# 3.2. CDW/CAY (B40)

DATE OF DESIGN. 1946

HANDBOOK. B.R. 1617

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FREQUENCY RANGE. 650 kc/s–30 Mc/s

POWER SUPPLIES. 115 V or 230 V 50 c/s a.c.

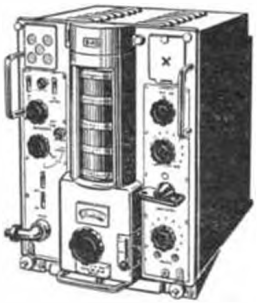

FIG. 1

## GENERAL

1. A superheterodyne receiver consisting of three basic units:

*a.* R.F. Unit. *b.* I.F. Unit *c.* A.F. and Power Unit.

The B40 series was designed to replace receiver B28. There are four models: B40(A), B40(B), B40(C) and B40(D). The B40(D) is described in this section and the differences between this and the other models are listed later. A B40(D) fitted for Common Aerial Working is known as an Outfit CAY: if not so fitted it is Outfit CDW.

## DESCRIPTION

2. **R.F. Unit**

*a.* AERIAL CIRCUIT

In outfit CAY the r.f. input arrives from either of the HF lines which run to each receiver in turn, depending on the position of the aerial selector switch (*see* Section 6 – Aerials). A micro-switch in the frequency range turret control ensures continuity of the aerial lines when changing over frequency ranges; this switch is fitted in both CAY and CDW.

The r.f. input transformer effectively forms the filter network required for the receiver's use in common aerial working. The secondary of this transformer forms part of the r.f. grid circuit and is tuned by a variable capacitor ganged to the main tuning control.

*b.* FIRST R.F. AMPLIFIER

*A high slope pentode.* In the CAL position of the system switch, the H.T. supply to this valve is broken. This prevents any signals from the aerial getting through the receiver, and prevents any oscillation from calibrating circuit from being radiated.

*Anti-cross modulation.* Controlled by a variable resistor adjusting the grid bias, which shifts the working point on the valve characteristic curve to a straighter portion thus reducing rectification of any strong but unwanted signal which would otherwise impose its modulation on to the wanted signal. A resistor and a crystal rectifier ensure that the grid of the r.f. amplifier remains negative with respect to the cathode. Without this safeguard it would be possible, in certain positions of the anti-cross modulation control, for the grid to pass current, reducing selectivity and increasing cross modulation.

*c.* SECOND R.F. AMPLIFIER

*A variable mu pentode.* Its grid circuit consists of the tuned secondary of the input transformer and fixed capacitors selected by the turret switch, and a variable capacitor ganged to the main tuning control.
*Gain.* Controlled by either a.g.c. which adjusts the grid bias or by manual control which adjusts the cathode bias.

*CAL position.* When the system switch is in the CAL position, the crystal harmonics from the b.f.o. are fed into the output circuit of the first r.f. and hence the input circuit of the second r.f.

*d.* MIXER. A triode-heptode valve, of which the triode is not used. The local oscillator output is fed to the injector grid and the r.f. output to the control grid.

*e.* LOCAL OSCILLATOR. A pentode which can be operated by the Crystal ON–OFF switch either as: *Crystal Oscillator.* Electron-coupled to the anode circuit which is tuned to the required harmonic of the crystal (see table under Crystal Compartment), or as

*V.F.O.* Tuned by main tuning control as 500 kc/s above the incoming signal (the crystal terminals being short-circuited).

A small variable capacitor in the oscillator circuit, operated by the OSC TRIM control, permits fine tuning which, since the range of the a.f. discriminator on the F.S.T. Convertor is only from 2025 c/s to 3075 c/s, is particularly necessary at frequencies above about 9 Mc/s.

3. I.F. Unit

*a.* THREE STAGE I.F. AMPLIFIER. Three variable mu pentodes with fixed transformer coupled inputs tuned to the I.F. of 500 kc/s.

*Bandwidth Arrangements.* The bandwidth switch alters the coupling between primary and secondary of the I.F. transformers. It also inserts a crystal gate filter between the first and second i.f. stages when in the 1 kc/s position of the switch. The three positions of the bandwidth switch are as follows:

8 kc/s Tight coupling – wide bandwidth.

3 kc/s Loose coupling – narrow bandwidth.

1 kc/s Loose coupling – very narrow bandwidth with crystal filter in circuit between first and second I.F. stages.

*Gain Arrangements.* A.G.C. adjusts the grid bias of the first and second i.f. stages. Manual gain adjusts the cathode bias of the first, second and third i.f. stages.

*b.* DETECTOR AND A.G.C. STAGE. Consists of a double diode.

*Detector.* One half of the double diode acts as a detector. The a.f. output is fed to first a.f. via a variable resistor controlled by a control marked a.f. GAIN.

*A.G.C. Stage.* The other half of the double diode is fed from the primary of the third i.f. Detector transformer. Negative bias is applied to the grids of second r.f., first and second i.f. stages and a reduced bias to the first a.f. stage.

*Note.* The a.g.c. time constant is automatically set to allow for a quick build-up but slow decay.

*c.* NOISE LIMITER. A double diode. One diode is a series limiter. At normal signal level it conducts and is in the a.f. path between detector and first a.f. stage. A short pulse of relatively great amplitude will close this diode down for the duration of the pulse, thereby breaking the a.f. output to the first a.f. stage. As these pulses are of such very short duration, the intelligibility of a.f. output is not seriously impaired. Any pulse, which is strong enough to break through the inter-electrode capacity of the first diode, is shunted by the second diode.

*d.* B.F.O. A pentode oscillator which can produce five output frequencies as follows:

| *Position* | *Frequency Kc/s* | *Position* | *Frequency Kc/s* |
|---|---|---|---|
| 1 | 497·45 | 4 | 501 |
| 2 | 502·55 | 5 | 500 |
| 3 | 499 | | |

Further details are given in the operation of the system switch.

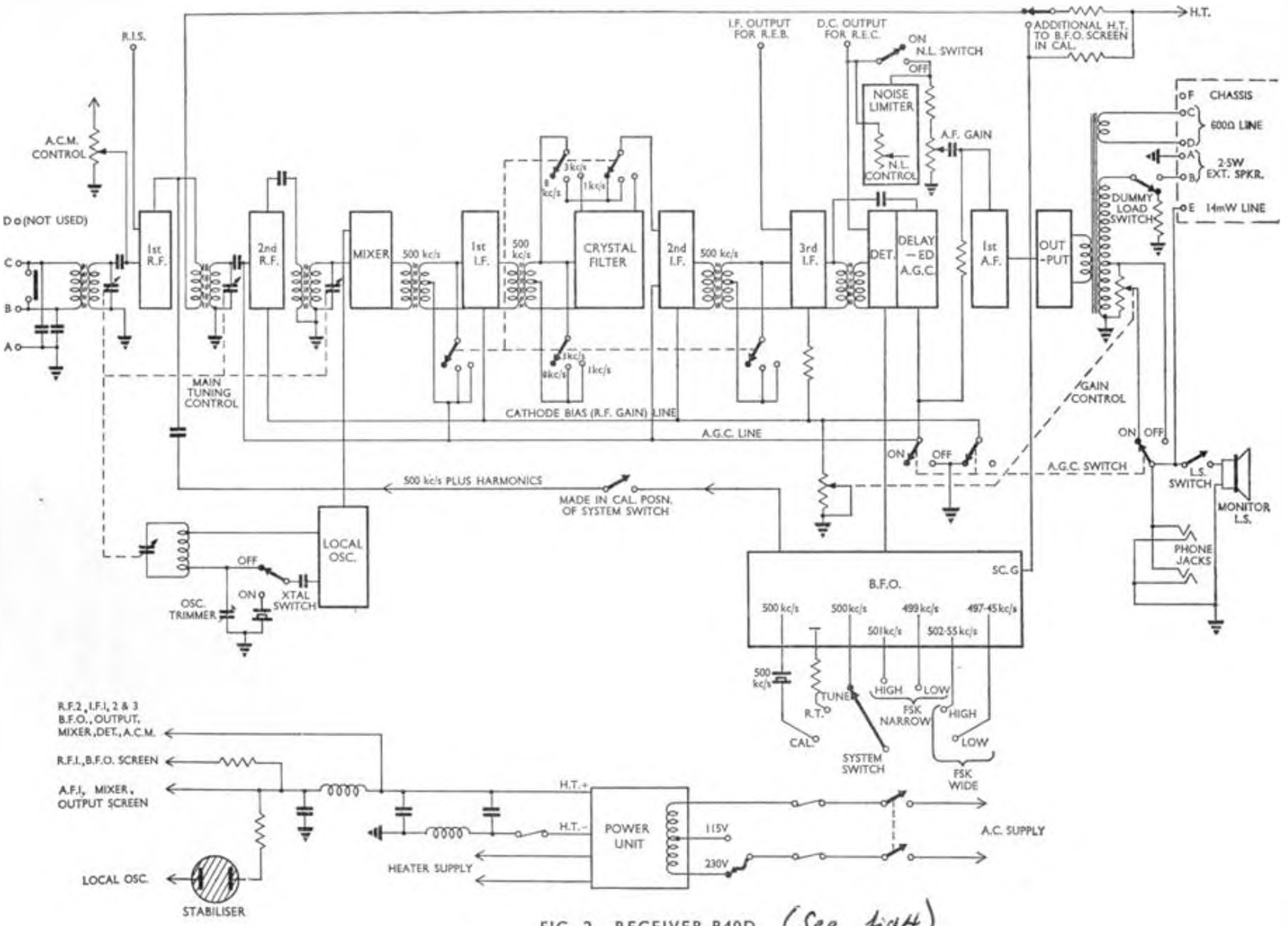


FIG. 2. RECEIVER B40D (See fig 4)

**4. A.F. and Power Unit**

*a.* FIRST A.F. AMPLIFIER. A variable mu pentode whose input is controlled by a variable resistor (A.F. Gain Control). Reduced a.g.c. is fed to this stage.

*b.* SECOND A.F. AMPLIFIER AND OUTPUT STAGE. A power pentode. It feeds the output transformer from which the following outputs are taken:

*Remote Outputs* (1) 600 ohm 35 mW line (to control system).
(2) 600 ohm 2·5 W line (to remote loudspeaker in R.I.C. bay when C.A.W. outfit EAL not fitted).

*Local Outputs* (1) Local phone jacks in receiver.
(2) Internal loudspeaker.
(3) External phone line (not normally used).

*Notes.* (i) All the above outputs are available simultaneously. (ii) The remote loudspeaker output can be switched from its line to a dummy load by means of the dummy load switch at the back of the receiver.

*c.* GAIN ARRANGEMENTS.

*A.F. Gain Control.* Affects all the a.f. outputs.

*Gain Control.* With a.g.c. switched OFF the Gain Control affects ALL outputs. With a.g.c. switched ON this control varies only the local outputs (see para. 6).

*d.* POWER UNIT.

*Mains Transformer.* This has two mains fuses (2 amps) in the input to the primary, and tappings on the primary for 115 V and 230 V a.c. supply. These are marked and situated at the rear of the receiver which must be withdrawn to gain access. It has three secondaries for valve heaters, rectifier heaters and main H.T. which is also fused (500 mA).

*Two Double Diodes.* The two anodes are strapped together, the whole forming a full-wave rectifier circuit with a valve at each end of the mains transformer H.T. winding. H.T. is provided for the first R.F., for the local oscillator (using a voltage stabilizer) and for all other stages.

**5. Frequency Shift Telegraphy**

In a Frequency Shift system the ~~MARK~~ Active signal is transmitted on one radio frequency and the ~~SPACE~~ Inactive signal on a different radio frequency. The difference between these two frequencies, known as the 'shift,' is established, at present, as 850 c/s for HF working. Thus for a nominal frequency of, for example, 5000 kc/s, the ~~MARK~~ Active and ACTIVE signals are radiated on 5000·425 kc/s and 4999·575 kc/s respectively.

In the Frequency Shift Convertor unit, the a.f. discriminator works in the WIDE shift condition over the range 2025 c/s–3075 c/s: the CENTRE FREQUENCY is therefore 2550 c/s. In the NARROW shift condition the centre frequency is 1000 c/s: this condition is normally only used for L.F., when the shift is normally 85 c/s. In the B40(D) therefore it is necessary to be able to produce as required two separate outputs for F.S.k. operation, one centred on 2550 c/s and the other on 1000 c/s. The first is achieved by either the 497·45 kc/s (LOW) or 502·55 kc/s (HIGH) outputs of the b.f.o., and the second by either its 499 kc/s (LOW) or 501 kc/s (HIGH) outputs.

The last two outputs are also used for c.w. reception.

**6. Controls.**

SYSTEM SWITCH. A seven-position switch.

*F.S.K. Wide Low.* B.F.O. operates at 497·45 kc/s.

*F.S.K. Wide High.* B.F.O. operates at 502·55 kc/s.

*F.S.K. Narrow Low.* B.F.O. operates at 499 kc/s.

*F.S.K. Narrow High.* B.F.O. operates at 501 kc/s.

*Tune.* B.F.O. oscillates at 500 kc/s, i.e. in tune with the i.f. System switch should be in this position when tuning in a c.w. station. Receiver is tuned for zero beat, indicating that 500 kc/s passing through i.f. stages is beating with 500 kc/s from b.f.o. at detector. r.f. and i.f. stages of receiver must then be at maximum efficiency.

*R/T.* The b.f.o. cathode is earthed through a high resistance and does not oscillate.

*Calibrate.* The H.T. to the first r.f. is broken, and screen supply to the b.f.o. valve is increased to provide a strong oscillation. b.f.o. is controlled by a 500 kc/s crystal and the output (500 kc/s plus harmonics) is fed to the output circuit of the first r.f. and hence the input of the second r.f. b.f.o. continues to feed 500 kc/s to the detector stage.

GAIN CONTROL. Adjusts two potentiometer on the same spindle.

*a.* In the cathode circuit of the second r.f. and all i.f. stages.

*b.* Across the a.f. output transformer secondary supplying the internal loudspeaker and local phones.

*Note.* Only one potentiometer is in circuit at a time depending on whether a.g.c. is switched ON or OFF.

A.G.C. ON–OFF Switch. In the OFF position the a.g.c. line is earthed. In the ON position the r.f. gain potentiometer is earthed.

RANGE SWITCH (TURRET SWITCH). Controls turret and changes the tuned circuits of the r.f. stages, Mixer and Local Oscillator.

CRYSTAL COMPARTMENT. A gauze electrostatic screen is fitted on the door (note earthing plunger). A pilot light indicates when crystal switch is to ON. The crystal frequency is always 500 kc/s above the signal frequency modified as shown in the following table, where Fs is the signal frequency.

| *Signal Frequency* | *Crystal Frequency* | *Signal Frequency* | *Crystal Frequency* |
|---|---|---|---|
| 650 kc/s to 7 Mc/s | Fs + 500 kc/s | 14·5 Mc/s to 22 Mc/s | $\frac{Fs + 500\ kc/s}{3}$ |
| 7 Mc/s to 14·5 Mc/s | $\frac{Fs + 500\ kc/s}{2}$ | 22 Mc/s to 30 Mc/s | $\frac{Fs + 500\ kc/s}{4}$ |

CRYSTAL SWITCH. This has two positions.

OFF. Local Oscillator is a v.f.o.

ON. Local Oscillator is crystal controlled.

ANTI-CROSS MODULATION. Alters the grid bias hence the working point of the first r.f. stage.

TUNING KNOB. Tunes ganged capacitors in the first and second r.f., Mixer and Local Oscillator circuits. It also turns the scale drum and logging scale.

DIAL LOCK. Locks tuning drum and is spring held.

TUNING DRUM. The frequency scale has special markings to indicate.

*a.* Calibration Points: Denoted thus: ●

*b.* R.F. Lining-up Points: Denoted thus: ⊹

MONITOR LOUDSPEAKER SWITCH. Controls receiver monitor loudspeaker.

NOISE LIMITER SWITCH. Brings in noise limiter to reduce interference caused by radar and other pulse transmissions.

LIMITER CONTROL. A potentiometer which is used to determine the level at which limiting action commences.

BANDWIDTH SWITCH. This has three positions:

*a.* 8 kc/s. *b.* 3 kc/s. *c.* 1 kc/s.

A.F. GAIN. Controls input to first a.f. and hence all audio outputs.

DUMMY LOAD SWITCH. Normally left in the OFF position (toggle towards the rear of the receiver) whether or not external loudspeaker is connected. This has been found necessary when receiver is operated in conjunction with K.H. series in ships not fitted with EAL.

DIAL LAMPS BRILLIANCE CONTROL. Controls a variable resistor, in series with one of the five dial lamps as selected by the turret switch.

AERIAL INPUT. There are four pins marked A, B, C, and D.

A – Earth.

B and C – Low impedance input.

D – Not connected.

R.I.S. Input. Not used.

D.C. Socket. Output from detector for disc recording (not now used).

I.F. SOCKET. Output from third i.f. for photographic analysis of transmission characteristics (REB).

## DIFFERENCES

7. The principal differences between the B40(D) and other receivers in this series are summarized below:

*a.* Differences between B40(D) and (C). The B40(C) has:

(1) No OSC. TRIM control.

(2) No crystal rectifier or resistor as safeguard in the anti-cross modulation arrangements.

(3) No F.S.k. positions on the system switch, which only has five positions. The first two are LOW and HIGH, which correspond to the F.S.T. Narrow positions of the B40(D) switch: the others are TUNE, CAL and R/T, and have the same characteristics as those in the B40(D).

(4) Only one rectifier valve in the power unit.

(5) Different type of valve throughout.

*b.* Differences between B40(C) and (B). The B40(B) has:

(1) No facility for common aerial working, and therefore minor differences in aerial input circuits. No aerial change-over switch. SO.6CL

(2) Two aerial inputs – 1 Low impedance – as in B 40(D).
2 High impedance – capacitor coupled to secondary of input transformer. Used for short aerial leads.

(3) No micro-switch in the turret-switch arrangements.

(4) No earthing of main turret switch.

*c.* Differences between B40(B) and B40/B40(A). The B40/B40(A) have:

(1) No A.G.C. switch. The system switch has an additional position marked MANUAL. In this position the a.g.c. is switched off and the b.f.o. is oscillating at the frequency of the i.f. (500 kc/s). In all other positions of the system switch the a.g.c. is in circuit. The disadvantage is that if a.g.c. is not required (i.e. when reading a very weak signal) the receiver must be slightly detuned in order to obtain a beat note, and as a result its efficiency is somewhat reduced.

(2) Screwdriver controls for limiter and a.f. gain.

(3) No window shewing the frequency range in use.

(4) Different markings for the Bandwidth switch. These are: (*Continued on page* 3.2.8)

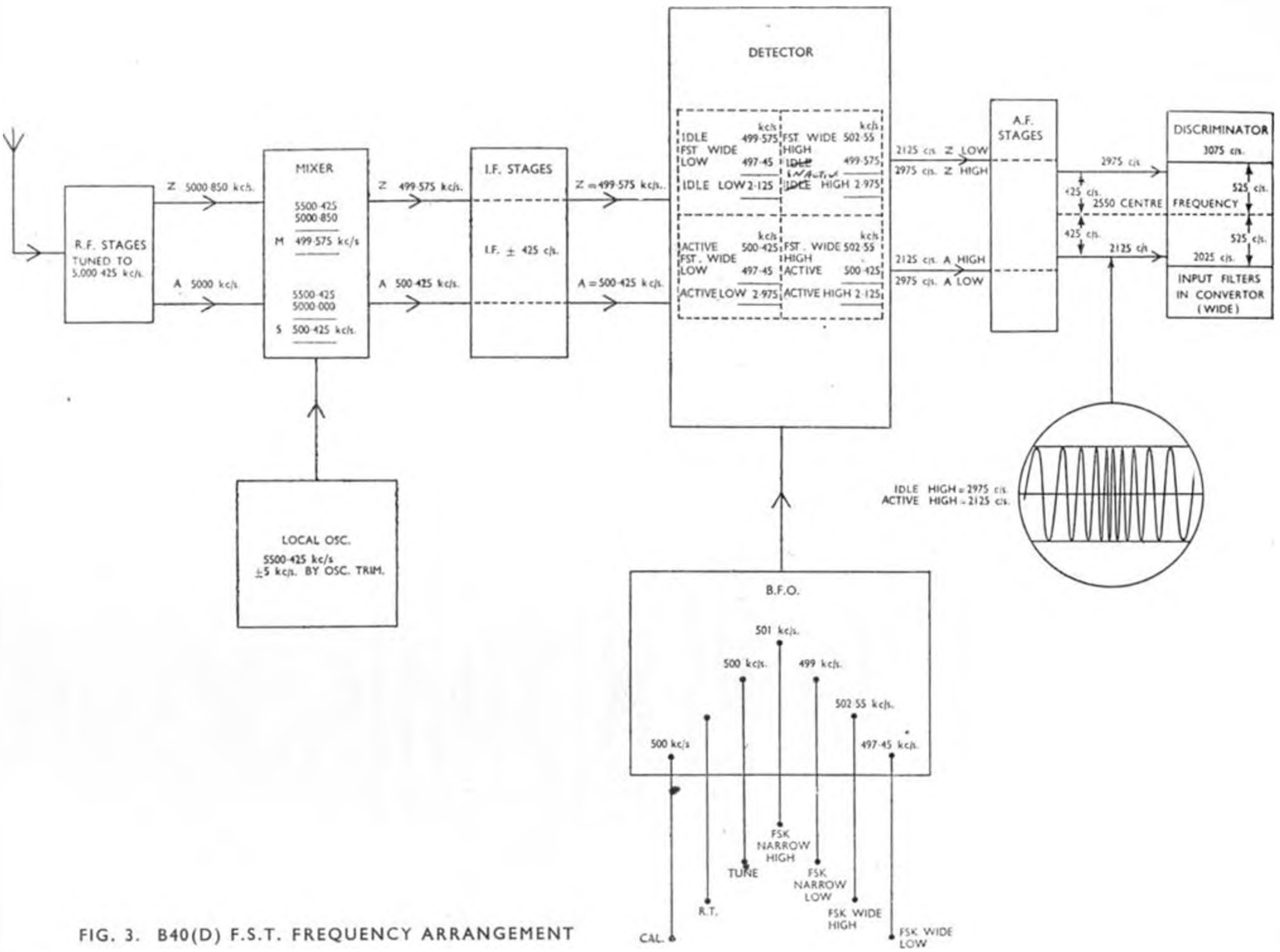


FIG. 3. B40(D) F.S.T. FREQUENCY ARRANGEMENT

(*Continued from page* 3-2-6)

WIDE – 8 kc/s on B40(D). In addition, the screen supply to the b.f.o. is broken in this position.

NARROW – '3 kc/s' in B40(D).

NOTE FILTER – '1 kc/s' in B40(D). There is a 1000 c/s filter with a bandpass of 200 c/s instead of a crystal filter.

(5) Aerial input pins marked 1, 2, 3 and 4 instead of A, B, C, and D.

8. **Operating Instructions For B40 B41**

*a.* Switch on receiver for at least 15 minutes before being required for use.

*b.* Switch off LIMITER, CRYSTAL and A.G.C. switches.

*c.* Turn Anti-cross Mod control to fully clockwise.

*d.* Set Range Switch to appropriate frequency band.

*e.* Adjust Gain Control for three-quarters of its travel clockwise.

*f.* Switch on Monitor loudspeaker.

*g.* Set bandwidth switch to NARROW or 3 kc/s position.

*h.* Set system switch to CALIBRATE.

*i.* Adjust A.F. gain control for three-quarters of its travel clockwise.

*j.* Tune the receiver by the main tuning control to the calibration mark nearest the frequency at which it is desired to work. A beat note should be produced. Slowly rock main tuning control for zero beat.

*k.* Adjust cursor by means of knurled wheel behind curved door until arrow in in line with calibration spot.

*l.* Set system switch to TUNE.

*m.* Switch on a.g.c. Adjust Gain Control to comfortable noise level.

*n.* Tune in to signal, adjust a.f. gain for comfortable noise level, and further tune for signal's zero beat.

*o.* (1) C.W. Reception. Set system switch to LOW or HIGH. Set Bandwidth switch to '1 kc/s' if necessary to clear interference, and readjust gain control as requisite.

(2) Voice Reception. Set system switch to R/T. Set bandwidth switch to WIDE or '8 kc/s' position.

*p.* For Crystal Oscillator working insert appropriate crystal and put crystal switch to ON.

*q.* Adjust main tuning control for maximum signal output.

*r.* If cross modulation interference is experienced, adjust anti-cross mod control to eliminate it.

*s.* If experiencing interference from atmospherics or pulse transmissions, switch on limiter and adjust limiter control for best reception.