in the case of the Modyne circuit by the fairly low value resistance for 22 Mc/s of 15 k\(\Omega\). This point assures that the constructor could employ any reasonably high-Q coil. At this point, altering the value of R\(_5\), if necessary, to sharpen up or flatten off the 22 Mc/s response curve.

The two chokes L\(_4\) and L\(_5\) may require a little experiment. The purpose of L\(_5\) is that of offering a high impedance at 22 Mc/s, and a conventional commercial component should cope here. L\(_4\) is intended to offer a high impedance to v.h.f. and a low impedance to 22 Mc/s, and may require some development work before it is finally satisfactory. It would probably be advisable, when initially putting the circuit into working order, to concentrate primarily on the 22 Mc/s super-regenerative section. To get this part of the circuit functioning correctly, the local oscillator, \( V_{1(0)} \), may be ignored, the 2pF condenser C\(_3\) being left temporarily out of circuit. In addition, L\(_2\) could be temporarily replaced by a resistor of some 75\(\Omega\), and the output of an amplitude modulated signal generator set to 22 Mc/s connected across it. When the super-regenerative circuit was satisfactorily tuned to 22 Mc/s and a faint hum audible, the v.h.f. section could then be brought into operation.

References

"However, once the initial slow introductory period has been overcome, I should imagine that the use of printed circuits will increase with rapidity. We are probably nearing the end of the initial period at the present moment, and I wouldn't be at all surprised to see the second phase come fully into being in 1958. So, although set manufacturers are probably not making much money at present by the introduction of printed circuits, they are still pressing on with them, albeit rather slowly, in the hopes of better things to come.

"Anyway, let's forget the manufacturer for the moment and get down to the service point of view, you have just raised the question that the introduction of printed circuitry may reduce the amount of work coming into the service shop, whilst I said that it would probably bring more in. I think it would be valuable at this point if we were to consider first of all just exactly what a present-day printed circuit does. An average contemporary printed circuit consists, quite simply, of an insulating board with a copper foil pattern which replaces the wiring of a conventional chassis. Because of this, the printed circuit board merely obviates conventional wiring, whereupon the only fault condition which has been deleted is that of breakage or shorting. It occasionally happens that a conventionally-wired receiver leaves its factory with a component connected to a wrong tag, and yet still manages to give a fairly good output. Printed circuit boards would prevent wiring mistakes of that type. However, manufacturing faults in this class are very few and far between, and their absence would make very little difference to the total amount of work handled by the serviceman.

"Well, that seems to be a reasonable argument, commended Dick. "What about cold joints and things like that?"

"I can't see printed circuits drastically reducing the number of cold joints in a set," replied Smithy. "And, here again, you have to face the fact that the number of cold joints in a conventionally wired chassis is not, in any event, very high these days. Don't forget that printed circuit components have to be soldered to the copper foil, and I would have thought that the risk of cold joints here is just as high as when the components are soldered to tags. Indeed, the risk may even be higher, as it is not quite as easy to solder to a flat piece of copper as it is to a tag around which there is an insulation. Of course, much printed circuit soldering will be done automatically, but this fact is not, to my mind, likely to reduce the number of cold joints encountered.

"So far as the overall reliability of a printed circuit set is concerned, you must also remember that it employs just the same components and valves as are used in conventionally wired chassis. It is these which cause the majority of failures, wherein it becomes irrelevant whether any particular component is stuck to a printed board or hung between two tags."

"You said just now," reminded Dick, "that printed circuits might actually increase the work we have to do. How do you justify that?"

"Well, I may have been gazing into the crystal ball rather deeply there," admitted Smithy, "although, on the face of it, events would seem to point that way. First of all, the inevitable result of printed circuits will be an increase in production, although this may not become evident for a number of years. Increased production, when it comes, means more sets are made to go wrong, and more sets to be passed on to the serviceman. Secondly, printed circuits may introduce one or two snags on their own account, such as lackness between conductors through the board, and so on—again more jobs for us! Time alone will tell what faults may arise from the use of printed circuits, but I would be very surprised if they introduced none at all. I suppose that I am being rather pessimistic in making such a statement. I have never looked only on the bright side of things!"

Practical Servicing

"I'll keep my fingers crossed for the future, then," Dick said. "In the meantime, have you anything after printed circuit servicing you could pass on?"

"Well, printed circuit servicing is all very straightforward," replied Smithy, "so long as you pay attention to several common-sense rules. The main thing to avoid is the use of brute force methods on the printed board itself. This applies particularly to soldering operations. Although the copper foil adheres very strongly to the insulated board it can come unstuck, and especially so if you apply too much heat. So any soldering operations which are needed have to be carried out quickly and carefully. Sometimes the copper foil is covered with a varnish, and as this may have fluxing properties it does not always need to be scraped away if you intend to make a joint. You can always check the properties of any varnish you may find by making an experimental dab with the iron in the centre of a large earthing section—most boards have large areas of copper at earth potential—to see how quickly tinning occurs. This quick test gives you more information than the use of a wire or brush on the circuit elsewhere. Remember, by the way, that the service manual should give you the best method of soldering to the board, and this should be consulted always."
"Whenever you make a joint to a board, it is best to use a miniature iron which is well tempered. In most instances the only time you should ever have to apply an iron to the board is when you suspect a cold joint between a component lead-out wire and the copper foil. Nine times out of ten, the mere application of the iron, without any solder or flux, will be enough to make the joint serviceable. A good idea consists of melting a little cold solder on to the tip of the iron and of shaking this off again just before applying it to the foil. This idea will ensure that the iron tip has a minimum of oxide, and that a quick thermal connection can be made to the solder in the suspect joint. Cold joints on printed circuit boards are fairly easy to find, by the way, as they frequently have an 'obvious' look about them. Usually, you will find that the solder collects in a blob around the component wire, instead of spreading nicely over the surface of the copper foil; or that, although the solder has spread over the copper, the component lead has the unmistakable appearance of not having 'taken.' Light, repeat light, taps on the components will usually make a cold joint show up as an intermittent. It is advisable to check for a cold joint by moving a component bodily back and forth over any great distance unless it happens to have thin lead-out wires. Rough movement of the component can cause the copper foil on the other side of the board to be strained, whereupon it may become torn away from the board. The lead-out wires on almost all resistors and many condensers fall within the 'thick' category; and these components are those which should not be moved around too violently."

"How do you replace faulty components on a printed board?" asked Dick.

"The best way," replied Smithy, "is, whenever possible, to cut the existing lead-out wires and solder the new component to these. There is a good reason for this particular policy. In most printed boards, component leads are clinched over in manufacture before soldering. Like this (Fig. 1 (a)), where you can see a cross-sectional view of a lead-out wire from a resistor soldered to the copper foil. Now, if you try to replace the component by simply unsoldering it from the board, you would find that you would have to keep the iron on the joint for quite a long time before you could straighten out the wire and pull it through its hole. This may cause overheating of the board. Sometimes, the lead-out wires aren't clinched over, being merely inserted straight into the holes in the board (Fig. 1 (b)). Even here it is preferable to avoid trying to unsolder the wires at the board; although the risk of overheating is much less in this case, since the wires can be pulled through their holes more quickly. Don't forget that, after unsoldering at the foil, the appropriate holes in the board will be full of solder, and this can be a nuisance at times. As I said just now, therefore, in order to overcome these snags the best plan consists of clipping the lead-out wires of the faulty component as close to its body as you can (Fig. 1 (c)), and then soldering the new component to those leads (Fig. 1 (d)). Even here repair of this nature can be made to look quite neat, incidentally, and it gives just as good results as did the previous connections to the copper foil itself."

Fig. 2 (a) Whilst servicing printed circuits, excess solder may accidentally bridge adjacent conductors
(b) A break in a printed circuit conductor
(c) The break of (b) bridged by a thin wire.
(d) An alternative, and somewhat safer, method of bridging the conductor break

Fig. 2C

you need to be fairly quick in order to prevent the heat travelling down the cut leads and loosening the joints at the copper foil. A

"It sounds to me," commented Dick, "that the thing to avoid in printed circuit servicing is the printed panel itself!"
"That's true enough," Smithy replied, "and you soon find yourself evolving new techniques for preventing damage. Sometimes, soldering directly to the copper foil becomes inevitable, of course, and there are some errors which you then have to take particular care to avoid. The worst one is that wherein the solder runs, perhaps because of a defect in one conductor and bridges over to the next (Fig. 2 (a)). The only way of overcoming this state of affairs, if you're ever unfortunate enough to have it happen to you, is to turn the board upside down—so that the solder is underneath—and, with the soldering iron applied, tap the board so that the excess solder falls off. You should never try to break the soldering joints by scrubbing the surface, with a penknife or a screwdriver. If you do this you may pull away the copper foil as well as the solder, and you are almost certain to break the skin of the insulating board as well. The latter could then become water absorbent at that point, and might later become leaky.

"Occasionally, due to careless handling, plus, perhaps, a thin section of foil, part of the circuit becomes broken (Fig. 2 (b)). If this happens, you may be successful in bridging over the gap with a piece of thin wire (Fig. 2 (c)). Both the wire and the copper should be approximately the same size before you make the joints. If the conductor happens to be very narrow at the point where the break occurs, or if the conductor is very close to it, it would be more advisable to make the junctions at points where the conductor widens (Fig. 2 (d)). Usually such widening will occur at connections to components, whereupon you already have the copper nicely tinned for you. A further solution is given by the fact that, since the conductor is almost bound to connect to components on either side of the break, you might then be able to connect your bridging wire between their lead-out wires above the board.

"Up to now, we have concerned ourselves with the soldering and component replacement problems. Are there the major troubles to expect with printed circuits?"

"They are, mainly," replied Smithy, "Most of the other snags you are likely to encounter are those of fault location, which apply equally to conventionally wired chassis. Before I finish I should point out that there are one or two precautions to take when working with printed boards. For instance, you should avoid using a soldering iron whose bit is heavily laden with solder near the board, as you then run the risk of dropping blobs of solder on to the components, and this may be quite difficult to get off again. Other undesirable things, such as paste flux—which you shouldn't use on printed boards in any case—between conductors may also cause a lot of trouble.

"A final point to remember about printed circuits is that they are liable to warp somewhat with age and heat. So, if a particular receiver employs a large board, you should keep an eye open just in case severe warping in service has caused any connection to become strained."

Another Problem

Smithy finished speaking and left Dick to ponder over the points he had just discussed. After a few moments, the Serviceman addressed his assistant once more.

"Well," he remarked, "I think we've had enough nattering for one day. Even so, though, I cannot help but be tempted to waste just a little more time before returning to the grindstone. So I'm going to set you a little problem.

"Oh no," protested Dick. "Not another 'hocus-pocus' effort, please!

"I'm sorry," continued Smithy mercilessly, "but my mind's made up. Our last problem proved to be very popular, and I think we should have a repeat performance. This time the whole thing is extremely simple indeed, and you should be able to give me an answer in two minutes. Are you ready?"

"Fire away," said Dick, resignedly.

"Well," the problem concerned a friend of mine who was walking past a Government surplus radio shop one morning, when he saw a large sign in the window which said: 'Buy warping in service has caused any connection to become strained.'"

"Could you tell me what condensers are in your bargain parcels?" he asked the salesman.

"Well," replied the salesman, 'each parcel is the same and each has four condensers in it. What is more, the values of all condensers are expressed in whole numbers of microfarads. That is to say, any condenser could be 1µF, 2µF, 3µF or any other number up, there being no fractions or decimals.'

"If I see,' replied my friend; 'could you give me more information?"

"Certainly, sir," said the salesman. "The product of the condenser values in each parcel comes to 36.'

"That still doesn't help me," commented my friend.

"Well," continued the salesman, 'the sum of their values is equal to the date next Tuesday.'

"My friend looked at the number indicated on the calendar by the assistant.

"I'm sorry, but I'm still not satisfied," he said.

*In Your Workshop, May, June 1957

A Photo-Sensitive Transistor

IT HAS BEEN KNOWN FOR SOME CONSIDERABLE time that germanium possesses photosensitive properties, but not until very recently has any real use been found in its application. The term 'photo-electric' is a familiar one and is used in describing a phenomena in which the movement pattern of electrons in a material is changed quite appreciably by the application of light to the material. Usually the amount of energy which the photo device can control is quite small, so that it has to be followed by a valve amplifier or perhaps a gas-filled trigger valve; in either case the purpose is normally to open or close a relay depending upon the intensity of the light falling on the photocell. A new type of photocell has now been introduced and is known as a "phototransistor." It does, in effect, combine the properties of the photocell with those of a transistor amplifier so that a remarkably high order of sensitivity can be achieved. In fact, the sensitivity is such that it can be made to operate a conventional type of relay without any additional form of amplification. Like most types of semiconductor diodes and transistors on the market today, the phototransistor employs a germanium element which has been found to possess excellent photo-sensitive properties. This has led to some rather queer results being obtained by experimenters using transistors, and it is worth digesting for a moment to describe an effect which may have already puzzled some constructors.

In a laboratory, engineers were working to test a new fully transistorised amplifier which differed from the normal run of amplifiers in that it had been developed with special care to give high fidelity reproduction. Now the results obtained were very good, but the performance was marred by a strong 100 c/s hum. It was naturally assumed that the hum was being picked up from adjacent mains wiring; but careful screening, and indeed even shorting the input terminals, did little to help. This was very disappointing, as it had been assumed that one of the advantages of employing transistors was that complete freedom could be obtained from mains hum, a defect which so often haunts the hi-fi constructor. Then one of the engineers switched off the fluorescent lighting in the laboratory and immediately the hum ceased, as it had, in fact, been caused by the photosensitivity of one of the transistors in the equipment. All forms of lamp, whether of the filament or discharge type, will flicker at mains frequency, and although persistence of vision renders this invisible to the eye, it does exist.

The applications of the phototransistor are very similar to those of any other form of photocell, namely automatic door opening, burglar alarms, counting and batching, machine protection, etc. For all these devices the mode of operation is basically the same—a beam of light is caused to fall on the cell, and when interrupted a relay in the cell circuit is energised. Other applications are..."
found in sound film reproduction, but it is in the classes already mentioned that the phototransistor excels because of its much greater sensitivity. The first example of this type of cell to appear in England is that made by the Mullard Company under the type number OCP21. Its physical size is extremely small by comparison with the more conventional type of cell, being only 15 × 5.9 mm. This, coupled with a very simple circuit, enables a high degree of miniaturisation to be achieved.

A typical circuit suitable for most of the on/off applications which have been listed above is shown in Fig. 1. It will be seen that the emitter-collector circuit of the transistor is joined in series with a relay coil and battery. The current which flows in this circuit will be dependent upon the light falling on the cell and the ambient temperature in its vicinity. The inclusion of this latter factor may come as a surprise until it is remembered that all germanium devices are temperature sensitive. In the phototransistor the effect of increasing the working temperature is to increase the dark current; this has the effect of reducing the ratio of light to dark current with increasing temperature. The effect can be minimised by connecting a resistor between base and emitter as shown in the diagram, a value of 6.8 kΩ being a good compromise; too low a value will reduce the sensitivity to changes in light level.

One of the advantages of the phototransistor is that its high sensitivity enables a normal type of relay to be employed. A typical 25 mW, 5000 ohm relay will be quite suitable for the job, as it will have a pull-in current of some 1½ to 2 mA, whereas the photocell will provide some 4 mA under light saturation conditions. If the use of a relay having a coil resistance other than that recommended is contemplated, care should be taken not to exceed the maximum collector dissipation of the phototransistor. To overhear the germanium pellet can permanently ruin the characteristics of the cell. The maximum dissipation on the collector will occur when the cell is in the half-switched-on condition, that is when the current is midway between the minimum and maximum values. The collector dissipation under this condition is calculated by taking the product of half the total current and half the supply voltage, and this should not exceed 25 mW.

Some knowledge of the dark current may be useful, particularly in those applications where a beam of light is used only occasionally to switch on the cell for a short period of time, as under such conditions a low capacity battery may be employed to give an almost indefinite life. At 25°C the dark current can be expected to be in the region of 50 µA.

The spectral response curve of the phototransistor is shown in Fig. 2, from which it will be seen it is most sensitive to light at the red end of the range. Knowledge of the response curve is useful in those applications where light of a given colour is used to operate the cell to reproduce the interference from ambient illumination. Normally, all that is necessary in the way of a light source for normal switching applications is a small torch fitted with a reflector and conical lens focusing a beam of light on to the cell. A good idea of the sensitivity of the system is obtained from the fact that if a 2.5 V bulb is under-run at 1.5 V, the light from the dimming glowing filament when focused on to the cell will operate it at a distance of several centimetres.

The Vision I.F. Strip

The circuit of the vision i.f. strip and video output stage is given in Fig. 4. As may be seen from this diagram, the circuit design is fairly conventional in character, well-tried basic principles being employed. The intermediate frequencies handled by the strip are 16 Mc/s vision, and 19.5 Mc/s sound. The coils specified are available pre-aligned, incidentally, thus obviating the necessity for adjustments after construction.

Not shown in Fig. 4 is the turret tuner, this being treated in these articles as a separate unit. The turret tuner immediately precedes the vision i.f. strip, its output at i.f. being fed directly to pin 6 of the Input Coil. Pin I of the Input Coil connects to the grid of the first i.f. amplifier valve V2; whereupon the coil functions as the inductive element of a pi filter, its tuning capacities on either side being given by the C8 of the first i.f. amplifier and the capacity to chassis of the lead from the turret tuner. An EF80 is employed as first i.f. amplifier in order to take advantage of the high input resistance which this valve offers.

The anode of the EF80 connects into the first I.F. Coil, thus providing a partial bandpass response by the use of a coupling winding in series with the primary. This coupling winding is fitted close to the secondary, and the overall arrangement has the advantage of providing a more closely controlled coupling factor for different core settings than is given
by the more usual transformer assembly wherein primary and secondary are separate coils spaced away from each other. Also connected to the anode of the EF80 is a take-off lead feeding into the sound i.f. strip. As will be gathered, the EF80 carries out the dual functions of sound i.f. amplification, whilst the remaining valves in the strip are concerned with handling the vision i.f. signal only.

The second i.f. amplifier valve, V3, follows the first I.F. Coil, and consists of an EF50. As was mentioned in last month's issue, the use of readily obtainable valves which are still 'current,' whilst also being available through ex-Government channels, is part of the policy behind the design of the Mayfair. Where such valves have no detrimental effect on performance their inclusion in the circuit confers the obvious advantage of saving in cost. An EF50 is a very good choice for the second i.f. amplifier, and, in practice, performs very well in this position.

In order to maintain a stable input capacity for V4 during changes in bias voltage (given by adjustments to the contrast control), part of this valve's cathode bias network consists of the unby-passed 33 ohm resistor R43. As the use of an unby-passed resistor at this point stabilises input capacity, it also prevents demagnetising of the first I.F. Coil secondary when contrast is varied. An unby-passed resistor, R43, is included in the cathode circuit of the EF80 for the same reason.

The anode of the second i.f. amplifier couples into the second I.F. Coil, this feeding the third i.f. valve, V4, in normal fashion. A second EF50 is employed here and, since this valve has a fixed bias potential, its cathode bias resistor is by-passed by the 0.001 µF condenser C15. Also connected between the second and third i.f. amplifiers is the Sound
Reactor Coil. This coil resonates with its parallel condenser to provide rejection at the sound i.f., giving, therefore, a “dip” in the overall response at this particular frequency. C15, connected in series with the Sound Reactor Coil, has negligible impedance at the frequencies involved, and functions merely as a d.c. blocking condenser.

The third i.f. amplifier valve feeds into the Diode Coil and, thence, to the video diode itself. This determines the overall half of the 6H6, V6, and it functions in a simple series-connected circuit. The rectified video signal provided by the diode appears across R16, the choke between this component and the cathode of the diode functioning as an i.f. filter. The video appearing across R16 is then applied directly to the control grid of the 6C6H6 video amplifier. Since the video at its grid is positive-going, the 6C6H6 may be biased well back, thereby preventing excessive cathode current in the absence of signal voltage. The video at the anode of the 6C6H6 is negative-going and is applied to the cathode of the c.r.t. As will be seen, no a.c. couplings at all are employed in the video amplifier section of the Mayfair, this representing a very desirable design feature. Three peaking chokes appear in the 6C6H6 anode circuit, these ensuring that the higher video frequencies are applied to the c.r.t. cathode without undue attenuation. Also connected to the anode of the video amplifier is a simple noise limiter circuit which includes the remaining diode of the 6H6. The noise limiter circuit operates in the following manner. In the absence of interference the condenser C19 remains charged at a value corresponding to the peak negative voltage level in the picture. Interference pulses causing greater negative excursions in video amplifier anode voltage are not normally of sufficient duration to alter the voltage across C19, with the result that the diode then prevents them from levels noticeably higher than the peak picture level.

Layout and Construction

The layout of the vision i.f. strip is shown in Figs. 5 and 6. As occurred in the layout illustrations given in last month’s article, all components in these two diagrams are designated either with their circuit reference or with a separate letter or number reference. These references are then used in the step-by-step instructions which describe the assembly. Valves, incidentally, are identified here by their reference letters, viz. “S” to “Z.” It may be noted that one tag on each of the tagstrips is shown black. This is that which is used for mounting and which, consequently, at chassis potential. All the i.f. coils have four tags, tag No. 1 being indicated on the coil itself by a red spot. The remaining tags are then numbered 3, 4 and 6 in a clockwise direction looking down at the bottom of the coil. Coil tag numbers are clearly illustrated in Fig. 6.

Construction commences by fitting the major components to the chassis. The first of these are valves V6 and Z, both being mounted above the chassis. Care should be taken to ensure that correct orientation is observed. One of the mounting screws of valveholder Z secures 5-way tag-strip H4, whilst the other mounting screw secures earthing tag T2. One of the fixing screws of valveholder S secures 3-way tag-strip K. Valveholders W, X and Y are next fitted, these being on the underside of the chassis. As with the two previous valveholders, care should be taken to ensure that correct orientation occurs. Next come the three 3-way tag-strips B, D and F; the two 5-way tag-strips E and L; earthing tag T1; and grommet G1. The positions of all these components are clearly shown in Figs. 5 and 6. They are followed by the input socket, under one fixing bolt of which is secured earthing tag T3. Finally, the coils are fitted, taking care once again to ensure that the pins take up their appropriate positions as shown in the diagram.

It should be stated at this point that it is possible that constructors making the vision i.f. strip may be supplied with a chassis which is punched for one valveholder and two coils in excess of those required by the Mayfair circuit. The additional holes in such chassis appear at the input socket end, and should be ignored.

Wiring up now commences. It is important to see that the components fitted take up the positions illustrated in the layout diagrams and that connections are kept short. The first components to wire up are the i.f. coils. Commence by connecting tag 1 of the Input Coil to pin 2 of valveholder S. Connect tag 1 of the first I.F. Coil to tag 3 of tag-strip E; tag 3 of this coil to pin 7 of valveholder W; tag 4 of this coil to pin 7 of valveholder S; and tag 6 of this coil to tag 2 of strip K. Next connect tag 1 of the second I.F. Coil to pin 2 of valveholder W; tag 3 to pin 3 of valveholder W; tag 4 to earthing tag T1; and tag 6 to pin 7 of valveholder X. The Sound Reactor Coil follows, tag 6 of this coil being connected to pin 7 of valveholder X. Tag 1 of the Sound Reactor Coil is connected later. Finally make the following connections to the Diode Coil: tag 1 to pin 2 of valveholder X; tag 3 to pin 3 of valveholder X; tag 4 to pin 3 of valveholder Y; and tag 6 to tag 3 of strip F. We now carry on to the general wiring of the strip. The heater wiring is first of all completed by connecting together pin 4 of valveholder S, pin I of valveholder W, pin 1 of valveholder X, pin 2 of valveholder Y and...
pin 5 of valveholder Z. The condensers are tackled next, in the following manner. C1 connects between tags 2 and 3 of strip F; C2 between 3 and 3 of strip F; C3 between 4 and 3 of strip K; and C4 between 3 and 3 of strip K. These are followed by C11 between tags 2 and 3 of strip G; C12 between tags 2 and 3 of strip E; C13 between pin 3 of valveholder W and tag 1 of the Sound Register Coil; C14 between pins 1 and 8 of valveholder X; and C15 between pins 6 and 8 of valveholder X. Wiring up of the condensers is completed by connecting C16 between tags 1 and 3 of strip F; C17 between tag 3 of strip F and pin 2 of valveholder Y; C18 between tag 3 of strip F and pin 4 of valveholder Y; C19 between pin 5 of valveholder Y and earthing tag T2; C20 between pin 3 of valveholder Z and tag 1 of strip H; and C21 between pins 1 and 8 of valveholder W.

The condensers are succeeded by the resistors. First of all connect R1 between pin 3 of valveholder S and tag 2 of strip B; R4 between tags 1 and 2 of strip B; R5 between pin 2 of valveholder S and tag 3 of strip B; R6 between tags 1 and 2 of strip K; R8 between tags 2 and 4 of strip E; R9 between tags 2 and 3 of strip B; and R10 between tags 4 and 5 of strip E. R11 connects next between pin 6 of valveholder W and tag 2 of strip D; R12 between tags 1 and 2 of strip D; R13 between pins 4 and 6 of valveholder X; R14 between tags 1 and 2 of strip F; and R15 between pins 5 and 8 of valveholder Y. The resistors are completed by connecting R16 between pin 2 of valveholder Z and earthing tag T2; R17 between pin 9 of valveholder Z and tag 1 of strip H; R18 between tag 5 of strip H and tag 4 of strip L; R19 between tag 2 of strip L and tag 2 of strip H; and R20 between tag 3 of strip L and tag 3 of strip H. This completes the resistors.

The four choices have next to be connected. These components should be handled with some care in order to avoid damage to their windings. Choke A (the diode filter choke, type 872) connects between pin 4 of valveholder Y and pin 2 of valveholder Z. Choke B connects between tags 2 and 5 of strip L; and choke C connects between tag 2 of strip L and tag 3 of strip H. Choke D connects between tag 3 of strip L and tag 3 of strip H.

All that now remains is the completion of the interstage and valveholder wiring. Chassis connections to valveholder S are first made, this being done by connecting together pins 5, 6, 9, and the centre spigot of this valveholder and earthing these to tag 3 of strip K. Similarly connect together pins 4, 5, 8, 9, and the centre spigot of valveholder W, earthing to tag 3 of strip E. Also connect together pins 4, 5, 8, 9, and the centre spigot of valveholder X, connecting to chassis via earthing tag T1. Pins 1 and 7 of valveholder Y are next wired together, these connecting to chassis via earthing tag T2. Also connected to tag T2 are pin 4 and the centre spigot of valveholder Z. Follow these operations by connecting together tag 4 of strip E, tag 2 of strip F, tags 4 and 5 of strip H, and pin 8 of valveholder Z. Connect together tag 1 of strip K and pin 8 of valveholder S. Also connect together pins 1 and 3 of valveholder S.

The wiring of the timebase section will be dealt with.

INDEXES

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OCTOBER 1957

ELIMINATING HUM

by J. G. WARD

The elimination of hum is a problem that sooner or later confronts every designer or builder of high quality amplifiers. It becomes increasingly difficult as the input signal level decreases and when high gain is necessary. Some recognition of the characteristic types of hum from different sources and how it enters into the system is necessary to enable practical methods to be devised to get rid of it.

Shielding, layout, planning of earth leads and filtering all form part of the problem, and although instruments—an oscilloscope and a valve voltmeter—are helpful, these are not generally available to the average home constructor. In addition, however, a very satisfactory job can be done without them.

It should be clearly understood that high fidelity reproduction demands a much lower relative hum level than does ordinary radio quality. In a good amplifier, the hum level should be 50 to 60 db below average listening level. The low level inputs available from tape playback heads, microphones and some pick-ups, together with the bass boost required, tend to aggravate the situation and good quality reproduction requires more care when dealing with this problem.

Anode supply ripple, due to insufficient filtering, is always a 100 cycle note, and can readily be located by connecting extra condensers across the h.t. supply. The power supply filter should contain components, chokes and condensers adequate for the equipment it is intended to operate; a single section filter, using a good choke and, if possible, paper condensers, is generally adequate for any power stage, and with additional decoupling for each preceding voltage amplifier stage will generally eliminate anode ripple. Where negative smoothing is employed, it is as well to have some series impedance in the positive line to get rid of ripple, which may be coupled through the mains transformer capacitance.

The filtering action of any given section is better the lower the d.c. current drain, so that an R-C filter section, supplying only one or two milliamperes to a resistance-coupled stage, will provide much more filtering than a similar stage drawing a heavy current. Push-Pull stages require less filtering and decoupling than do single-ended stages; power pentodes and tetrodes are more tolerant of anode supply ripple than are triodes, because of their higher anode resistance, i.e., a volt of ripple produces less anode current swing. Negative feedback over the output stage will reduce hum originating in that stage, but will not reduce hum originating in the earlier stages which may be included in the feedback loop.
The a.c. ripple voltage actually appearing at the anode of a valve is less than that at the h.t. connection by the ratio

\[ \frac{R_L + R_a}{R_a} \]

where \( R_L \) is the anode load resistance and \( R_a \) the anode resistance of the valve. In Fig. 1, if the valve is an L63, operating with an anode load of 100,000Ω and an anode impedance of 0.1Ω, the h.t. supply ripple will appear at the anode.

It is not obvious why the heater supply should be tied to earth. If this were not done, the heater winding would assume a c.e. potential, obtained through its capacitance to the high voltage winding of

the nominal rating of the heater supply voltage, i.e., with most modern valves, 6V instead of about 300V. When the centre tap of the heater supply is earthed, two a.c. potentials of about 3V each can couple hum into the grid circuit; these two 3V potentials add up to 6V, which is a lot of phase out of these, and their effects more or less cancel each other. It may be thought that an exact centre tap would be all that is necessary for this purpose; but the stray impedances from each side of the heater to the grid are rarely equal; it is for this reason that the hum balancing potentiometer adjustment generally effects an improvement.

Wiring Techniques

Capacitance from any a.c. wiring to a low level signal circuit introduces a 50 cycle voltage therein in direct proportion to the a.c. voltage present, the stray capacitance and the impedance of the affected circuit. In Fig. 2 is depicted a grid circuit with a resistance \( R \) of 1MΩ coupled to a stray capacitance of 1pF shown as \( C_f \). If the hum voltage \( E_h \) is 1 Volt there will appear at the grid 1/3200 of a volt, about 1/3 millivolt, since the reactance of 1pF at 50 c/s is about 3200MΩ; if \( C_f \) should be coupled to a 300 volt mains transformer lead the grid circuit would receive 300/3200 volts, about 0.10 volt. 1pF is about the capacitance between two pieces of pushback wire, an inch long, loosely twisted together. Fig. 3 shows the same situation where the signal source \( C_s \) is capacitance, as from crystal microphones and pick-ups. The stray capacitance and the signal source act as a capacitative voltage divider.

This does not mean that all low-level input wiring should be located feet away from everything else or that everything should be elaborately screened; rather it is necessary to avoid the problem and the extent of the effects. Extravagant use of screened wire is rarely necessary; if it is, it indicates a poorly planned chassis layout. The capacitance between two wires can be kept very low, (a) if they are about 2 inches apart, (b) if they are kept close to the chassis and not up in the air, (c) if the layout is planned so that bypass condensers and other components not associated with the "hot" grid circuits assist in the shielding. Twisting heater leads together helps, although not absolutely necessary, providing they are close together and grid leads are kept away. It is as well to use screened braid on the grid lead to a top cup grid and to use a grid line for the signal. The hole where such leads pass through the chassis should have a rubber grommet in it to avoid an earth loop. It is not wise to use a blank tag on a black phenolic valveholder as an anchor point for top cap grid leads, as there can be an unbalanced leak across the valveholder tags.

Earth Loops

Currents of half a millivolt per foot often exist across a chassis on which a mains transformer is mounted; the transformer winding induces a 50 cycle voltage, causing a current to circulate in the chassis. It is asking for trouble to include a section of chassis in series with a low-level input circuit. Fig. 4 shows what happens when the cathode and grid are returned to different points. \( E_h \) is a hum voltage distributed along the chassis; this voltage is included with the signal; the remedy is to return the grid and cathode to the same point, as in Fig. 5.

When wiring from a diagram it pays to study the purpose of each lead, to avoid a situation shown at Fig. 6 from developing. In this example too many earth leads have been used, forming a shorted turn or earth loop. Stray magnetic fields will induce an a.c. voltage in such a loop and the voltage across the loop is included in the grid circuit. If the grid lead and grid return lead are too widely separated, as in Fig. 7, another one-turn coil is created, ready for the induction of a 50 c/s voltage. As the voltage induced in a loop is proportional to its area, the remedy is to keep the grid return lead and the grid lead close together.

Fig. 8 shows how the pick-up lead can innocently cause hum to be introduced into the input circuit. This shows the screened pick-up lead earthed to the gramophone motor frame at one end, and to the amplifier chassis at the other. The motor frame has a capacitance to the mains line, as has the amplifier chassis. These capacitances are shown as \( C_1 \) and \( C_2 \) in the sketch with the mains voltage in between. A hum voltage is thus applied across the ends of the pick-up lead screening. The remedy, shown at Fig. 9, is to use the screening only for the signal voltage and to use a separate wire to connect the motor frame to the amplifier chassis; better still is to use twin screened lead. In this way loop pick-up effects can be avoided.

Sometimes an otherwise perfect amplifier cannot be tuned to a powerful carrier wave. This is due to rectification of r.f. picked up by the mains wiring, the r.f. being modulated by a.c. The remedy is to eliminate the r.f. signals by preventing them from
getting into the amplifier from the a.c. line; this can be done by earthing both sides of the mains through condensers of about 0.005 to 0.01 μF; see Fig. 10. If the hum persists, a 10,000Ω resistor connected between the earth and aerial terminals of the tuner will generally clear the trouble; see Fig. 11.

Can Anyone Help?

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

B. N. HOPKINS, ZL1DJ, c/o 145 Euston Road, Morecambe, Lancs., would like to purchase the manual, or circuit, of the Hallicrafters SX28A communications receiver.

J. R. NORRIS, 98 Wickham Hill, Hassocks, Sussex, wishes to obtain an aerial coil for a pre-war Pye Model PS/B, and wishes to know if anyone has such a component to dispose of.

S/Sgt. SOUTHBY, 23 Para FD AMB, Parsons Barracks, Aldershot, wishes to purchase or borrow for payment the circuit and/or instruction manual for the ex-Am Test Set No. 31. All correspondence answered.

D. GIBSON, G3JDG, 5 Edward Close, St. Albans, Herts, is praying some kind angel will lend a circuit diagram of the Premier 6in television. Would return same unmarked by return of post.

W. KAY, 66 Kirk Street, Bolton, Lancs., wishes to borrow or purchase information, service data, etc., for the American U.H.F. receiver type R-3A/ARR-ZX (also type numbered: Receiver R1584—possibly British Services number).

G. HEDLEY, 4 Fuzee Road, Tadley, Basingstoke, Hants., wishes to obtain circuit details, valve types and conversion data for the Unit No. LU244.

C. E. WARD, 280 Deansgate, Manchester 3, Lancs., wishes to obtain circuit diagram or any relevant information on the R.1355 for conversion to inexpensive television (or a copy of Data Book 4, "Inexpensive Television").

A. F. SMITH, 61 Westfield Road, Dagenham, Essex, wishes to borrow or purchase any information on, or the circuit of, the 12in Defiant T.V. Model TR1246, drawings No. 2817 and 2818.

J. H. BACHELOR, 36 Hadley Way, Winchmore Hill, London, N.21, wishes to obtain information on, or uses for, the Raytheon valves JRP5676, JRP5672, JRP5678 and JRP2621 (2G217).

C. G. PRATT, 1 Ridley Street, Kettering, Northants, wonders if any reader can supply information and circuits of transistorised hearing aids.

R. LENG, 12 Poplar Street, Failsworth, Lancs., wishes to borrow or purchase servicing data and the circuit of the Baird model T163 television. He has a number of old copies of The Radio Constructor and various radio books for disposal; please state wants.

F. G. MORGAN, 68 Arnfield Road, Withington, Manchester 20, would like to buy or borrow a copy of The Radio Constructor for May 1952.
The Mercury

SWITCHED F.M. TUNER

Part 1

A new James kit described by G. BLUNDELL

THE V.H.F.-F.M. METHOD OF TRANSMISSION has now been in use for a number of years and covers a considerable part of the country. The quality and freedom from interference is something which the man in the street has now come to accept and expect. The woman in the street, though, finds the tuning a little more complex and is not prepared to tune for maximum reduction of interference. She will not really accept f.m. until all tuners are as simple to use as the switched tuner described in this article.

Why V.H.F.?
The medium waves are, of course, already overcrowded, and even within a limited audio range a whistle filter must be used to intercept the carrier of the adjacent stations. Also, the sidebands of the adjacent stations will be heard and the background can never be really quiet except under very favourable conditions. V.H.F. was, therefore, the only choice, and this has the advantage that the range of transmissions is not much greater than line of sight, and so stations spaced 200 miles apart can use the same frequency with no danger of interference. This does not mean that the service area of the v.h.f. station is less than that of a M.W. one, since the latter will not give a first class service area much greater than that covered by line of sight, although, of course, poorer signals can be obtained at much greater distances.

Why F.M.?
The decision to use f.m. was nearly unanimous by the committee set up to study the problem. One point made against f.m. was that it was more complex and difficult to align, and to ensure the life stability necessary to achieve the best results. This, surely, is a challenge which will be met by manufacturers, and is met in the tuner described in this article.

Pre-war life-stability of 465 k.c/s i.f.'s was something of a problem when almost universal use was made of compression condensers for tuning, but with the advent of dust iron cores this problem has nearly vanished. The simplest possible f.m. set is more complex than the equivalent a.m. set, but when the latter is fitted with the necessary impulse limiting circuits, the difference is not much.

A simple listening test, though, at almost any position except, perhaps, within a couple of miles of the station, shows the superiority of the f.m. signal as regards freedom from impulsive interference and far lower background noise. Complex limiters on the a.m. receiver could, of course, improve the rejection of the impulse interference, but there is nothing that can be done about the background noise. This test could only be made when the B.B.C. were radiating the same programme on both f.m. and a.m.

It might be expected that the a.m. transmission would require a narrower bandwidth receiver, and that there could be more transmitters in the same band. Unfortunately, though, the complex limiters used rely, for optimum working, on having a wide bandwidth in the receiver in order to produce interference pulses with a sharply rising wave shape. When this is taken into account, and it is also remembered that the stability of v.h.f. oscillators is not so good as lower frequency types, one realises that the spacing could not be less than 0.2 Mc/s between stations. This, in fact, the spacing chosen for f.m. transmissions.

F.M. transmission can use any nominal bandwidth; the choice of the B.B.C. has been that ±75 k.c/s deviation of the v.h.f. carrier represents full modulation, and this happens at maximum i.f. and audio amplitude at the frequencies normally encountered. As Band I transmissions have approximately the same service area as Band II t.v. transmissions, it is of interest to note that most of the new t.v. aerials are fitted with slot aerials, which are capable of radiating three f.m. programmes simultaneously.

As reception is limited to line of sight, a switched f.m. tuner need only receive the three programmes once the novelty of listening to the police (an offence!—Ed.) and commercial transmissions has worn off. This does so rapidly, as the "programmes" radiated, while interesting, do not have much variety.

Choice of Frequency of F.M. Stations
In any one area the three programme frequencies will be spaced 2.2 Mc/s apart. The only limitation on choice is that adjacent channels should be about 2-300 miles away. This leads to the simplified method of switching used in this tuner. On the medium waves, frequencies have to be chosen to avoid after-dark interference. Interference may be expected from stations in Russia, Germany, Italy, etc., and, therefore, there is no simple relationship of frequencies of programmes in any one area.

Wiring
In order to produce a successful design of tuner it is necessary to take into account all the variations of wiring which are possible. For example, all the exhortations about short wiring still do not make the average constructor forget his audio experience. Neat wiring is not necessarily the best from the v.h.f.

---

Block diagram showing arrangement of stages in the "Mercury" tuner
COMPONENT LIST

C1  0.005μF ceramic  R1  270Ω
C2  0.01μF ceramic  R2  1kΩ
C3  0.005μF ceramic  R3  47kΩ
C4  0.001μF ceramic  R4  270Ω
C5  0.005μF ceramic  R5  10MΩ
C6  0.005μF ceramic  R6  100kΩ
C7  47pF silvered mica  R7  100kΩ
C8  47pF silvered mica  R8  47kΩ 3W
C9  0.005μF ceramic  R9  2.2MΩ
C10 0.005μF ceramic  R10  47kΩ
C11 200pF ceramic  R11  47kΩ 3W
C12 0.05μF paper  R12  100kΩ
C13 0.05μF paper  R13  100kΩ
C14 500pF ±10% ceramic  R14  2.2MΩ
R15  100kΩ

V1  EF80  supplied with converter
V2  ECF80
V3  EF80
V4  EF80
V5  EF80
Crystal Diodes, GEX34

Chassis, ready punched, Jason Motor & Electronic Co.
Side panels (2), Jason Motor & Electronic Co.

The converter section (Drawing M4352) is supplied ready-built and tested, hence the absence of values.
The I.F., limiter and discriminator stages (Drawing M4353) are assembled and wired by the constructor—the values of components are given in the list herewith.

IFT1, IFT3 Type L4, Jason Motor & Electronic Co.
IFT2 Type L12, Jason Motor & Electronic Co.
Heater chokes Jason Motor & Electronic Co.
Valveholders (3), Nylon loaded B9A, McMurdo
Tag strips, one 2-way, one 6-way, one 3-way less earth.

Grommets (2)
4-way power supplies lead
Single screened audio lead
Pointer knob
Front end unit with name plate, completely wired and tested, Jason Motor & Electronic Co.

THE RADIO CONSTRUCTOR

OCTOBER 1957
though, is more complex and, therefore, proved more troublesome. In fact, if the unit is built as described in the instructions (R.R. 3), no trouble results. There is, however, a great temptation to "tidy it up"; alternatively, if all condenser leads are carefully covered with sylphlex, it is almost impossible to keep the wiring short enough.

Because of these points it has been decided to produce this design in two parts: converter and i.f. strip, and to supply the converter only as a ready-built unit in the same way as some Continental tuning units are available here. This decision was made because the frequency changer and reactance circuits have proved to be intolerant of alterations of layout and lead lengths.

The circuit, therefore, consists of the following stages as shown in the block diagrams: R.F. — F.C. and Oscillator—Reactance Section—I.F. Stage—Limiter—Limiter—Discriminator. The function of each stage will now be described.

The Converter

This unit, which is supplied ready-tuned, consists of the first three stages: R.F. — Frequency Changer—Reactance Section. The i.f. stage is an ECF80 with the aerial/grid circuit preset to the middle of the band. In the anode circuit is a coil which is switched to each frequency.

The second valve is an ECF80 with the pentode section operating as a self-oscillating frequency changer, while the triode section acts as the variable reactance. Various types of frequency changer circuit were tried to find one which would give a reasonable gain in the presence of the damping imposed by the reactance valve. This is a type which, in addition to acting as a pentode mixer, also oscillates between anode and grid No. 1. The i.f. tuning condenser is marked C in the circuit diagram of the converter. It will be seen that the oscillator coil is in series with this condenser, but at i.f. the impedance of the oscillator coil can be ignored. The impedance of the decoupling condenser Cp is also low and, therefore, the condenser C is effectively across the coil at i.f. At oscillator frequency the circuit behaves quite differently. The condenser C now acts as a coupling condenser from anode to the oscillator coil, and the i.f. coil acts merely as a choke supplying h.t. to the anode and, otherwise may be ignored. A coupling coil is taken to the grid of the pentode and the circuit, therefore, oscillates. In series with this coupling coil is a second coil which injects programme signal from the r.f. stage to complete the frequency changing process.

Reactance Section

In order to keep the oscillator in tune there must be a variable reactance to correct any mistuning, and appropriate circuitry makes the triode section of the ECF80 look like a capacity from the point of view of the oscillator circuit.

A reactance may be recognised in a circuit solely by the phase angle between the voltage across the circuit and the current in the circuit. If the voltage and current cycles are in step, maximum voltage and current occurring simultaneously, then the circuit is, in effect, a pure resistance. If the current cycle is 90° ahead of the voltage cycle, then the circuit is effectively a pure capacitance. Therefore, if a valve can be made to take current 90° ahead of the a.c. voltage (in this case the oscillator frequency), then the valve will look like a capacitance. This is done by feeding voltage to the grid of the valve through the internal capacity of the valve marked Ca on the circuit. The phase of this voltage is altered by the resistance R in the grid circuit.

This results in a reactance whose actual capacity may be varied by altering the gain of the valve. Because the current and voltage are not exactly 90° apart, there is also a resistive component which does damp the oscillator section of the frequency changer circuit, hence the previous remarks about choice of suitable mixing circuit to work well in the presence of this damping.

A varying voltage is fed from the discriminator which is positive on one side of correct tune and negative on the other, and corrects any mistuning of the oscillator.

I.F. Stage

This is quite conventional, automatic gain control being fed back from the limiter to the grid of this valve.

Twin limiters are used. Without the second limiter the gain of the set is such that 100 microvolts of aerial signal produces 1 volt at the grid of the limiter. This is adequate to cover the average signal area of any of the stations. Unfortunately, considerable variations from the average signal may be found due to, for example, the receiving site being in a valley, or behind a gasholder. Alternatively, near an airport considerable variations of signal are found due to the strong signal reflected from the plane, which may momentarily cancel the normal signal. Twin limiters help to combat this, and result in an aerial sensitivity of better than 10 kV. A positive bias is applied to the grids through resistors R5 and R6 to improve the limiting action.

The Foster-Seeley Discriminator is the part of the set which differs most from the normal a.m. set. This circuit was chosen because of the greater output which results in a bigger correction voltage being applied to the reactance valve, and is the simplest circuit for normal use.

(to be continued)
Radio Miscellany

JUDGING BY THE REQUESTS I HAVE RECEIVED in recent weeks from those who wish to be recommended an "ideal test-piece" record, there is a distinct revival in gramophone interest. Maybe this recent outburst is due to the fact that a wide range of 3 and 4-speed electric motors has recently been available at attractive prices.

Or, of course, it may be that even in the matter of hi-fi, in order to keep up with the Jones's one's hi-fi has to be just that bit hi-fer than one's neighbours!

The latest enquiry comes from an Aberdeen reader who asks for a recommendation for a 45 r.p.m. (extended play) record of permanent interest. Seeing that these records are far from cheap he, with native thrift, wants one which can also be played for enjoyment. For the same reason, it is not particularly interested in 33 r.p.m. (long play) records. He wants a recording of a good standard which will be as satisfying to listen to in ten years time as it is today. Something which has solo passages, as well as the full crunch of the whole orchestra in order to check for fidelity. His record has two strings, brass and wind instruments all thrown in, with plenty of top and bags of bottom.

I am a little difficult about making a recommendation. So many saxophones will go bang if it fails to please. However, I have made a couple of modest suggestions by post, but I dare not put them forward publicly. There must be lots of records that meet such a demand more adequately than my limited knowledge of the record world covers. Every time I look at a catalogue of standard recordings I become deeply conscious of the shortcomings of my musical education!

Among the 33 r.p.m. long play types there are a few particularly fine records. The Petrouchka Ballet Suite (Stravinsky) has been used for years by Decca to demonstrate and popularise modern long-play record reproduction. It serves very effectively. That, however, is an expensive record—39/4, or seventy-nine and a quarter saxophones. Another (at the same price) which might prove of years' interest is the Russian Ballet d'Ouvert for the Orchestra. The value of the latter as a test record lies in the fact that solo parts are provided for practically every instrument.

However, our reader wants a 7in extended play, so these two scarcely fill the bill.

Can any reader who has allighted (by accident or otherwise) on an extended play record which goes most of the way to satisfying the demands of a careful Aberdeenian, both for test and entertainment purposes, please quote the make and number—and I will prepare a list (with any comments of interest) of those that get several votes.

Like Topsy, it just Grewed

My reference to the use of the QO call last month has raised a query as to its origin. A reader enquires whether it started simply because the letters seemed to be the most appropriate to use as a general call or an invitation to anyone to reply, or as part of a planned code. Its origin, of course, goes back to the days before telephony, when with other abbreviations it quickly became general usage. It was readily recognised that sending common phrases in full was a shocking waste of time and effort. Hence the Q-code came into use—groups of three symbols of which could be readily understood either as a request or confirmation. QSY, for instance, means either "Please change frequency" or "I will change frequency"; and QRA, "What is your position?" or "My position is—"

As the most frequent use of radio communications was by the English-speaking peoples, "Q" was doubtless be readily accepted as a most logical general call. Up to about 1912 the letters CQD (CQ-Distress) were used to mean exactly the same thing as the more modern S.O.S call. At the time of the Titanic disaster it was the CQD call which was used in the early transmissions asking for help. Later it was changed to S.O.S—a signal which had been agreed upon with a little earlier by an International Convention.

It was felt that an unskilled operator could more easily and its origin, of course, more easily and more readily recognise it. Some people, oddly enough, still believe that the signal is for Save Our Souls, although obviously it would be meaningless to anyone who did not speak English.

Apart from all other considerations, the letters C and Q when linked in Morse possess a lovely natural rhythm. If you are not a code user, just sing to yourself the words "Charlie, Charlie. Here comes the Queen." There you have the perfect CO call, the long syllables being the dashes and the short ones the dots. It also has the virtue that it is easily remembered as the dominant initial letters are C and Q.

Chassis Bathing

I am beginning to wonder if this heading is not the most appropriate I have ever chosen. Recently I have seen so many chassis that were literally bashed out, rather than fashioned to shape by gentle persuasion, that it almost suggested itself.

I hate to feel that this column, which is supposed to be chaty, is in danger of developing into a lecture, but having ruined more good aluminium than anyone else in the United Kingdom, perhaps I can speak with some authority on the subject.

If you want the finished job to look like an exhibition piece—and who starting off with a sheet of virgin polished aluminium doesn't?—cover the bench with a pile of opened news-

pliability of duralumin can be restored by rubbing both surfaces with soap and warming over a gas-ring. Immediately the soap becomes dark brown the metal should be plunged into cold water. After it has been thus annealed it can be worked without fear of cracks developing. Preferably the bending or shaping should be done as soon as possible after the annealing treatment, as age hardening again sets in rapidly. Although this is an old dodge among metal workers, when I recently asked a half a dozen do-it-yourself constructors, not one of them knew about it.

Short Ends

Several more letters have come to hand from readers who would like to see a "Described—but not forgotten" column as a regular feature. To remind those with short memories, such a column was for constructors to air their views on the success (or otherwise) they met with in building sets described in these pages, or to share with others ideas for successful modifications they had tried. Judging by the correspondence on this subject, the JASON FM Unit was the most widely constructed item described in recent times. Incidentally, for Jason fans there is a new paper. As the work proceeds, keep peeling off the shell. This way you will remove all the swarf which causes the horrible scratches which no amount of subsequent polishing will erase. In bending, scribe deeply and if your iron is not wide enough iron by a band iron to knock it into an evenly spaced blows with a leather covered mallet. It is also important to keep hand pressure on the free end so and prevent it springing back to its former shape.

So far these points are usually observed by the intelligent constructor, but only too often the aluminium doesn't readily bend. Hence the blows get heavier until it does, and the finished chassis is covered with small scars and bruises which permanently mar its appearance. Worse still, cracks often appear along the bent edge. The reason for this is that the aluminium is "old." Too much force used on old aluminium is almost certain to result in cracks appearing.

What is not generally realised among beginners is that old aluminium can be rejuvenated, making it easier to work and avoiding cracking. Incidentally, purely aluminium is softer and does not age or become brittle like duralumin, etc. Aluminium alloys all appear to suffer from age hardening. The model full details of which are to be found in this issue. The description mentioned in the Mullard "3-3" Quality Amplifier described in our April, 1956, issue. This, no doubt, would have proved even more successful if it had not neglected buying the more recently introduced valves!

Mr. A. J. Felstead of St. Luke's Road, Maidenhed, suggests a modification to the Mullard Portable which he has used with excellent results in hotel bedrooms from Kent to Cornwall. When he tried to use it in his caravan which has an aluminium roof and body, the screening was so effective that the otherwise strong signals obtained were completely lost. He then arranged for a short throw-out wire aerial which was quickly attached as an optional addition. A length of 1.5 feet was found to give full volume. It is connected via a 100pF capacitor to the grid of the first valve, the aerial being plugged into a new socket brought out to the upper edge of the panel.

An interesting point is raised by a "3-3" amplifier builder, I. R. of Bristol. His model greatly impressed a neighbour, who persuaded him to build him one like it. When he built (continued on page 202)

CENTRE TAP talks about Items of General Interest
Sand Filling the W.B. Senior Bass Reflex Corner Console

by E. G. WILSON

This article details a simple method of sand-filling a commercial cabinet normally supplied in kit form. The materials required are easily obtainable, and the total cost of conversion does not exceed thirty shillings.

A sand-filled cabinet similar to the one described has been used for over two months in the writer’s home, and in his opinion it represents a considerable improvement over the non-sandfilled version. This is due to the increased clarity of the bass response and a general reduction in resonances even on heavy orchestral passages and sustained organ notes.

The technique of construction is quite simple. By the use of ⅛ in strip and hardboard, cavities are added to each of the walls of the cabinet. These cavities are filled with dry sand.

Cut and fix lengths of ⅛ in strip to the top, bottom, sides and backs to form recesses as shown in Fig. 1. In dimensioning the strips remember that the whole cabinet has to be fitted together, and due allowance must be made for any extra thickness of hardboard introduced. For example, the strips already fitted to the backs (A in Fig. 1) will need to be shortened to allow for the hardboard fitted on the top and bottom cabinet walls. The writer found no difficulty in working with the cabinet assembled and the backs removed.

If, however, an unassembled cabinet is being converted, it will probably be easier to do all the constructional work before assembly. Butt joints are adequate for the corners, and Casco glue and panel pins are used at sandtight joints. The cardboard corner pieces make additionally sure that no sand leaks occur at the corners. These are made from cigarette packets and are secured with Casco (Casco is unsuitable as it requires considerable pressure to obtain good adhesion). The flaps marked "B" in Fig. 2 should be at the top of the cavity to engage with the hardboard top when it is fitted.

When the glue on the strips and corner pieces has hardened, fill the cavities with dry sand packed fairly tightly. Cover the tops of the cavities with hardboard cut to size and secured with Casco glue and panel pins. Remember to put Caso on the flaps B of Fig. 2 before fitting the hardboard. This ensures a good sandtight joint on the finished job.

Fit the ⅛ in. carpet felt to the two backs, covering to within ⅛ in. of the edges. This is most easily done using Croix and drawing pins.

When all the joints are dry, assemble the cabinet—bearing in mind that all panels are now considerably heavier than the designer originally intended, and therefore additional care is necessary to make sure that no damage is done to the cabinet as a whole. The same care should be exercised when the cabinet is moved to its working position, which should, if possible, be such that it does not have to be changed very often for cleaning or other domestic reasons.

Materials required are listed below. It is advisable to check dimensions and quantities before ordering to avoid waste:

⅛ in hardboard .... 18 square ft.
⅛ in softwood .... 40ft
Builder’s sand ... 2 buckets full
⅛ in panel pins ... as required
“Casco” glue ... or similar
“Croix” glue ... or similar
⅛ in carpet underfelt ... 1 square yd.
Drawing pins ... as required

THE RADIO CONSTRUCTOR

OCTOBER 1957
General Purpose...

by R. H. SMART

Introduction

This unit was primarily designed as an amplifying intercom between the author's workshop and the house. It was thought that an amplifier used exclusively for this purpose would be unnecessarily wasteful, and so a number of features were included to enable the unit to be used for general experimental work without detracting in any way from its original purpose.

Facilities Offered

(1) Intercom between two stations with complete secrecy at both if required.
(2) High and low gain amplifier inputs.
(3) Mixing of inputs.
(4) "Slave" may be disconnected when amplifier is used for experimental work if desired.
(5) Should "slave" be disconnected under item 4 an audible or visual alarm is incorporated should "slave" wish to speak.

Main Amplifier

The circuit is shown in Fig. 1, and it will be seen that it is a conventional three-stage design with the following modifications. Provision is made to switch the intercom input transformer T3 out of circuit and replace it with a socket and volume control VR3 to provide a high gain input. A low gain input is provided via VR1 to the grid of V2. This may be mixed with the output from V1. VR2 should be adjusted for normal intercom working, but as it is likely to be altered during testing, etc., it would be just as well to mark the amplifier panel and VR2 knob to facilitate quick return to intercom.

It will be noted that the coupling between V1 and V2, condenser C2, is of an unusually low value. This is to decrease the bass response on intercom, and it may be lowered further if desired. It does, however, affect the bass response of "Input 1."

The power supplies incorporate full-wave rectification and are well smoothed to avoid hum troubles. Modifications may be made to suit components available, but it is not recommended that the mains be connected to chassis, as this could result in the full mains voltage appearing on the remote wiring to the "slave."

Amplifier Switching

This function is performed by S2. It has three positions, viz.:

(1) Intercom.
(2) Amplifier only, "slave" disconnected.
(3) Amplifier only, "slave" connected in parallel with main loudspeaker.

When switched to (2) or (3) and the "slave" wishes to speak, operation of relay CO (Fig. 2) completes a circuit via S2L for the audible or visual alarm. Switching to (1) immediately restores intercom facilities.

Intercom Switching

Fig. 2 shows a comprehensive system requiring a three-wire connection between the stations. K1 and K2 are Post Office type key switches, it being an advantage if K2 is of the non-locking type, i.e. to return to normal when finger pressure is removed. CO is a relay of the well-known 3000 type. The relay and key switches are obtainable on the surplus market.

With K1 and K2 "up," both stations are connected to the amplifier output. If K2 is depressed, the negative (chassis) line is extended via K1 to operate relay CO. CO then connects the "slave" to "input" and "slave" may speak. Operation of K1 disconnects CO, returning the "slave" to output and connects the master to input. Note that the master may speak whether or not K2 is depressed. Should K2 be left in the "on" position, the "slave calling" alarm can be disconnected at S2.

The positive potential to operate the relay and buzzer (if used) may be obtained from the HT line via suitable dropping resistors. The value of these resistors will vary with the resistances of relay and buzzer used. Alternatively, a battery may be used and an extra pole added to S1 (Fig. 1) to switch it out of circuit when the unit is turned off.

3-in or 5-in loudspeakers perform well as microphones and can be used to good
advantage in the unit. For general work, however, a larger unit is generally required, and the author has used a 6 in energising speaker successfully in the past with the amplifier. At the present time a 9 in speaker is in use in the workshop in conjunction with a 3 in at the house. Naturally, one has to speak closer into a larger speaker, but at the controlling end this is no disadvantage.

Figure 3 shows a much simplified system of switching when secrecy at the "slave" is not required, and no calling alarm is incorporated.

![Diagram of intercom switching](image)

**LITERATURE RECEIVED**

From Glyne Radio Ltd., 18 Tottenham Court Road, London, W.1, we have received the new Comprehensive Catalogue 1957 of over 100 pages packed with radio and television components, kits, cabinets and all manner of other items of interest to the home constructor. One of the most comprehensive that we have seen, it is available from the above address, price 2s. post free. A monthly Newsletter — well worth receiving, is also available.

Standard Telephones and Cables Ltd., Fleetray, Sidcup, Kent, have now produced and released the latest in their manual series, the Brimar Radio Valve and Teletype Manual No. 5. Complete details of all the Brimar range of valves, t.v. tubes, transistors, Brimistors, metal rectifiers, etc., together with base connections, data, and characteristic curves are included. In addition to the foregoing, other items include contact-proofed rectifiers, germanium diodes, abac, formulae and a complete section of circuits of amplifiers, receivers, f.m. tuner unit, radio tuner unit and various transistor circuits. The Manual is available from radio dealers, etc., price 6s.

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TRANSISTOR MORSE OSCILLATOR

by F. G. RAYER

WHEN PRACTISING Morse, it is soon found that the note from a buzzer is not very satisfactory, as it does not resemble the tone heard from Morse transmitters. A valve oscillator is frequently employed to overcome this, the signal being heard in phones, or listened to with a speaker. The usual type of simple valve oscillator is shown in Fig. 1, and it is vastly superior to the buzzer.

Though such an oscillator had been used on and off for many years, it was felt that a transistor circuit would be preferable, primarily because of the considerable economy in current consumption. No h.t. would be necessary, and even a small dry cell should have a very long life.

With this in view, it was found that the circuit in Fig. 2 was satisfactory. Multi-vibrator circuits using two transistors were well known, but it was felt that a worthwhile saving would arise from having one transistor only, a transformer being used exactly as in Fig. 1. The circuit in Fig. 2 was, therefore, used. It is a ready oscillator, and gives ample volume for two sets of phones with a 12V battery. The current drain is only around 1mA.

The 100kΩ potentiometer was provided to vary the audio tone, as this was felt desirable. As resistance is reduced, the tone rises until the transistor goes out of oscillation. The lowest audio frequency will depend upon transformer, transistor, and room temperature. The characteristics of the phones also vary it somewhat.

Transformer
This item requires special mention, because a component suitable for the valve circuit may not function well with a transistor. The latter is a current-operated device, whereas a valve is voltage-operated. The transformer thus needs to have windings of fairly low resistance. It is also helpful if its inductance is a little low, so that it would not be a very good component by a.c. coupling standards.

When the circuit has been connected up, the results to expect will soon become apparent. If no oscillation arises, it may be necessary to reverse connections to one winding. The effect of exchanging the circuit positions of primary and secondary can also be tried.

If the transformer will not give satisfactory results, another component of different type must be tried. If several old or ex-service transformers are to hand, one is likely to suffice. The ratio is not important, but may best be around 1:5 to 1:15.

A component with low inductance, which gives a very high-pitched note, may have a condenser of about 0.05pF upwards wired in parallel with the primary.

Constructional Points
The wiring plan is shown in Fig. 3; dimensions are of no importance. Of the various possible methods, that of wiring phones and key in series with the battery has been selected, as this avoids the need for any on/off switch, and means that the oscillator is always out of action when the key is open, or phones removed. The components are so few that in some cases it may be possible to assemble the oscillator on an old Morse key, complete, to form a single unit.

When wiring up, the polarity of the battery must on no account be incorrect, the inner carbon rod being positive. The cell is soldered directly into position, as its normal life is several months.

The transistor must on no account be heated, or permanent damage is likely. It is best, for this reason, to leave its wire ends full length. The soldered joints should be made with reasonable speed, the transistor lead being held by flat-nosed pliers to conduct heat away.

THE RADIO CONSTRUCTOR

OCTOBER 1957
Some form of resistance-capacitance bridge is a valuable asset to the experimenter's workshop, since with its aid the value of any capacitor or resistor can be measured quite accurately. In the instrument to be described an accuracy of ±5% or better may be obtained, depending upon the accuracy of the components used.

A disadvantage of many R-C bridges is that they require the use of a mains supply to operate them. By using a transistor in the circuit it is possible to make the bridge work from a 1½ volt battery, thus making the instrument both portable and economical.

The instrument consists of a bridge network, in which the unknown component is measured, and an audio frequency oscillator which provides an a.c. supply for the bridge network. Since only a small amount of power is required from the oscillator, a transistor may be used.

The Audio Oscillator
One of the small p-n-p type junction transistors which are now obtainable is used for the oscillator. It is connected in the common emitter arrangement, with transformer feedback from the collector to the base. As with a valve oscillator, there is a phase reversal in the transistor and the transformer is connected to give a further phase reversal, so that a positive feedback is obtained.

The transformer should have a ratio of about three to one, with the larger winding in the collector circuit. Some valve type transformers are unsuitable because they have windings with high d.c. resistances which cause large voltage drops and may prevent oscillation.

A suitable transformer may easily be wound on the core of an old audio transformer using, say, 200 turns of 30 s.w.g. wire for the primary and 60 turns for the secondary. Alternatively, a suitable transformer specially made for transistor work may be obtained.

A small heater isolating transformer was also found to be suitable for this circuit. The windings must be connected up in the right way round for oscillation. If the transformer is not marked and the circuit does not oscillate, then one of the windings should be reversed.

Any of the small junction transistors now available will work in this circuit, although it may be necessary to alter the circuit constants to suit the differing characteristics of various makes of transistor. With some transistors it is found that a rough note is produced. This appears to be due to excessive feedback and may be cured by damping the primary of the transformer with a shunt resistor. The value required will vary from about 1.5kΩ to 10kΩ, depending on the transistor used. For convenience, a variable resistance is used here, the value being adjusted to give a clean note with the transistor in use.

The primary of the transformer is tuned by a shunt capacitor to give an audio note of about 1,000 c/s. The actual value of this capacitor will depend upon the inductance of the transformer used. A value of from 1,000pF to 5,000pF will usually be required.

In the base circuit, the transformer secondary is connected in series with a bias resistor to the negative side of the supply. This resistor provides a current bias of about 15 microamps for the base circuit and is decoupled by a capacitor. The use of this bias helps to produce a clean note.

The Bridge Network
In this instrument the bridge network has been arranged to give six ranges with a linear scale on both resistance and capacitance measurement. This makes the scale easy to draw and allows good accuracy to be obtained.

For measurement of resistances a Wheatstone bridge is used with a pair of headphones as the detector. In the measurement of capacitance a DeSauty type bridge is used. This is a Wheatstone bridge in which two of the resistors are replaced by capacitors.

For the Wheatstone bridge shown in Fig. 1, the value of R1 while the bridge is balanced is:

\[ R_1 = \frac{R_2}{R_3} \]

In the case of the DeSauty bridge shown in Fig. 2, we get:

\[ C_4 = \frac{C_2}{R_3} \]

It will be noted that the ratio \( R_3 \) is common to both circuits and, in fact, the resistors \( R_2 \) and \( R_3 \) are known as the ratio arms of the bridge. It will be convenient to make \( R_1 \) and \( C_4 \) the unknown components, so that \( R_4 \) and \( C_1 \) become the standards against which the unknowns are compared. By making \( R_2 \) variable and calibrating it, the ratio of \( R_2 \) to \( R_3 \) may be varied to balance the bridge, and the value of the unknown component read off from the scale fitted to \( R_2 \). For both resistance and capacitance this scale will be linear since the unknown is directly proportional to \( R_2 \).

The usual practice for changing the range of the bridge is to change the value of the standard component \( R_4 \) or \( C_1 \). For six ranges this means that twelve high tolerance components are needed, six of them being capacitors. An alternative method is to use a potentiometer to select the value of \( R_2 \) so that the ratio of \( R_2 \) to \( R_3 \) is changed. With this arrangement only two standard components are needed, one for resistance and one for capacitance.

If \( R_2 \) is a 10kΩ potentiometer, then the scale fitted to it would read from 0 to 10kΩ and multiples of this. This arrangement places the 1kΩ, 10kΩ, 100kΩ values at the ends of the scale, so that it may be difficult to obtain accurate readings for these values. To overcome this, the scale is made to read from 1kΩ to 11kΩ, thus bringing the 10 values in at the upper, and more accurate, end of the scale. This result is easily obtained by adding a 1kΩ fixed resistor in series with the 10kΩ potentiometer, thus making the range of values of \( R_2 \) 1kΩ to 11kΩ.

When switching from resistance to capacitance measurement, it is necessary to transpose the standard and unknown components in order to make the capacitance scale linear. Thus \( C_4 \) becomes the unknown capacitor. The switch used for this is a three-way type, the third position being used to switch off the battery supply to the oscillator when the instrument is not in use.

[Diagram of the Wheatstone bridge and the DeSauty bridge shown as Fig. 1 and Fig. 2, respectively.]

Construction
The complete circuit diagram of the instrument is shown in Fig. 3. No specific details will be given of the construction of the unit, since these will vary according to the components used and the requirements of the constructor himself. It is an advantage to mount all of the components upon the front
The transistor must be soldered into the circuit with some care by gripping the leads with a pair of pliers, as they are soldered. This prevents damage to the transistor due to heat from the soldering iron. If a small iron is used and the joint made quickly, this precaution may be unnecessary. The collector connection is usually indicated by a coloured dot on the body, and the other connections should be obtained from the data sheet for the transistor used.

Components used for the bridge network must be of at least 5% tolerance, and if the desired closer tolerance components may be used. The potentiometer must be of the linear type and about 1.5 or 1.6 inch diameter. Smaller diameter components have a shorter track and will not be as accurate as the larger unit. No great advantage is obtained by using a miniature component here, since the size of the unit is governed by the scale dimensions. For the oscillator circuit ordinary 20% components may be used.

For convenience the phones should be connected to the circuit through a jack plug and socket. The test leads for the unknown component may be brought out to d.c. terminals, or to flying leads fitted with crocodile clips.

Calibration

When the instrument has been wired up, a scale must be drawn so that the values of the components being measured can be read off directly from the scale. The most accurate method of making the scale would be to calibrate each range separately, using an accurately calibrated variable resistance and an accurate capacitor box. Since such apparatus is unlikely to be available to the amateur constructor, a simpler method must be used. For this method the tracking of the potentiometer is assumed to be perfectly linear and the other components of the bridge accurate.

Most potentiometers have an angle of rotation of 300°, although there are some types which have an angle of rotation of only 270°. This angle is usually found by fitting a knob to the potentiometer and measuring the angle of rotation with a protractor.


The author of this interesting book has resided in America for the past few years and has already become well established as a writer on audio subjects in technical journals. He produced many articles in this country some time ago which were notable for their ingenious design, so he is well able to discourse on the aspects of hi-fi sound reproduction contained in this volume.

The text is almost wholly descriptive and conversational. Very few mathematics are used; one could almost imagine that he is talking to you here and there just to emphasize an explanation or to give simple proofs of a few functions. On the other hand, much that could have been expressed mathematically has been made clear in graphs, charts and by means of several graphs and charts. This, and the author's lucid style, makes the book absorbing to read and refreshingly easy to understand.

The ten chapters forming the major part of the book are liberally illustrated with basic circuit diagrams, each of which is discussed in detail. Component values are given only where it is necessary to discuss specific values, and their effects on a particular circuit principle. As a result, it is hardly possible to formulate a complete amplifier circuit design simply by stringing together individual circuits that catch the eye in various chapters.
A CONSTRUCTOR VISITS THE
1957 NATIONAL RADIO AND TELEVISION SHOW

THE WRITER HAS ALWAYS HELD A POND BELIEF that it is possible to gain entry into almost any London exhibition by the simple process of flashing a business card at the entrance and stating briskly: "Pleas"! If one looks sufficiently the attendant will then let one through. This scheme has worked excellently in the past, especially at the London Audio Faire. (Would "Free Grid of Wireless World" please note?) But for the writer tried it out this year at the Earl's Court Exhibition but the attempt was unavailing. The booths held by the radio and television manufacturers had no room for his correct Press Ticket before a distant disdain indicated that he could pass through the turnstiles.

However, despite this rather discouraging start, the writer enjoyed his visit to the Radio Show as much as he has always done in the past. This was less "gadgety" this year than has appeared at previous exhibitions—incidentally, the major radio and television manufacturers tending to present their wares in almost an overly dignified and staid manner. On hot afternoons the atmosphere in Earl's Court tends sometimes to a certain stuffiness, and it is a pity if this is added to by a smugness in the stands layout.

Part of the restrained tone of this year's show may have been due to the fact that technical developments have recently occurred or are impending in the domestic radio and television scene. Because of the manufacturers have had the time to consolidate their present position, and have been able to concentrate more on cabinet design and presentation.

Television

The preoccupation with cabinet styling was very apparent on the stands devoted to television. One was a technical development in conventional t.v. receivers consisting of the introduction in some models of 90 degrees phase inverter circuit. Here, the results given are more apparent in the form of picture than in any improved picture response. There is a strong tendency towards the "33" screen, which is the area of the front of the cabinet. The "push-through" type of tube mounting, wherein the whole of the front of the tube is visible instead of being partly masked, is also apparent.

Possibly the biggest change in television production was the introduction of a new type of mass production of cable of the type employed in the manufacture of transportable receivers. Most of the models shown employed 14 in tubes and were housed in cabinets of a standard type, in black, in cloth-covered plywood, or moulded plastic.

Sound

A noticeable saving in cost. A particularly interesting portable model was the Ferguson 141 receiver (type 45), insofar as it had a very comprehensive inbuilt telegraphic aerial system, this being capable of a considerable range of adjustment. The two tele-

2000 local and national advertisers.

The great change evident at the Show was that the great number of new products featured at the Home Communications Centre, which features equipment designed to suit the subscriber's needs.

A final point which is worthy of emphasis is that home-constructor workshops to meet customers' desires for the home could be found. The Home Communications Centre, for instance, has a stock of all types of equipment, from the smallest to the largest, and of all sorts and sizes, and all are equipped with the latest design features, including the latest in the field of broadcast equipment.

THE RADIO CONSTRUCTOR

TEN OCTOBER 1957

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A FAIRLY LARGE PERCENTAGE OF BRITAIN'S population still rely on dry (and sometimes wet) batteries to provide them with radio entertainment and, generally speaking, for them television is out of the question. There seems no reason, however, why they should not enjoy t.v. sound at any rate, and to assist them the circuit shown in Fig. 1 is offered merely as a suggestion.

The valves required are in cheap and plentiful supply, and the fact that they have 2Y filaments presents no difficulty if they are connected in series-fashion and fed from a 4.5-volt two-terminal battery via a limiting resistor.

A super-regenerative detector can be successfully employed as its poor selectivity characteristic is of no consequence, rather an advantage, as a fairly wide bandwidth is desirable. Nor does the quality of the output matter particularly, as few existing battery receivers give undistorted output.

An undesirable feature of this kind of detector is its ability to radiate, and on no account must an aerial be connected to its input direct. Radiation can, indeed, take place even when no aerial is connected, and adequate screening is a must.

A layout is suggested in Fig. 2—an under-chassis diagram. It will be noted that all components capable of radiating are effectively screened by the chassis box. V₂ is mounted horizontally, and as a further precaution a plate of 16SWG aluminium should be firmly bonded across the bottom of the chassis on completion, so that a closed-in construction results. Holes drilled in the chassis sides will ensure ventilation. A top-of-chassis diagram is not shown, as only V₁ and L₄ (shown dotted) will be visible. While V₁ does contribute to the gain, its main purpose is to act as a buffer between the aerial and V₂, and it should not be omitted.

Coils may be wound on ¾in Aladdin formers, iron dust cored, using 22SWG enamelled copper wire, the turns spaced from each other slightly. Six turns were found suitable for Channel 5, but variations in wiring, etc., may possibly necessitate some deviation from this figure. Initially 7-8 turns should be wound on, and turns removed one at a time until the desired transmission is heard. The primary of L₂ consists of 2 turns of P.V.C. covered wire wound over the earthy end of the secondary winding. Alternatively, ready-made coils may be used and suitable types are obtainable from Osmor, Denco, Teletron, etc.

The chokes are easily made by winding a length of fine wire on a ½in mandrel. The length is readily calculated in the case of a quarter-wave choke by multiplying the quarter wavelength by ten and winding on this number of inches. For example, if 1 metre = 40 inches (actually 39.37in) and the working wavelength is 5 metres, then

\[
\text{Length} = \frac{40}{5} = 8 \text{ turns.}
\]

A component list is given below for those who depend on batteries.

**Component List**

| Capacitors | C₁, C₂, C₃ | 1,000pF |
| Resistor | R₁, R₂ | 10kΩ |
| Resistor | R₃, R₄ | 270kΩ |
| Resistor | R₅ | 100kΩ potentiometer |
| Resistor | R₆ | 10Ω |
| Valve | V₁ | VP23 |
| Valve | V₂ | VP23 |

**Miscellaneous**

Valve bases: Mazda Octal (2), Chassis 6in × 5in × 2½in plus base panel. Chokes (see text), Co-axial plugs and sockets (2), Belling-Leec, S₁, on/off toggle switch, H.T. Battery 90V, L.T. Battery 4.5V. One control knob, Nuts, bolts, etc.
JASON

SWITCH TUNED
FM FEEDER KIT

(AS DESCRIBED IN THIS ISSUE)

Designer approved kit

This excellent unit enables the selection of
Home, Light or Third programme at the
touch of a switch. Complete freedom from
drift is ensured by the incorporation of Auto-
matic Frequency Control. When used in
conjuction with a suitable amplifier superb
quality is obtainable. The highest standards of efficiency and reliability that are the
well-known features of the Jason Standard and Fringe Model FM Tuners have been
maintained.

Up to the time of going to press a special price for the complete kit has not
been finalised. However, as usual, we shall be offering this kit at a most com-
petitive price. Send 2½/- for our itemised price list and the instruction book.

STOP PRESS—Price just announced—Complete kit £9.19.6 P. and p. 2/6

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