Using the B44 Mk. 2 Transmitter-Receiver on 70 Mc/s

By A. J. GIBBS, G3PHG*

FROM time to time, there becomes available on the Surplus Market an item of equipment that can be readily adapted for amateur use. Such is the case with the B44.MkII transmitter-receiver which, although originally intended for radio-telephone communications within a restricted area, can be modified to produce a potent and sensitive mobile transceiver for the 70 Mc/s band.

In its unmodified form, the transmitter and receiver sections of the B44 each operate on one crystal controlled spot frequency within the range 60 Mc/s to 95 Mc/s. The transmitter and receiver frequencies may or may not be the same, and are selected according to operational requirements. The power output of the transmitter is of the order of 3 watts into a 75 ohm load, whilst the receiver sensitivity is rated at 2 μV for 50 mW output.

After modification, the transmitter output is increased to 10 watts into a 75 ohm load, and offers a choice of two operating frequencies. The receiver sensitivity is increased to better than 0·5 μV and provides continuous tuning between 70·1 Mc/s and 70·7 Mc/s. The modifications which bring about these changes do not involve changing any valve types, although the r.f. stage of the receiver could be completely removed, and an E88CC cascode arrangement substituted. However, under normal mobile working, there is some doubt as to whether all the work involved in such a modification is justified.

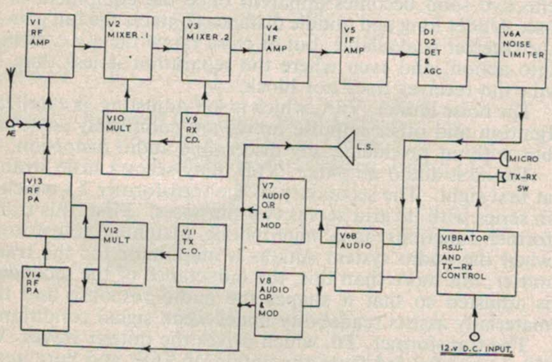


Fig. 1. Block diagram of B44 transmitter-receiver.

Before modifying equipment, it is always helpful to have a fairly thorough knowledge of it in its basic form. For this reason, this article falls fairly naturally into two parts. The first is concerned with the equipment in its original form, and the second enumerates the various modifications.

Since none of the modifications are particularly difficult or involved, except perhaps that associated with converting the receiver from crystal control to variable tuning, there may well be a temptation to undertake all the modifications in one fell swoop. This must be resisted. Each modification should be individually completed and the equipment checked before progressing to the next. This is vitally important in relation to the conversion of the receiver to variable tuning. *The B44 must be aligned using crystal control before this is attempted.*

While the order in which the modifications are listed may not seem, at first sight, to be the most logical, they are arranged in such a manner that the equipment can be made operational fairly quickly, and moreover, so that subsequent modifications do not cause the unit to be out of service for any great length of time.

* 6 Dairyfields, Gossops Green, Crawley, Sussex.

General Notes

The B44 is contained in a solid die-cast case, and has an even more solid front panel. This panel, upon which are mounted all the input and output sockets together with the controls, is attached to the chassis. The panel screws to the body of the case, and around the joint between the two is a rubber gasket. All sockets are fitted with waterproof caps. The original idea was to make the equipment so watertight that it could be thrown in a river for a few hours—yet be retrieved in good working condition.

The unit is powered from a 12 volt (nominal) secondary battery, and has a built-in vibrator power supply. The consumption is approximately: RECEIVE (stand-by) 3·5 amps; TRANSMIT 5·1 amps. With a fully charged 48 ampere hour battery in good condition, continuous operation for a period of 12 hours may be expected on a transmit-to-receive basis of 1 : 3.

The B44 is a transceiver which uses a common audio system for both receiver output and transmitter modulator (See Fig. 1).

The change-over from TRANSMIT to RECEIVE is accomplished by two relays which are actuated by a press-to-talk switch incorporated in the microphone housing. The contacts of this switch are so timed that the relays operate and mute the loudspeaker before the microphone insert is connected, so avoiding the audio howl which would otherwise occur.

A master control switch is fitted to the front panel and this has three positions: (i) OFF (ii) STAND-BY and (iii) TRANSMIT. In the STAND-BY position only the receiver functions, and in order to conserve current, the transmitter heater line is disconnected, as are the transmit-receive relays. If the press-to-talk switch is operated while the equipment is in the RECEIVE position, feedback will occur, and this serves as a warning that the transmitter is switched off. In the TRANSMIT position of the master switch, the transceiver becomes fully operational—after time has been allowed for the transmitter valves to warm up. This will be between 45 seconds and 90 seconds depending on the battery.

It should be particularly noted that, in its original form, the B44 is designed for *negative earth* supplies. If it is operated in a motor vehicle without modification, great caution will be needed to prevent it coming into contact with any metalwork, for if it does, it may well end up as a permanently spot-welded attachment. Take heed ! !

Receiver

The receiver arrangement is shown in block form in Fig. 1 while the circuit diagram is given in Fig. 2. Particular attention should be paid to the method of securing the mixer injection frequences, for although the system used in the B44 is now common commercial practice, it loses none of its cunning for all that, and could cause some confusion to those not familiar with this particular technique.

Fundamentally, the receiver comprises a bandpass tuned r.f stage, V1, followed by two frequency conversions, V2 and V3, feeding an i.f. amplifier system V4, V5, detector D1, a.g.c. D2, Noise Limiter, V6A, Audio, V6B, and push-pull output stages V7 and V8.

The r.f. stage, V1, is a straightforward pentode arrangement which requires no particular explanation, the grid coils

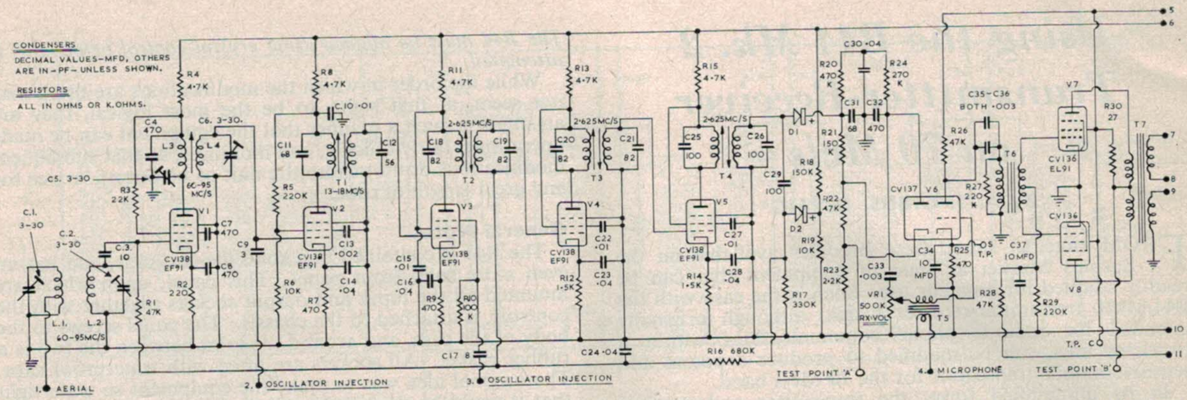


Fig. 2. Receiver and audio/modulator circuit. The terminals marked 1, 2, 3, 5, 6, 7, 8, 9, 10 and 11, connect with those bearing the same numbers in Fig. 3. Terminal 4 goes to Fig. 4.

L1, L2, and the anode transformer L3, L4, tuning over the signal frequency range 60 Mc/s to 95 Mc/s.

The first mixer, V2, is an EF91 operated as a pentode with oscillator injection to the signal grid g1. All incoming signals are converted to a first intermediate frequency in the range 13 Mc/s to 18 Mc/s by suitably adjusting the injection frequency. The second mixer is also an EF91, V3, but with the oscillator injection taken to the suppressor grid, g3. The output of this mixer is always at the fixed i.f. of 2·625 Mc/s.

The oscillator injection frequencies for both mixer stages are derived from a common crystal oscillator, V9 (Fig. 3) which feeds (a) the second mixer *directly*, and (b) after a frequency multiplier stage, V10, the first mixer. Since the output of the second mixer is at a fixed frequency, the output of the first mixer must vary over a specific range depending upon (i) the received frequency; (ii) the harmonic of the crystal oscillator, V9, produced by the multiplier V10, and (iii) the frequency of the crystal itself. While the B44 will accept signals in the range 60 Mc/s to 95 Mc/s, the first i.f. is restricted to the range 13 Mc/s to 18 Mc/s and this reduction in frequency range is accomplished by the correct selection of the crystal harmonic in the anode of V10. The main i.f. is 2·625 Mc/s as has been stated, and two stages of amplification V4 and V5 follow standard practice.

The detector and a.g.c. rectifier stages both employ semiconductor diodes: D1 and D2 respectively. Delay bias for the a.g.c. diode is derived from a simple potentiometer chain R18, R19 which is connected directly across the h.t. line. This delay is so arranged that the overall noise produced by the receiver does not trigger the a.g.c. system, and a fair level of signal is required to produce a.g.c. action. Such an arrangement is essential when short grid base pentodes are controlled by a.g.c. in view of the rapid manner in which they cut off. That this a.g.c. system is highly effective soon becomes apparent once the equipment is in use. Under long and middle distance contacts the full gain of the receiver is available, but at close range the a.g.c. swings into action, and even where the separation is less than 50 yd., the receiver does not block.

The noise limiter, V6A, which is self-adjusting, is excellent. Ignition and other impulse noises are completely removed, but without producing any discernible audio distortion.

The first audio amplifier, V6B, may seem a little strange at first sight. The secondary of the transformer T5 which is in series with its grid serves two purposes. First, this transformer functions as a microphone matching transformer when the audio system acts as a modulator for the transmitter, but more than this, the inductance of the secondary is adjusted so that it shapes the audio response and this materially assists readability under weak signal conditions.

The transformer, T6, which drives the output valves, V7, V8, is parallel fed from the anode of V6B, and here again some audio frequency shaping is introduced by C35 and C36.

The output valves, V7, V8, not only function as audio amplifiers for the receiver, but also as modulators for the

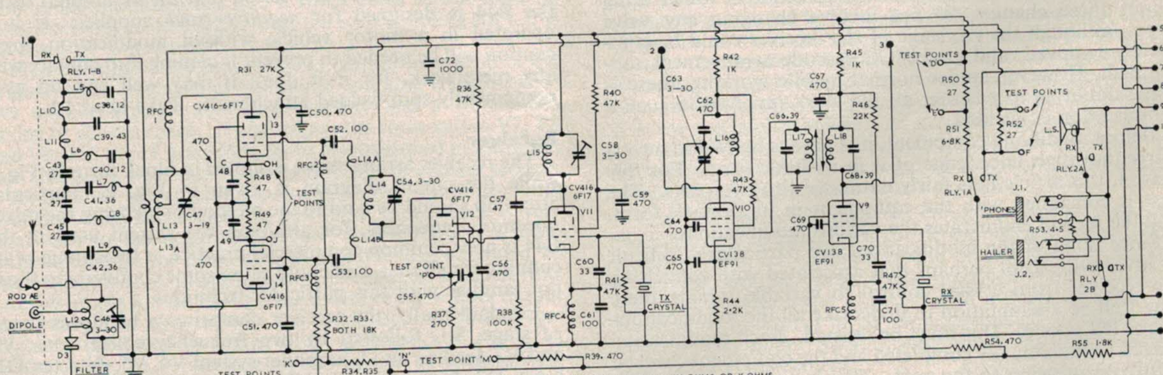


Fig. 3. Transmitter and receiver crystal oscillator/multiplier. The terminals marked 10, 12, 13 and 14 connect with those bearing the same numbers in Fig. 4.

transmitter. It should particularly be noted that they are operated under class B conditions with fixed bias. It is because of this, and the fact that there is more than ample reserve of power in this stage, that the B44 carrier power can be substantially boosted without suffering from severe undermodulation.

Receiver Bandwidth

The bandwidth of the first i.f.—13 Mc/s to 18 Mc/s—is of the order of 280 kc/s at the 6db points, while that of the second i.f.—2·625 Mc/s—lies between 50 kc/s and 70 kc/s at the 6db points.

When the receiver is to be used within the frequency range 60 Mc/s to 76 Mc/s, which includes the 70 Mc/s allocation, the frequency of the receiver crystal, together with that of the first i.f., is determined as follows:

Frequency of received signal F
Let first i.f. be F_1
Let second i.f. be F_2
Let crystal frequency be F_x
Let multiplier output be F_m
Let crystal oscillator output be F_o

For a signal frequency between 60 Mc/s and 76 Mc/s:

$$F_o = 3F_x$$

and $$F_m = 9F_x.$$

Now since $$F_1 = F - F_m = F - 9F_x$$

and $$F_2 = F_o - F_1 = F_o - F + 9F_x = 3F_x - F + 9F_x = 12F_x - F$$

therefore $$F_x = \frac{F_2 + F}{12}$$

Example: Received frequency 70·32 Mc/s

F = 70·32 Mc/s . . . Given.
F_2 = 2·625 Mc/s . . . Fixed second i.f.

As $$F_x = \frac{F_2 + F}{12}$$

Substituting $$F_x = \frac{2{\cdot}625 + 70{\cdot}32}{12} = \frac{72{\cdot}925}{12}$$

THEREFORE CRYSTAL FREQUENCY IS 6·079 Mc/s

First i.f. is $$F_1 = F - 9F_x = 70{\cdot}32 \text{ Mc/s} - (9 \times 6{\cdot}079 \text{ Mc/s}) = 70{\cdot}32 \text{ Mc/s} - 54{\cdot}711 \text{ Mc/s}$$

HENCE FIRST I.F. IS 15·609 Mc/s

Receiver Alignment

It is essential to undertake the initial alignment of the receiver section of the B44 while its local oscillator is crystal controlled and not after conversion to a tunable type.

Even as it stands, the alignment procedure can be quite tricky if any appreciable shift is required to bring it on to the 70 Mc/s band, and the introduction of yet another—and unproven—variable might well make it an exceedingly difficult operation.

The alignment of the B44 most certainly cannot be undertaken with a wet finger and a screwdriver. The minimum of test equipment required is as follows:

(a) A signal generator which is reasonably accurate in the 2 Mc/s to 3 Mc/s and 13 Mc/s to 18 Mc/s ranges, and goes up to 70 Mc/s. In-so-far as the last-mentioned frequency is concerned, the second harmonic of a generator on 35 Mc/s could be employed.

(b) *One* of the following items: (i) valve voltmeter; (ii) audio output meter or (iii) a microammeter with a sensitivity of 500 μA or better.

(c) A damping circuit consisting of a 0·01 μF capacitor and 1K ohm resistor in series fitted with short clip leads.

While it may just be possible to align the B44 without the use of a signal generator, it will involve hours of frustration and tons of luck—so don't try.

The general order of the alignment procedure is to check out the second i.f.; align the first i.f. to the precalculated frequency associating with this adjustments to the crystal oscillator, and finally adjust the r.f. signal circuits together with the crystal oscillator multiplier stage.

Second I.F. Amplifier on 2·625 Mc/s

Connect either an audio output meter to the 'phone jack on the front panel, or a valve voltmeter across the a.g.c. line (between the junction of D2/R17—negative—and chassis. Tag 5 on tag strip F. See Fig. 6) or a sensitive microammeter across part of the diode detector load (across R23. Connect meter between Test Point A—positive—and chassis. See Fig. 5).

Set the generator to exactly 2·625 Mc/s and connect between pin 1 of V5 and chassis. Adjust the generator output to give about half scale reading on the meter indicator. If a valve voltmeter is employed, this should be set to its 5 V range. Adjust the *upper* core of T4 for maximum output. Connect the damping network between pin 5 of V5 and chassis. Adjust the *lower* core of T4 for maximum output.

Remove the damping network and connect between pin 1 of V5 and chassis. Connect generator between pin 1 of V4 and chassis. Retune upper and lower cores of T4 for maximum output. Tune *upper* core of T3 for maximum output. Transfer damping network to between pin 5 of V4 and chassis. Now tune *lower* core of T3 for maximum.

Remove the damping network. Connect the generator between pin 1 of V3 and chassis. Retune T3. Tune *upper* and *lower* cores of T2, and in that order, for maximum output.

The output of the generator will have to be progressively decreased as the various stages are tuned to resonance, and this should be done in such a manner that the meter indicator remains at about half scale reading.

To complete the alignment of the second i.f. amplifier, all the core settings should be finally checked working back from the detector to the second mixer.

First I.F. and Crystal Oscillator

Fit the correct frequency crystal to the receiver crystal oscillator socket.

Set the signal generator to the precalculated first i.f. and connect it between pin 1 of V3 and chassis.

Gently rock the signal generator about the calculated

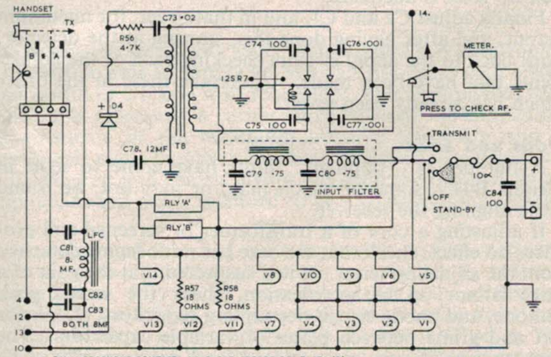


Fig. 4. Vibrator power supply and control circuits.

first i.f. to see if any output can be secured. If not, leave it set to the calculated figure and adjust L18, *upper* core in screening can, until output is secured. Alternate these adjustments, i.e. rocking the generator about the calculated frequency and L18 core, until output is secured. Once this has been achieved, adjust L18 for maximum output.

Connect the generator to pin 1 of V2 and set it to the first i.f. Adjust T1, *upper* core and then *lower* core for maximum output.

R.F. Stage and Crystal Multiplier

Connect the signal generator to pin 1 of V2, and set its frequency to about 70·3 Mc/s. Rock the generator tuning about this point until some output is obtained. It may be necessary to increase substantially the generator output in order to secure a response, and furthermore, as very few generators are accurately calibrated in this region, the frequency at which output is secured may appear to be incorrect. Once some output has been secured, adjust L17, *lower* core and L16, and in that order, for maximum output.

Transfer the generator to pin 1 of V1. Adjust C5 and C6 to their mid-positions, and then adjust the core common to L3, L4 for maximum output. Finally, touch up C5 and C6 until no further increase in output can be secured. C5 and C6 should be around their mid-positions after the adjustments have been completed, and if they are not, further attention should be given to the common core of L3, L4.

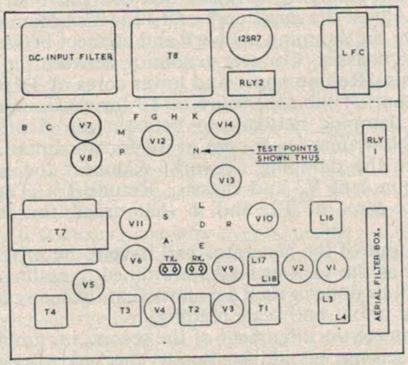


Fig. 5. Layout of above chassis components.

At this stage there may well be so much gain from the receiver that it is impossible to keep the output of the generator down sufficiently to prevent overloading. If this is the case, connect a short wire aerial to the aerial input socket, and remove the generator to a distance at which the pick-up level is adequate.

Finally adjust C2 and C1, and in that order, for maximum output, and after having done this, starting at the detector, work back to the aerial circuits checking each of the adjustments that have been made. Undertake these in the order which has already been given.

Odds and Ends

A number of "popular" faults have come to light in various B44's, some of which may, or may not, be found while aligning the receiver.

If adjusting a core of a transformer or screened coil produces no effect, check that the core has not become detached from the adjusting screw. If it is suspected that the gain of a stage is not up to specification, check the screen grid, cathode, and anode circuit decoupling capacitors. Look for dirt and grime between plates of variable capacitors. The vane spacing is very close indeed, and great care must be taken when adjusting them to avoid placing too much pressure on the screw. One capacitor in particular, C4, 470 pF, is very prone to blow up, and should be replaced irrespective of whether it seems to be good.

Modification 1—Aerial Filter

The aerial filter has a power insertion loss of 3db, and this reflects on both the transmitter and receiver. As we are concerned with optimum performance, and are not likely to operate the B44 adjacent to transmitters working on closely related frequencies, this unit can be removed completely.

This is a perfectly straightforward operation which requires no particular explanation.

Measurements conducted on a B44 transmitter operating without the filter box have shown the following attenuated radiations in relation to the carrier frequency and power: 35 Mc/s not measurable; 105 Mc/s 85db down; 140 Mc/s 60 db down. All measurements were made at a distance of 40 ft., and are well within the requirements of the licensing authority.

Modification 2—Rod Aerial Mountings

Once the filter box has been removed, the rod aerial mountings may also be detached from the front panel. In each of the two holes left, a chrome bezel neon indicator may be fitted, green in the top, and red in the bottom. Wiring these to the receiver h.t. supply—Test Point D—and the transmitter h.t. supply—Test Point G—respectively will provide a visual check on the h.t. supplies, as well as indicating TRANSMIT or RECEIVE.

Modification 3—Changing to Positive Earth

As the Plessey 12SR7 vibrator is a self-rectifying unit, changing the polarity of working involves replacing the rectifying elements of the 12SR7 by some external rectification system. BY100 silicon rectifiers are used for this purpose. While it is possible to get away with using only two rectifiers, it is false economy to do so as the reliability factor is not adequate, due in the main to the peaky nature of the waveform produced by the vibrator.

Four BY100 rectifiers should be arranged in pairs, and the rectifiers in each pair wired in series so producing two complete rectifier units. Across each individual rectifier a 470 pF 500 V capacitor should be connected.

Disconnect the wires attached to pins 2 and 5 on the base of the 12SR7 vibrator (See Fig. 6). Tags 1 and 2 on tag strip A will be found to be unused. Connect one of the wires to tag 1, and the other to tag 2. Arrange the rectifier units as illustrated in Fig. 7(a). If the B44 being modified is fitted with a meter, the leads on the rear of this must now be reversed.

This completes the working polarity changes, and the B44 will now operate with positive earth systems.

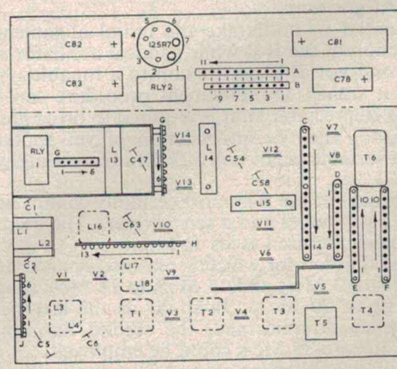


Fig. 6. Position of components on underside of chassis. Component tag strips are identified by code letters. The tags are numbered in the direction indicated by the arrow.

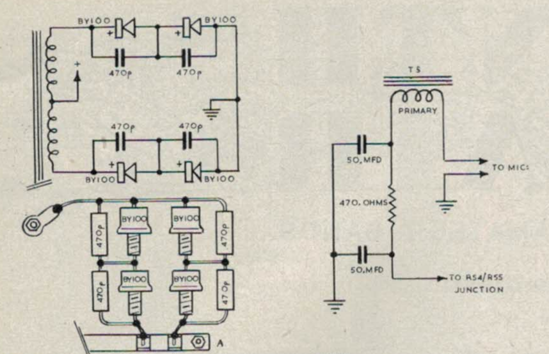


FIG 7A FIG 7B

Fig. 7. Revised rectifier circuit allowing operation on positive earthed supplies. Modifications required to microphone input circuit to accommodate a carbon microphone.

Modification 4—Bias Supply

One of the modifications to be detailed later involves changing the microphone type from electromagnetic to carbon. As the polarising current for the carbon microphone is derived from the bias line supplying the modulator valves and transmitter, an extra load is placed on this supply. While this is quite within the capabilities of the transformer T8, the bias rectifier, D4, is not man enough for the job.

To prevent bias failure, and the consequential damage, the bias rectifier should be replaced. A BY100 may again be used, although in this case a much smaller silicon diode could be employed. The rectifier will be found between tags 8 and 11 on tag strip A.

Modification 5—Increasing I.F. Gain

Both the i.f. amplifier valves are run with a very high value of cathode bias, and a substantial increase in sensitivity can be achieved by reducing the cathode resistors fitted—1·5K ohms—down to 220 ohms (See R12 and R14 on V4 and V5, Fig. 2).

Modification 6—Reducing First Mixer Noise

Pentode mixers are notoriously noisy and the EF91 arrangement in position V2 is no exception. This can be converted to a triode mixer by the simple expedient of connecting the screen grid directly to the anode, and disconnecting the screen feed resistor R3. Quite obviously this does not give the absolute optimum performance, but nevertheless it is simple and very worthwhile. Experiments with injection levels from the local oscillator line seem to indicate that, as it stands, the level given by the existing coupling arrangement is satisfactory.

The supply to the screen grid of V2 is taken from tag H7—bottom (See Fig. 6). The wire running from this tag to the valve base should be disconnected, and pins 5 and 7 on the valve base connected together.

Modification 7—A.G.C. and Detector Diodes

The diodes fitted to the B44 in positions D1 and D2 have been found to suffer from ageing effects causing inferior back resistance and a poor forward to reverse ratio. These should be changed for diodes type OA81.

The diodes are located inside rubber sleeves and positioned between tag strips E and F near the transformer T4.

Modification 8—Increasing A.G.C. Delay

With the now increased gain of the receiver, shot and thermal noises rise to a level far greater than that of it in its original form. This results in a small standing a.g.c. voltage being developed which produces a reduction in gain—quite at variance with our objective. This is overcome by increasing the positive delay voltage applied to the a.g.c. diode D2.

The biasing resistor R19 should be increased from 10K ohms to 15K ohms. In some cases 22K ohms has been found satisfactory. The object is to use as large a value as possible, but not so large that the receiver blocks under local reception conditions. This resistor will be found positioned between tags E9 and F9 (See Fig. 6).

Modification 9—A.G.C. Line Clamp Diode

In some instances where the delay voltage has been increased, it has been found that the a.g.c. line swings positive under no signal, or low signal, conditions. If a valve voltmeter is available this point can be verified.

This may be overcome by fitting a clamper diode to the a.g.c. line. The diode, type OA81, should be fitted between tag H1—lower—and chassis with its positive end connected to the tag H1.

Modification 10—Delay Voltage Decoupling

From the circuit of Fig. 2, it will be seen that the delay voltage junction R18, R19, is not decoupled. This creates quite a lot of noise. It can be overcome by fitting a 0·1 μF capacitor from the junction of R18, R19 to chassis. The capacitor should be fitted from tag F10 to earth.

Modification 11—Audio Top Cut

A worthwhile reduction in receiver hiss can be achieved by introducing some top cut into the receiver audio system. As this must be positioned so that it does not affect the operation of the modulator, it is arranged between the slider of the volume control and chassis, and consists of a 0·001 μF capacitor wired in this position.

This completes the first series of modifications to the receiver and power supply.

(*To be continued*)

International Red Cross Tests

A series of test transmissions has been arranged by the International Red Cross Society. These will take place on September 21, 23, and 25, at 07.30, 13.00, 16.30 and 22.30 BST on 7210 kc/s. Reports which will be acknowledged by the IRCS direct from Geneva, should be sent to G. A. Allcock, G3ION, 71 Bassett Green Close, Southampton, Hants.

Single Sideband (Continued from page 574)

the passbands are usually wider than this and KW Electronics Ltd. will be able to supply an MF 455-10K filter with a 6db bandwidth of 2·5 kc/s if so requested. Filter bandwidth in a receiver is inherently a compromise between the conflicting requirements of the maximum possible selectivity and a reasonable audio bandwidth without objectional colouration.

The circuit and chassis layout has been given primarily as a guide, as this is not intended to be a constructional article.

* * *

It is regretted that it is quite impossible to find sufficient time to answer individual queries in relation to receiver construction. Any reader requiring further help is therefore referred to the RSGB publication *Communication Receivers*, to the excellent article by George C. Monkhouse in the June, 1964 issue of the Bulletin, and to *Single Sideband*, February, 1964.

Part 2

Using the B44 Mk. 2 Transmitter-Receiver on 70 Mc/s

By A. J. GIBBS, G3PHG*

THE block diagram of the transmitter was shown in Fig. 1 and the circuit details in Fig. 2 in the first part of this article.†

The line-up consists of a Colpitts crystal oscillator, V11, followed by a multiplier, V12, feeding push-pull p.a. valves V13, V14. The p.a. at all times functions as a straight amplifier.

The crystal oscillator, V11, has its anode circuit tuned to either the second or third harmonic of the crystal. In the range 60 Mc/s to 80 Mc/s, it is tuned to the third harmonic. The multiplier either doubles or trebles, and in the range 60 Mc/s to 80 Mc/s it operates as a doubler, the final output being at the desired carrier frequency. Capacity coupling is employed between the crystal oscillator and the multiplier.

The p.a. grids are inductively coupled to the tank circuit of the multiplier by a lumped inductive circuit consisting of L14a, L14, and L14b. Protective bias is applied to the p.a. so avoiding the damage which would occur in the event of failure of the drive.

The transmitter is liberally supplied with test points which permit the functioning of each stage to be easily checked. The circuits related to each test point are as follows: M—multiplier grid drive; P—multiplier cathode current; K—grid current of one p.a. valve; L—grid current of the other p.a. valve; H—cathode current of one p.a. valve; J—cathode current of the other p.a. valve.

Transmitter Crystal Frequency

The overall frequency multiplication which takes place within the range 60 Mc/s to 80 Mc/s is six times (c.o. × 3; mult. × 2). The crystal frequency is therefore equal to the carrier frequency divided by six. For a frequency of 70·32 Mc/s, the crystal frequency will be 11·720 Mc/s.

As it is possible to tune the multiplier so that it functions as a tripler, a multiplication factor of nine times can be secured (c.o. × 3; mult. × 3). Under these conditions, a 7·813 Mc/s crystal would produce a carrier frequency of 70·32 Mc/s. However, crystals in this frequency range should be avoided for two reasons. First, they produce TVI, and secondly, due to the increased multiplication factor, it is difficult to produce adequate drive for the p.a.

While the official procedure is to extract the third harmonic from the crystal oscillator, and double this in the multiplier when the final frequency lies between 60 Mc/s to 80 Mc/s—which of course covers the frequency range in which we are interested—with an 11·72 Mc/s crystal this means that the output of the crystal oscillator is on 34·26 Mc/s. This is dangerously near the vision i.f. of most television receivers. On the effective " goodness " of the TV receiver front-end, and the radiation from the B44—itself a variable factor—will depend what patterning, if any, the transmitter produces. One way round this is to reverse the procedure, and to tune the crystal oscillator to the second harmonic of the crystal, and make the multiplier triple the frequency. In some cases, however, this tends to make the drive to the p.a. a little short of the required amount, and in bad cases actually reduces the r.f. available.

It is suggested that the initial setting up of the transmitter is carried out in the official manner, and if patterning becomes a problem, to try the frequency multiplication the other way round.

Transmitter Alignment

In addition to a reliable wavemeter calibrated at 24 Mc/s, 33 Mc/s and 70 Mc/s, two other items are particularly well worth having when setting up the B44 transmitter. The first is a dummy load of about 75 ohms, and the other is an s.w.r. bridge. Attention is drawn to the article by Paul Harris, G3GFN, in the May, 1964 BULLETIN which describes suitable equipment. Failing an s.w.r. bridge, an r.f. voltmeter—also described in the May issue—can be used.

The dummy load should be connected to the transmitter output with the s.w.r. meter or r.f. voltmeter also in circuit. Failing any of this equipment, a lamp load can be used, but it is nowhere near so satisfactory for producing the maximum output. A 12 V 12 watt car tail lamp can be used.

A shorting link should be placed across the primary of the microphone transformer, T5, and a flying lead connected to the relay switch line at the microphone socket, the other end of which is provided with a crocodile clip. Connecting this clip to the chassis will trip the equipment from receive to transmit.

Turn the master switch to the TRANSMIT position, and insert the transmitter crystal. Inside the p.a. tuning compartment will be found a tag strip—G on Fig. 6.† Remove the link between tags 5 and 2. This disconnects the h.t. to the p.a.

Key the transmitter by connecting the clip on the flying lead to the chassis. Connect a meter set to its 5 mA range between test points M and N, M being negative. Tune C58 for maximum indication of the meter, and check with the wavemeter that L15 is resonant at about 33 Mc/s.

Transfer the negative lead of the meter to test point L, leaving the positive lead on test point N. Tune C54 for maximum indication on the meter. This should not be less than 3·5 mA, and will not be more than 4 mA. Check with the wavemeter that L14 is resonant at 70 Mc/s. This is *most* important for it could inadvertently be tuned to about 99 Mc/s, in which case the final transmission frequency is likely to be in association with some other service.

Now shift the test meter lead to test point K and confirm that the drive at this point is the same as that at point L. If it is not within 0·25 mA, then adjust either L14a or L14b, or both, until the readings at L and K are within this tolerance. *Caution:* Adjustments to L14a and b should be made either with the power off, or with a plastic rod.

Switch off. Restore the p.a. h.t. link between G2 and G5, and ensure that a dummy load is connected. Offer up the wavemeter to the p.a. tank circuit L13, C47. Key the transmitter, and quickly adjust C47 for resonance at 70 Mc/s as indicated on the wavemeter. Once the approximate position of C47 has been located, then either the s.w.r. meter, r.f. voltmeter, or light from the dummy load will indicate the progress of further adjustments.

If a resistive dummy load is employed, together with an s.w.r. meter, then the position of the link L13a and the tuning of the p.a tank capacitor C47 can be adjusted for optimum power transfer into this load, after which no further adjustments will be required.

A final check is to measure the cathode currents of the p.a. valves. With a meter set to its 50 mA range, the negative lead connected to the chassis, touching the positive lead to the test point H should show a reading *not exceeding* 35 mA. Shifting the positive lead to test point J should produce a reading within 2 mA of that obtained at test point H. If this is not so, and assuming that the grid drive is within the

* 6 Dairyfields, Gossops Green, Crawley, Sussex.

† Part 1 of this article was published in the September issue of the RSGB BULLETIN.

tolerances given, then the output valves are badly mismatched and at least one will have to be replaced.

Modification 12—Increasing Transmitter Power

The transmitter power may be substantially increased by the simple expedient of changing the value of the p.a. screen grid resistor R31. The existing value, which is 27K ohms, should be removed and replaced by two 22K ohms ½ watt resistors connected in parallel. R31 will be found connected between tag G4 and the base of V13.

This modification increases the carrier power output from 3 watts to approximately 10 watts.

Modification 13—Increasing Modulation

Once the carrier power has been raised, it is essential to increase the power output of the modulator to a level more satisfactory for the new p.a. d.c. input. This is accomplished by changing the microphone from an electromagnetic type to a carbon, and adjusting the polarizing voltage to produce the required peak output from the modulator.

The revised circuit is shown in Fig. 7(b).†

The screened lead which runs from the microphone input socket to the input transformer, T5, has its screening at the transformer end removed from the tag on the transformer to which it is connected. A new earthing point is fitted to one of the transformer retaining screws, and the braiding of this lead connected to it. This now leaves one of the transformer tags disconnected. From this tag a 50 μF 50 V capacitor is connected to the new earthing point, with its *positive*, note, *positive* earthed. From this same transformer tag, a 470 ohms ½ watt resistor is connected to the junction of R54/R55, and also from this junction another 50 μF capacitor is connected to chassis—positive again to earth. A carbon insert microphone may now be used.

To avoid vibrator hash, the connection on the rear of the microphone input socket which links the switch line to the screening of the cable should be removed. The screened cable should only be earthed at the new tag point fitted by the transformer T5. No other earthing is required. This implies that the screening of the microphone cable shall not find any earthing through the plug and socket arrangement, from which it must be insulated. If a T-17 microphone is employed, the screening of the microphone lead must, of course, be connected to the metal of the handset.

The B44 should now be fully operational using crystal control in the receiver, and having one transmission frequency.

Modification 14—Improving the R.F. Amplifier

The gain of the r.f. amplifier of the receiver may be increased by reducing the value of the cathode bias resistor from 220 ohms to 150 ohms (R2). A worthwhile increase in small signal performance can be achieved by increasing the value of the coupling capacitor between L2/C2 and the grid of V1 (C3). The existing C3, which is 10 pF, should be replaced by a 50 pF capacitor.

Yet a further increase in small signal performance may be secured by transferring C3 to the " hot " end of L1. However, depending upon location, f.m. transmissions may appear within the passband of the receiver, and this modification should be undertaken on a trial and error basis.

Modification 15—Tunable Receiver

Converting the B44 into a continuously tunable receiver is, electrically, a simple task. The problems arise in relation to the fitting of a suitable dial.

Since both conversion injection frequencies are derived from one single oscillator, moving the frequency of this oscillator will shift both injection frequencies simultaneously, and by the correct amount. All that is needed is to convert the crystal oscillator V9 into a tunable Colpitts oscillator. The circuit is shown in Fig. 8.

† Part 1.

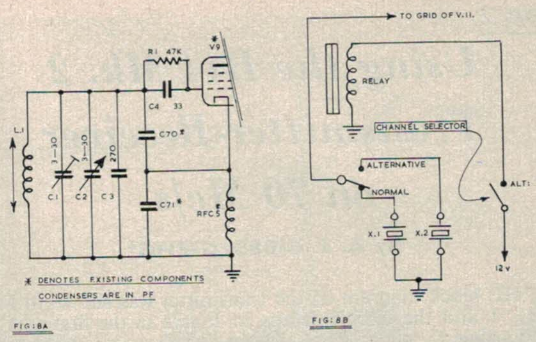


Fig. 8. (a) Revised circuit for converting receiver crystal oscillator to a tunable type. The coil L1 consists of 14 turns of 18 s.w.g. wire wound on a ¼ in. former, the turns being spaced by the wire diameter. An Electroniques type TO5 may be used in which case C1 will not be required. (b) Circuit for providing an alternative transmitter channel.

One mechanical arrangement which has proved satisfactory is to remove the " hailer " socket, and to fit in its place the oscillator tuning capacitor. However, as the tuning is a direct drive, it does give it a slightly sharp feel, but not uncomfortably so, except perhaps where signals are right down in the noise. In such cases a small amount of reduction would be useful—but not essential.

Modification 16—Alternative Transmitter Frequency

With the increasing usage of the 70 Mc/s band, the provision of an alternative transmission channel is fast becoming a necessity rather than a luxury. At the time of writing it appears that two frequencies are being commonly used, 70·26 Mc/s and 70·32 Mc/s, the actual frequency varying from area to area. It would seem prudent to adopt these two channels for the B44 so that it can be switched to the local channel when moving from one area to another, and then treat the " foreign " frequency as an alternative. By this means one gets the best of both worlds.

The modification consists of fitting another crystal socket alongside the present transmitter crystal socket, and wiring these to a miniature 12 V single pole change-over relay. The relay wiring should be arranged so that the contacts are normally " made " in relation to the local channel, and when it is energized it changes over to the alternative frequency.

To make space for the crystal socket and relay, the support bar which runs from the top of the PSU cover to a point on the chassis adjacent to the crystal sockets is removed completely. The new crystal socket and relay can now be fitted.

Once the aerial filter unit has been removed, the press switch next to the meter no longer serves any useful purpose. This switch can be removed—note that it unscrews bodily from the front panel—and the meter wired permanently to the 12 V line which was connected to the switch. In its place a toggle switch should be fitted and used to operate the channel selector relay.

The circuit of the modification to give alternative frequency working is shown in Fig. 8B.

Modification 17—Increasing Receiver H.T.

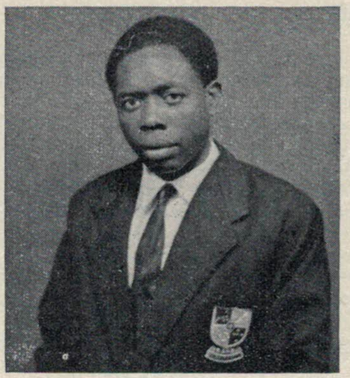
As it stands, the receiver h.t. is fairly low, and its performance can be further improved by shorting out the resistor R51 (see Fig. 3) which has a value of 6·8K ohms. This resistor will be found on tag strip B—see Fig. 6.

Modification 18—Transmitter Crystal Drift

Certain B44 transmitters tend to drift quite badly. In all cases this is due to over excitation of the transmitter crystal.

(*Continued on page 641*)

Construction of a Crystal Receiver



By FABIAN E. SONE STONE, FRS359 *

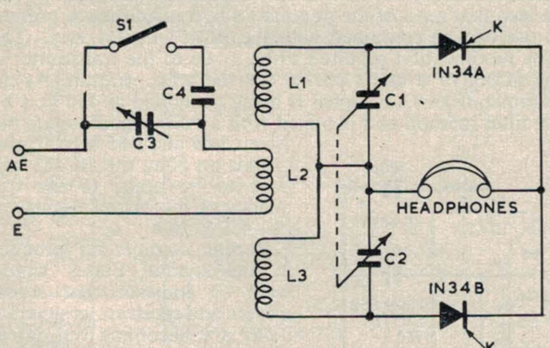
A CRYSTAL receiver serves well as a bedside radio. It may be left on even though the listener may have fallen asleep, and as headphones are used, other nearby persons are not disturbed by the radio. However, for successful operation, the following three points should be observed:

(i) The receiver should be located within 20 miles of broadcasting stations which it is desired to receive.

(ii) An efficient aerial-ground system must be employed.

(iii) The headphones should be of the high impedance type, for the higher the impedance, the more satisfactory will be the reception.

The aerial should be at least 200 to 300 ft. long, and should be erected as high as possible. A water pipe may be used for



Circuit of the crystal receiver. See text for details of components.

the earth connection. If such a pipe is not handy, a rod driven into moist soil to a depth of at least 2 ft. will serve satisfactorily for this purpose.

The Circuit

In the circuit, two crystals are used. These crystals are operated in conjunction with two tuning circuits comprised of inductors L1 and L2 and their respective tuning capacitors C1 and C2. The circuit arrangement is such that both alternations of the signal cycle are utilized, and the current flows through the headphones in one direction only.

The tuning inductor is comprised of three coils. The centre coil, L2, is the aerial coil which is straddled by two secondary coils, L1 and L3. All three windings are on the same former which has a diameter of 1 in. and is approximately 4 in. long. L2, the centre winding, is composed of approximately 45 turns of 32 B & S (36 s.w.g.) enamelled copper wire. The exact number of turns will depend on the length of the aerial. For use with a double section 500 pF tuning capacitor (C1 and C2), L1 and L3 should each be 125 turns, and for use with a double section 365 pF tuning capacitor the number of turns should be increased to 135. L1 and L3 are also wound with 32 B & S (36 s.w.g.), and are spaced approximately $\frac{1}{8}$ in. from L2. The smaller the spacing, the louder the signal, but the tuning will be broader. Hence, if the completed receiver does not have sufficient selectivity, the spacing between the primary and secondary coils should be increased. C3 may be either 350 pF or 500 pF, depending on the aerial attached. A value of 0·001 μF is suitable for C4.

Operating Instructions

To operate the receiver, connect the aerial to terminal AE, and connect E to ground. Tune in a station signal with the ganged capacitor C1 and C2, and adjust C3 for maximum volume. If the frequency of the station is below 800 kc/s, close the switch S1 and observe whether the volume of the signal increases. If no appreciable difference in volume occurs, experiment with different values of C4.

* Director, College of Engineering Technology, Muyuka, West Cameroon.

Using the B44 Mk. 2 on 70 Mc/s

(Continued from page 640)

This can be substantially reduced by placing a 100 pF capacitor from the cathode of V9 to chassis.

It should be noted that the amount of drift, even in the worst case, will not be sufficient for the transmission to shift out of the bandpass of another B44, and that the amount of drift can only be determined with a selective receiving system.

Whether the 100 pF capacitor is fitted should depend on two factors. Firstly, as this capacitor results in a slight loss of drive to the p.a., if the B44 in question is already shy of drive, it is probably better left off. Secondly, it depends to what extent fixed stations are worked—as opposed to B44s —and the degree of selectivity which they employ.

Modification 19—P.A. Output Link

The p.a. link fitted to B44s has been found sub-optimum for working into a correctly matched 75 to 80 ohm load.

The existing link, L13A, should be removed and replaced by a single turn of 22 s.w.g. p.v.c. insulated hook-up wire. This should be positioned well into the cut in the p.a. coil former, and the ends which go to the terminating tags bent only slightly around the former as they depart from it. The one turn ends up looking like a bent U on its side. Once this new link has been fitted, the p.a. tuning capacitor should be re-trimmed. To get the last ounce out of the B44, there is no doubt that an s.w.r. meter is an invaluable adjunct when making adjustments to the p.a. link and transmitting aerial.

Conclusion

While the list of modifications may seem formidable, none of them can lay any claim to being complicated or difficult. The resulting improvement in performance makes them very worthwhile, and turns the B44 into a most useful piece of equipment which gives a very good account of itself on the 70 Mc/s band.

C