# A Band V Receiver

## By R. B. Archer

### A SOUND RECEIVER WITH PROVISION FOR FUTURE DEVELOPMENTS

THE writer was impressed at the 1961 Radio Show with the number of manufacturers whose advertisements implied that their current television receivers could be adapted easily for use with UHF transmissions, if and when they were introduced.

***Parameters***

It is perhaps useful to note that while the new frequencies in themselves may cause little difficulty, other factors may well influence profoundly the design of receivers intended to receive signals on Band V. Simple 'conversion' of frequency will not necessarily suffice, as the following considerations may show. Direct conversion on the lines of the early Band III conversion, will enable present receivers to be used if the present line frequency standards continue, and if present modulation standards are maintained — these include lower sideband transmission, sound frequency lower than picture frequency, and positive picture modulation. These derive from the fact that all modern receivers are designed for a vision I.F. of 34-38Mc/s, sound I.F. of 38·15Mc/s, negative-going line and frame sync pulses, and a nominal bandwidth of 3Mc/s picture. In fact, both the above assumptions are unwarranted by the information available at the time of writing. Until the Pilkington Committee presents its report nobody will be certain of the standards to be adopted on Band V.

The future of regular broadcasting on Band V may well be left for speculation; the present experimenter may prefer to concentrate on the current low-power transmissions on Band V—with an eye to the future, of course. A reasonable guess for the high-power transmissions, due to begin some time in 1962, is that they will be on the frequencies, and with the standards, which

1. All the following components are critical to the design and must be kept within 10% tolerance.
   (a) All inductances.
   (b) C1, C2, C7, C12, C15, C16, C19, C20.
   (c) C3 (this must also be of high quality and of small enough minimum capacitance).
   (d) R2, R3, R4.
2. So far as R5 and R6 are concerned, their values are less important than that they should be equal in value and matched if possible to within 2%—this should be possible to achieve by judicious selection of suitable resistors from 10% components.
   The smaller of the two should be R5, so that the grid of V2 connected to their junction is positive rather than negative to the cathode of that half of V2. Grid current will then flow, and the voltage at the grid will be stabilised. Grid current of a small value does not affect the working of this half of the valve.
3. The remaining components are non-critical in nature, and the nearest reasonable values will often be suitable.
4. The suppressor grids of V3 and V4 must be connected to chassis.
5. Note than an underchassis screen plate is required across the valveholder of V2.

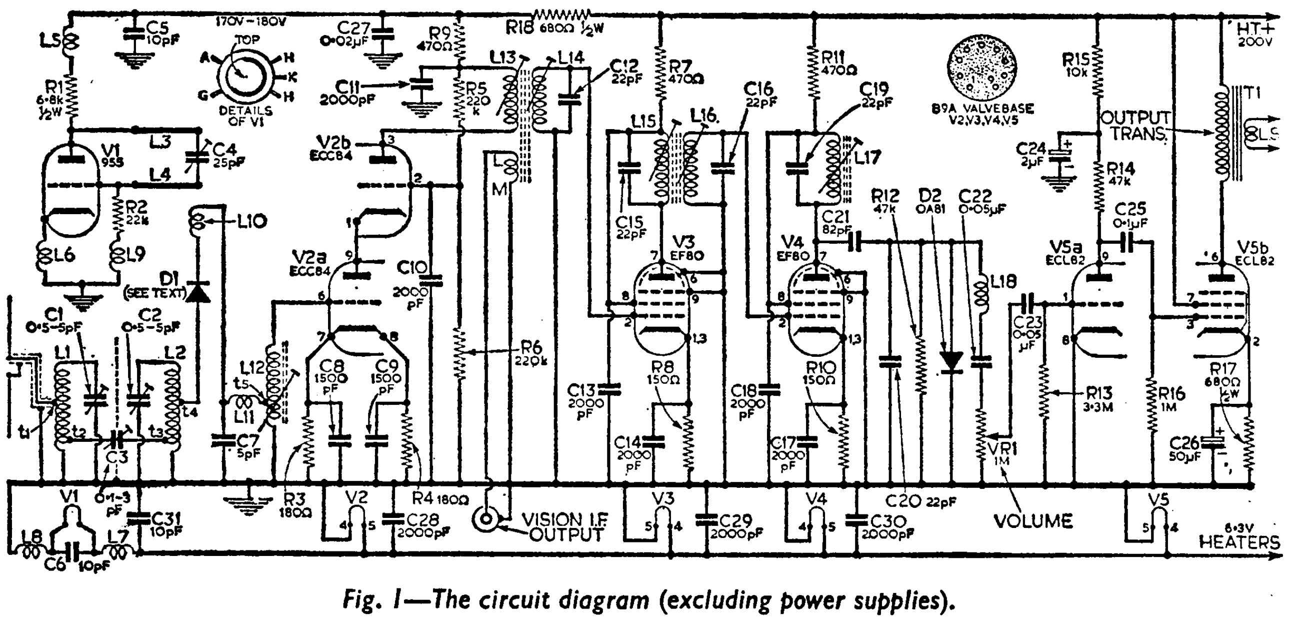



*Fig. 1—The circuit diagram (excluding power supplies).*

the BBC used when experiments ended in 1958. It is doubtful at any rate whether the BBC will wish to retune the high-power klystrons then used until something definite is settled. The frequencies previously used were 654·25Mc/s vision, and 659·75Mc/s sound.

### Results

It will thus be seen that the most obvious difference between next year's probable broadcasts and Channel 1 to 12 standards is the sound on the higher frequency. This indicates the probability that the higher vestigial sideband will be transmitted, with the carrier 6dB down near the lower edge, of the sideband. Present-day standards will thus be 'mirror-imaged'. However, if F.M. sound is transmitted, present detectors will make a poor show of receiving it, to say the least. Again, the present I.F.'s of 34·65Mc/s (vision) and 38·15Mc/s. (sound) will not be suitable because these are separated by only 3·5Mc/s, whereas a separation of 5·5Mc/s, or thereabouts, will be needed. Sound-on-vision may well be a problem. As can readily be shown, the use of sound traps of any reasonably practicable design inevitably increases the response of the vision I.F. amplifier outside the pass-band. Thus, a vision I.F. amplifier in itself sufficiently selective to reject a frequency 5·5Mc/s remote from the vision carrier, may actually be badly impaired by the presence of sound traps tuned to reject a frequency 3·5Mc/s remote from the carrier. Obviously what is required may well be a completely redesigned receiver.

For the present, however, these considerations may be shelved, since the current low-power transmissions from Crystal Palace are on one frequency only and are amplitude-modulated. In describing a receiver for these broadcasts it has nevertheless been thought advisable to make some provision for the future, and consequently some design limitations have been accepted.

In the first place, the oscillator has been made tunable over a wide range. If the present 405-line standards are used later, the first I.F. stage will be usable, in conjunction with the R.F. and oscillator stages, to convey a complete signal, via Channel I, to any receiver. If 625-line standards are used, the whole receiver will be usable as the sound receiver while either a poorish picture will be obtainable on most (slightly modified) domestic receivers, or a very good picture will be obtainable on a companion receiver specially designed. Of course, if colour should be transmitted, some more thought will have to be undertaken, but something will have been contributed to a colour receiver.

### Design

This receiver is, of course, a superheterodyne. The local oscillator runs at a frequency of 619·6Mc/s, but the frequency is adjustable to 699·9Mc/s

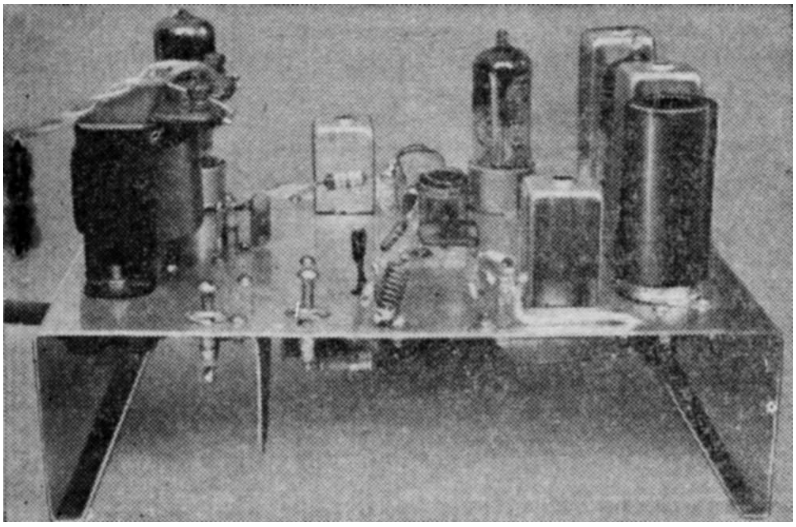
**COMPONENTS LIST**

**Resistors:**

| | | | |
|---|---|---|---|
| R1 | 6·8k ½W | R11 | 470Ω |
| R2 | 22k | R12 | 47k |
| R3 | 180Ω | R13 | 3·3M |
| R4 | 180Ω | R14 | 47k |
| R5 | 220k (matched pair with R6) | R15 | 10k |
| R6 | 220k (matched pair with R5) | R16 | 1M |
| R7 | 470Ω | R17 | 680Ω ½W |
| R8 | 150Ω | R18 | 680Ω ½W |
| R9 | 470Ω | VR1 | 2M (log) |
| R10 | 150Ω | | |

**Condensers:**

| | |
|---|---|
| C1, C2 | 0·5pF—5pF tubular adjustable |
| C3 | 0·1pF—3pF airspaced adjustable |
| C4 | 25pF bee-hive type trimmer |
| C5, C6, C31 | 10pF silver mica |
| C7 | 5pF silver mica |
| C8, C9 | 1500pF ceramic |
| C10, C11, C13, C14, C17, C18, C28, C29, C30 | 2000pF ceramic |
| C12, C15, C16, C19, C20 | 22pF silver mica |
| C21 | 82pF silver mica |
| C22, C23 | 0·05μF tubular 250VW |
| C24 | 2μF electrolytic 250VW |
| C25 | 0·1μF tubular 250VW |
| C26 | 50μF electrolytic 12VW |



*A view of the complete receiver*

if this becomes necessary later on. The intermediate frequency, for the sound on 659·75Mc/s, is at 40·15Mc/s, which would enable a mirror-imaged but probably usable vestigal sideband to be tapped off for a vision I.F. amplifier, in certain circumstances as previously implied.

No R.F. amplifier is used, because it is likely that most experimenters will be unable to obtain the special UHF valves required. Instead, a band-pass input stage is used, employing tuned transmission lines; this stage feeds a silicon crystal into which is also passed R.F. current from the local oscillator. Mixing takes place in this circuit.

Because of the absence of an R.F. stage the first I.F. stage employs a low-noise cascode amplifier; the remaining two I.F. stages use conventional pentodes, the noise contribution of which is of negligible importance. Because the current low-power transmissions are amplitude modulated, a simple crystal detector is used, but room has been allowed for a phase discriminator to be substituted later, if it is needed. The audio amplifier is of conventional design.

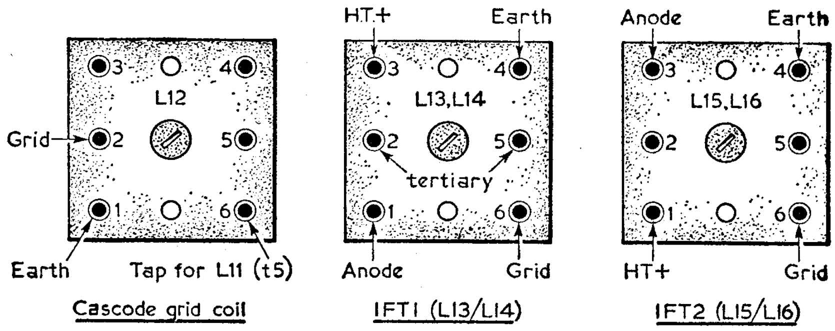



*Fig. 2—Details of the coil base connections.*

***Circuit***

Fig. 1 shows the circuit diagram. The oscillator consists of a coaxial lines oscillator. L3 is the outer of the coaxial tubes and L4 the inner conductor, while C6 is an air-spaced bee-hive type trimmer of maximum capacity 25pF. Details of the construction will be given later. The valve used is a 955 acorn triode, and the mixer consists of a silicon crystal. In the prototype, a government surplus crystal CV291 (a low-noise type) was used, but any microwave crystal can be used; CV103, 253, 291, 364 and 1844 are manufactured by AEI Electronic Apparatus Division, Carholme Road, Lincoln. The mixer crystal is coupled to the oscillator by means of a loop of wire placed close to the coaxial assembly.

***Aerial Circuits***

The input circuits comprise a tuned-lines band-pass assembly; coupling between the elements is capacitive, via C3 and each is tuned by a 0·5—5pF capacitor, C1 and C2. The aerial coaxial input is tapped direct on to L1, while the silicon crystal is tapped on to L2 at a suitable point.

L11 is a small choke which, together with C7, isolates the R.F. and oscillator stages from L12, the inductor tuned to the I.F. of 40·15Mc/s. A tap on L12 enables the low impedance of the crystal circuit to be matched to the input resistance of the first I.F. amplifier.

L12, the input, and L13, the output, of the cascode first I.F. amplifier, are tuned by stray capacitances only. Damping is not artificially introduced in this receiver because only sound is to be received. Later, it may be necessary to add damping for the bandwidth required.

***Neutralisation***

However, the circuits L12 and L13 are essentially broad-band in nature; L12 is damped by the input resistance of V2—about 22k at 40Mc/s—while L13 is damped by the output impedance of the valve. The only other points of interest in the cascode circuit are the absence of neutralisation—it was found unnecessary—and the reduction of cathode impedance by the use of parallel resistors and associated decoupling capacitors. These are connected to the two cathode pins.

The rest of the receiver is conventional in design. Layout is by no means critical, provided the usual precautions against stray capacitance and inductance are observed. In the cascode stage it is usually important to keep the output anode connection 'out of sight' of its cathode pin.

*(To be continued)*

***TABLE OF INDUCTANCE WINDINGS***

***Cascode Grid:***

***10 turns 28s.w.g. enamelled copper wire spaced by thickness of 34s.w.g. wire, tapped at 2 turns from earthy end for crystal diode connection.***

***Cascode Anode:***

***P. 10 turns 28s.w.g. enamelled copper wire spaced by thickness of 34s.w.g. wire.***

***S. 6 turns 24s.w.g., close-wound, spaced 1·2cm from anode winding; C=22pF.***

***Tertiary (for lead-out of vision signal eventually): $1\frac{1}{4}$ turns thin insulated wire over H.T. plus end of primary (i.e. nearest to grid winding).***

***I.F.T. 2:***

***P. $6\frac{1}{2}$ turns 24s.w.g. close-wound.***

***S. 6 turns 24s.w.g. close-wound.***

***Capacity=22pF (each winding).***

***Spacing 1·2cm between ends of winding.***

***3rd I.F. anode inductance:***

***5 turns 24s.w.g. close-wound; C=22pF.***

***All above on 0·27in. diameter formers, in screened can with VHF, purple coded, dust cores (Aladdin).***

***Note: L12 and L13, L14 and L15 need a long former and a long can ($2\frac{1}{2}$in.).***

***L11 and L16 need only a short former and a short can ($1\frac{1}{4}$in.).***

***L12 and L13, L14 and L15: in each case, P and S are wound in the same direction on the former. The 'inside' of each winding is of low R.F. potential—one to H.T. plus, the other to chassis.***

***L18 consists of 60 turns of 38s.w.g. enamelled wire wound on a $\frac{3}{16}$in. diameter former or $\frac{1}{2}$W resistor; no dust core is required.***

# A Band V Receiver

## THE PRACTICAL DETAILS OF THE CONSTRUCTION

By R. B. Archer

*(Continued from page 186 of the January issue)*

ALTHOUGH most of the layout and wiring of this receiver is not critical, it is necessary in the cascode stage to keep the output anode connection 'out of sight' of its cathode pin. This is arranged in this receiver by a suitable positioning of the heater decoupling capacitor C28 or the grid decoupling capacitor C10. Heater and H.T. leads must be kept well out of the way of circuits carrying R.F., but no heater chokes have been found necessary in the I.F. section.

### Construction (see Fig. 3)

The input circuits are constructed as follows. A hole of suitable size is drilled in one vertical side of the chassis, 2¾in. from the back edge, to take the low-loss aerial coaxial cable. No coaxial socket is used, as it introduces a capacitive discontinuity in the input lead too near the input circuit. At points X and Y an ⅛in. hole is drilled, and ¾in. 6B.A. brass bolts inserted, so as to project *below* the chassis. These are

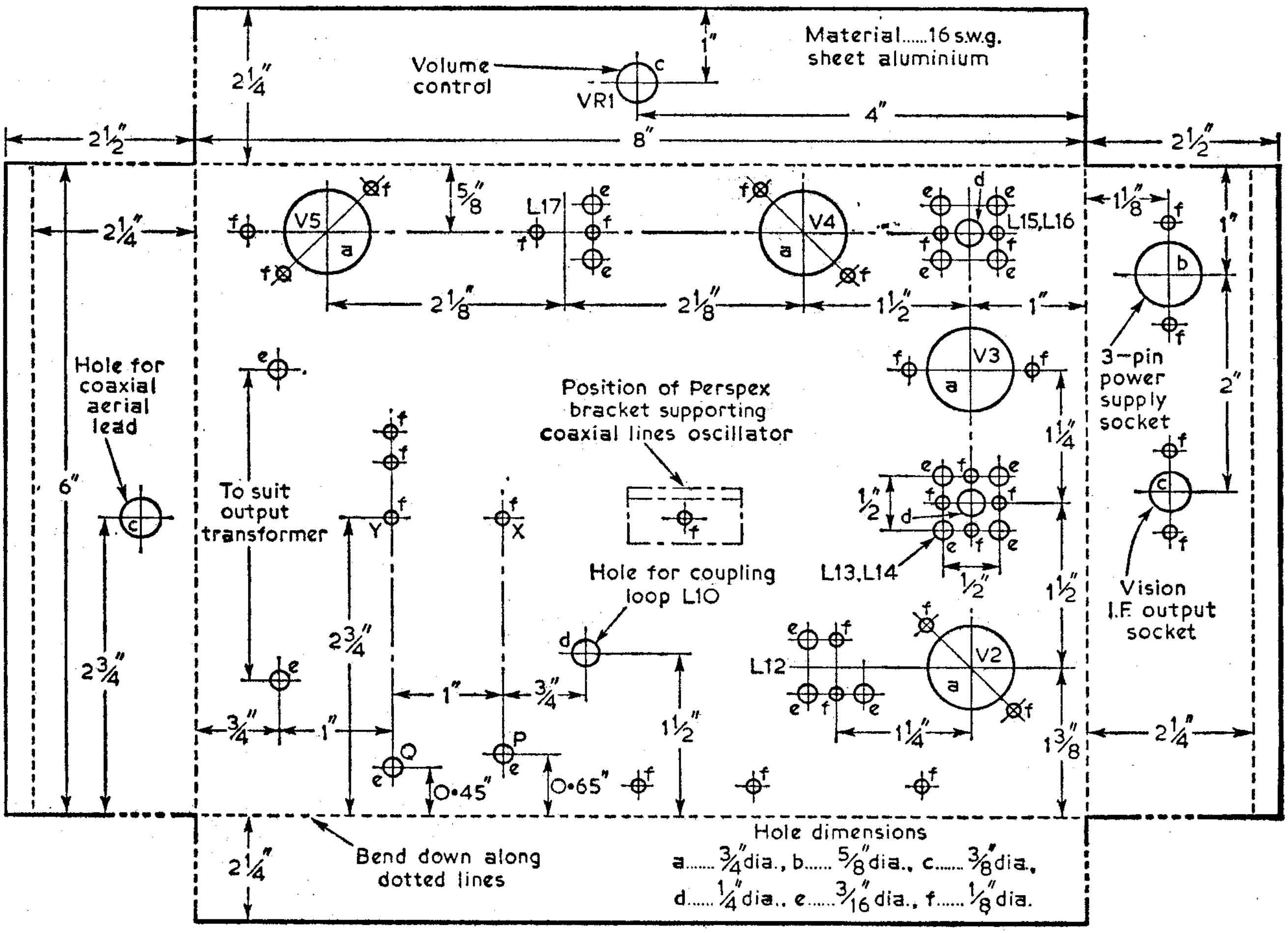



*Fig. 3—The drilling details of the chassis.*

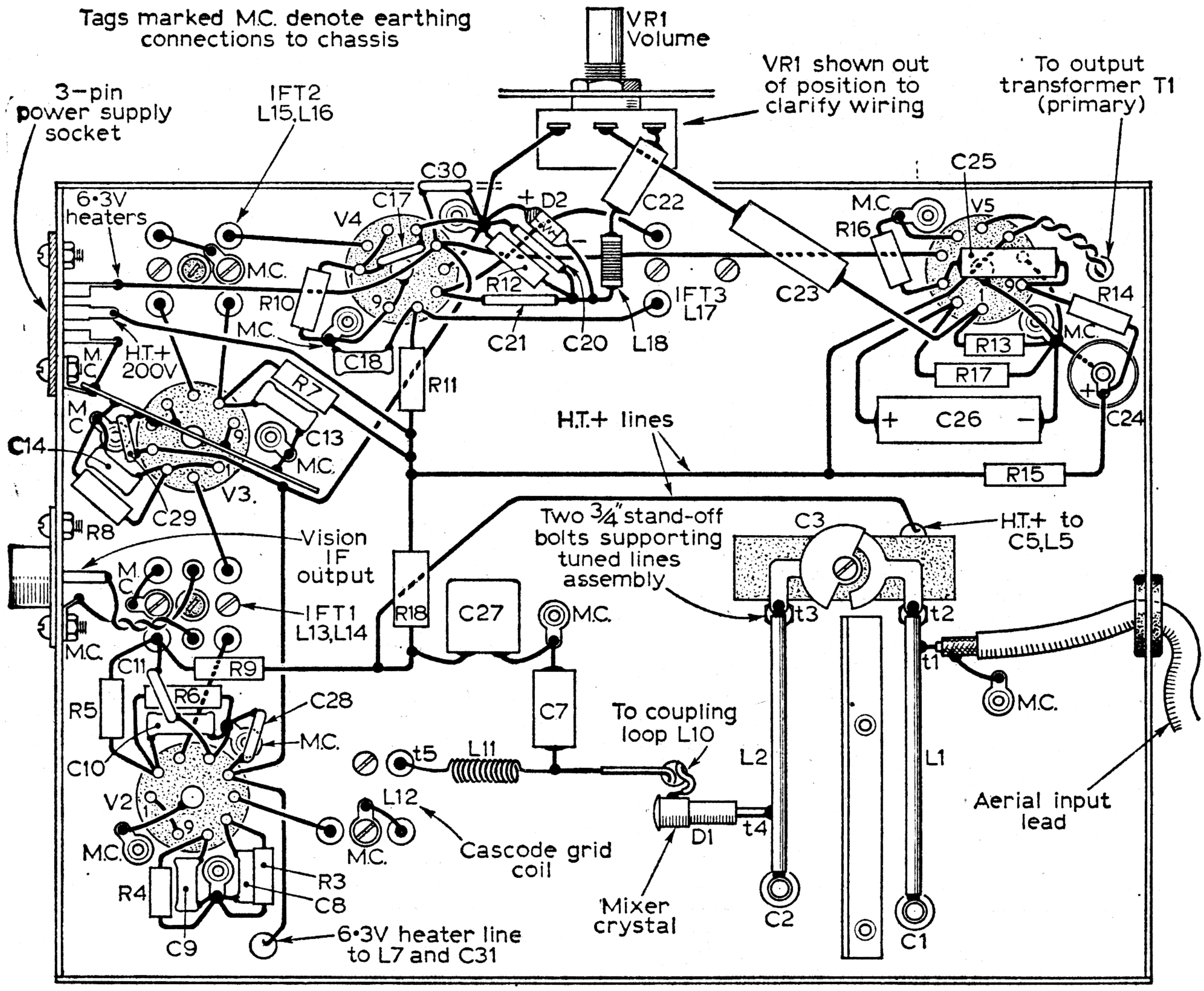



*Fig. 4—The underchassis layout and wiring of the receiver.*

secured firmly with a nut and washer, and using a hot iron, the end of each is tinned. Holes P and Q are next drilled, and enlarged with a small file to be $\frac{7}{32}$in. square; these are to take the tubular ceramic capacitors which tune the input circuits, and the latter may now be fixed in place with their flexible screw clips projecting below the chassis. A small screen is now put in place just midway between the lines PY and QY. When in place this screen should measure about 1½in. × 2½in. (see Fig. 4.)

Two pieces of silver-plated copper tubing, L1 and L2, ⅛in. o.d. are now prepared. The larger, L1, is soldered to the top of the bolt Y, and measures 2·0in. in length. The other end will now just reach to the tubular capacitor C1, and the wire end of C1 is soldered to it, making sure L1 lies parallel to the chassis and the small screen. The shorter tube L2 is now similarly mounted and soldered to the tubular capacitor C2.

Next the air-spaced variable capacitor C3 is mounted between X and Y, soldering it securely. The aerial is not attached yet, for reasons of practical convenience, but later the inner conductor will be soldered to L1 at a point 1·7in. from the end attached to C1.

***Mixer***

Clips are now prepared for the silicon crystal. Both are readily fashioned from thin brass sheet—the top contact strip of a spent cycle battery serves admirably. The smaller clip is a roll formed round a $\frac{1}{16}$in. drill, this is soldered on to L2 at a point 0·6in. from the end joined to capacitor P, and is arranged to lie across L2. The larger clip is formed round a $\frac{7}{32}$in. or $\frac{3}{16}$in. drill and its inherent springiness enables the crystal to be gripped securely. This clip has a projecting end, which is tinned for attaching to the coupling loop L10.

L10 consists of a length of PVC insulated wire 4in. in length. At the centre it is wound into a two-turn loop about 1cm in diameter—wound, for example, on a pencil. The ends of the loop are bared and tinned, and put through a suitably placed hole, about ¼in. in diameter, in the chassis. One end is soldered to the large crystal clip, the other to the capacitor C7, which has been fixed to the chassis. At the same time, the choke L11 is added, and connected to the tapping point on L12. The coupling loop L10 now projects about ¾in. above the chassis and will later be adjusted in position, near the oscillator circuit, to give the correct crystal current.

***Coaxial Lines***

The oscillator is next constructed, but is not assembled on the chassis until the I.F. and audio amplifiers have been wired, tested and aligned. It consists of a coaxial lines oscillator (see Fig. 5), and the elements are so designed as to have a

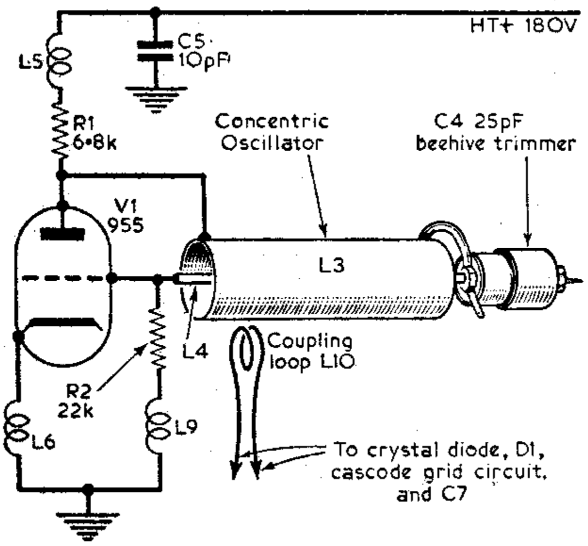



***Fig. 5—The coaxial lines oscillator.***

low impedance; this implies that its physical size is about as large as possible for a given frequency.

The outer tube is a brass cylinder of internal diameter $\frac{9}{16}$in. and 1·9in. in length. The thickness of the walls of the tube hardly matters, but in the prototype the outside diameter is $\frac{5}{8}$in. This tube is carefully cleaned internally (and, for appearance, exernally also) and is silver-plated internally at least. This will require some care, and because of the difficulty of stirring the electrolyte inside the tube it is recommended that a warm bath be used —about 60°C—and the current kept to about 20mA or less. The silver anode should be in the form of a strip of silver about 2in. long and $\frac{1}{8}$in. wide. A 2in. length of $\frac{1}{8}$in. o.d. copper tube is also prepared and silvered; this forms the inner conductor of the coaxial assembly.

Next, the small diameter tube is pushed over the centre lug of the beehive trimmer, and, using a really hot iron, is soldered into place. The outer tube is now positioned and is soldered to both the outer lugs of the beehive trimmer. At this stage some care is needed to ensure that the tubes are coaxial, or as near as may be. Small errors, up to about $\frac{1}{16}$in. eccentricity, do not make any appreciable difference to the working of the oscillator.

Suitable clips are now soldered to the other ends of the coaxial tubes, to take the pins of the 955 acorn valve. Edge-gripping clips are much to be preferred because the acorn pins can then be inserted right up to the glass envelope of the valve. When cool, the coaxial tubes are mounted on a Perspex bracket (with a hole in it) affixed to the chassis top side. If the assembly turns out to be slack in the hole it can be secured with a little contact adhesive. Before this is done, however, it will be as well to attach R1, and R2; the anode resistor is mounted on the end of the outer coaxial tube nearest the beehive trimmer; the grid resistor R2 is mounted on the inner conductor close to the acorn grid clip. To enable this to be done the inner conductor projects about $\frac{1}{16}$in. from the coaxial assembly.

By using a closely coupled high-Q assembly of this nature the frequency of oscillation can be brought very nearly to the limit for the valve. In one experiment the acorn behaved quite well at about 800Mc/s, so no difficulty will be experienced at 619Mc/s or even 700Mc/s if that frequency is required at any time.

*(To be continued)*

THE PRACTICAL DETAILS OF THE CONSTRUCTION

# A Band V Receiver

By R. B. Archer

*(Continued from page 235 of the February issue)*

LAST month details of the construction of the coaxial lines oscillator were given.

### *Acorn Clips*

In the prototype the acorn valve is secured in position by a choke of 18s.w.g. wire attached to the cathode pin and the chassis. Chokes of smaller gauge wire carry the heater current. However, it may well be desirable to use a tagstrip to mount the acorn; if care is exercised, it may be possible to solder the valve pins direct to the tag strip, but edge-gripping clips are recommended. Such clips may be obtained by dismantling a popular type of B8A valve-holder; although somewhat difficult to solder, the phosphor-bronze clips make an excellent contact.

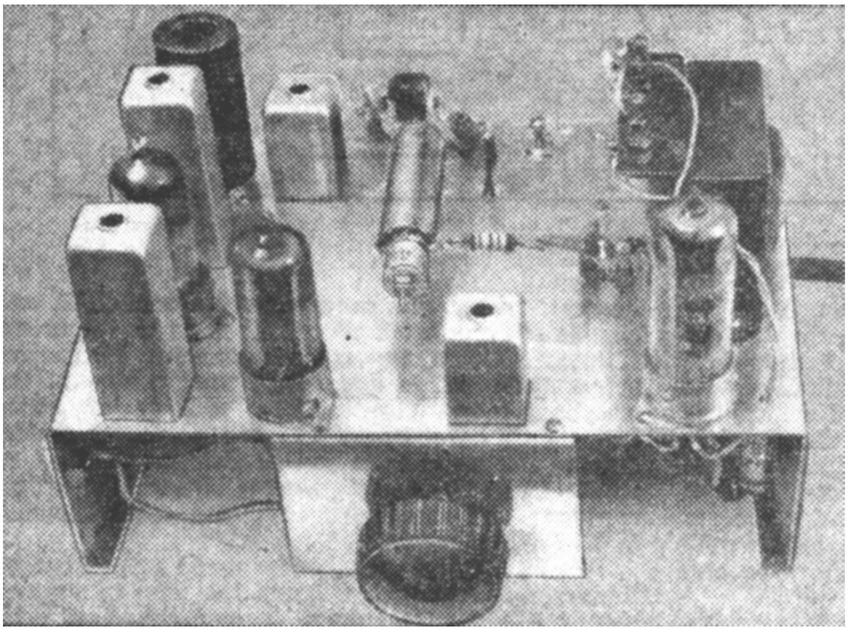
All the chokes in this receiver—L5, L6, L7, L8, L9 and L11—consist of 12cm. of 24s.w.g. bare tinned copper wire wound on an ⅛in. drill as temporary former. The winding is pulled out a little and then compressed again; this gives an even spacing between turns of about half the wire's diameter—enough to avoid much self-capacitance. If the acorn is mounted by means of a heavy-gauge cathode choke, the length of wire needed is the same. Stand-off ceramic insulators may be used to carry the H.T. lead.

It will be noted that the oscillator operates with a choked cathode. This renders the circuit operation less dependent on circuit 'strays'. Because of heater-cathode capacitance, the heater leads have to be 'choked' also. They are made to have the same R.F. potential by virtue of the capacitor C6 (Fig. 1, page 184 of the January issue).

### *I.F. Alignment*

Alignment of the I.F. amplifier follows normal practice, using an injected frequency of 40·15Mc/s. The next step is to align the oscillator. For this a signal generator will be needed unless the reader is very close to the transmitter. (The signal generator used by the writer was described by him in *Practical Television*, October and November 1959. This has had much use since it was built, and has proved to be very reliable; such an instrument is almost compulsory for any serious experimenter with Band V frequencies. Its only serious fault is slight detuning as maximum output is reached—but this is very seldom needed in actual practice.)

First, the coupling loop, L10, is arranged to be about 1in. away from the grid of the acorn valve. Its position will be adjusted accurately later. H.T. and L.T. supplies are switched on, and a five to ten minute warming-up period is allowed. The prototype requires seven minutes to reach a stable operating condition. The signal generator is set to 660Mc/s, and the coaxial lead is brought near L1—a separation of about 2in. will be found satisfactory in the inner



*A top view of the completed receiver.*

conductor of the cable projects about 1in. from the sheath. Modulation is switched on. The beehive trimmer is rotated, using a Perspex tool or a trimmer made of insulating material; at about half capacitance the signal will be heard. Adjust for maximum volume.

### *R.F. Alignment*

Next, L1 and L2 are trimmed for maximum volume, C3 being practically at zero. Now C3 is increased a little, retuning L1 and L2 for maximum volume. As this operation proceeds the signal generator output will have to be much decreased, volume, or evidence of a double-humped response, is achieved, C3 should be decreased a little and L1 and L2 again retuned. C3 needs only to be a fraction of a pF to obtain correct coupling; coupling (KQ) should be about 1·3—just over critical—but since the Q of the resonant lines L1 and L2 is so high K will itself be very small.

### *Mixer Current*

Finally, adjustment of the crystal current is made. This is to enable the conversion loss to be minimised and noise to be avoided. To measure crystal

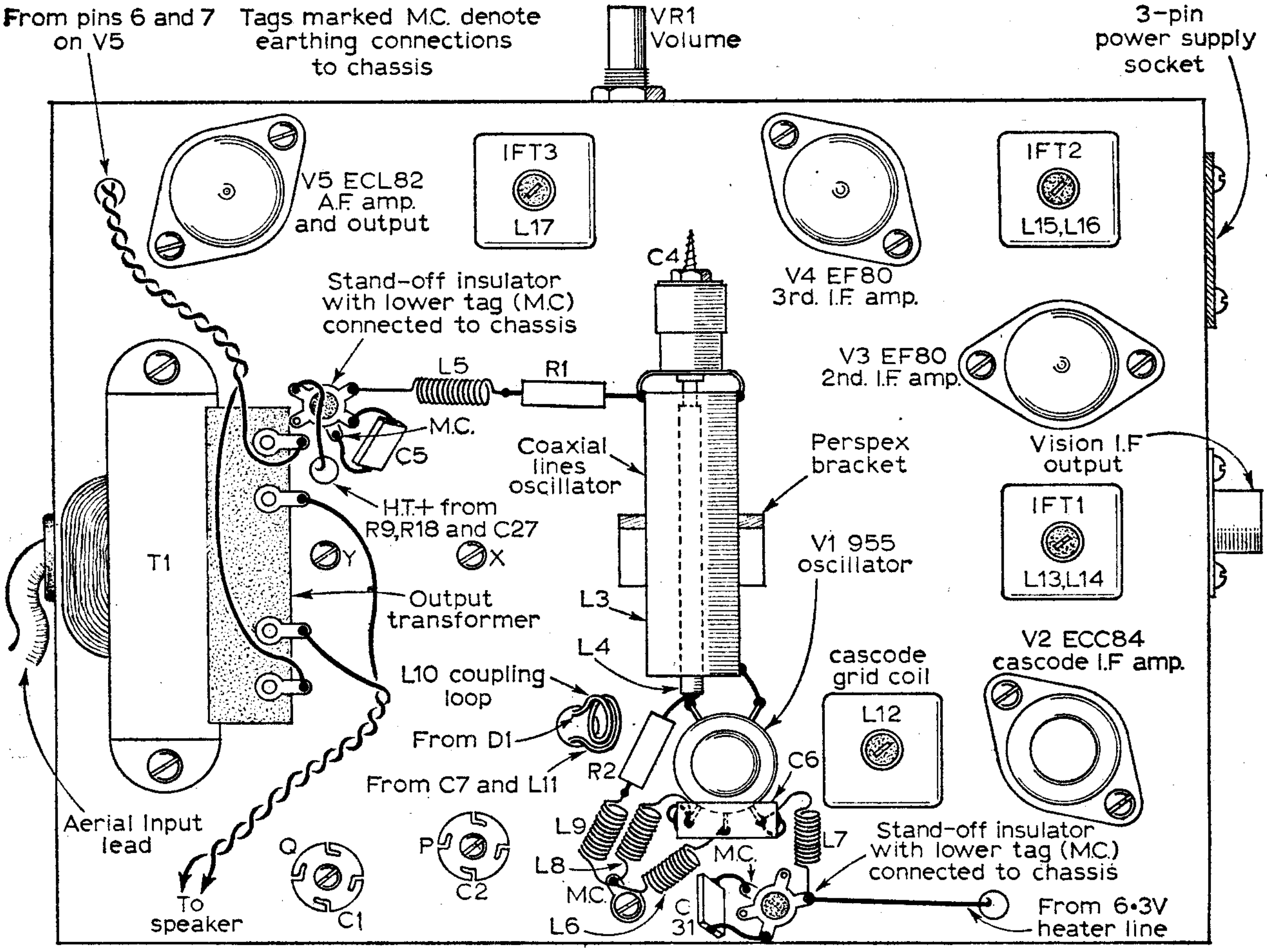



*Fig. 6—Above chassis layout of components.*

preferably by placing the coaxial lead much further from L1. Before C3 is increased more than a very little, the aerial input connection to L1 should be made, and L1 retuned. If it needs little or no retuning for maximum volume, a good match has been achieved. From this point, if the aerial is attached, it may be difficult to reduce volume sufficiently. If so, a short-circuit across the aerial will give little help, because of the inductance of the 'short' itself. It will be better to separate the signal generator from the receiver by putting it in the next room.

C3 may now be increased little by little, retuning L1 and L2 each time. As soon as a reduction in current, break the connection between L12 and chassis and put a 500pF capacitor across the break. Connect also a low-reading current instrument across these points and adjust the position of the coupling loop L10 until a reading of about 0·3—0·4mA is obtained. It will be found preferable to use an ebonite rod or Perspex trimmer to adjust L10. When satisfactory, remove the 500pF capacitor and the instrument, and earth the end of L12 again.

The final adjustment is now made by connecting the aerial, directing it towards the transmitter, and setting C4 for maximum volume. A final trim may be made on L1 and L2. ■