

EDDYSTONE

All transistor communications receiver
type 960



Installation notes
Operating instructions

Manufacturers :

STRATTON & CO. LTD.

ALVECHURCH ROAD, BIRMINGHAM, 31

Telephone: PRIORY 2231/4

Cables: STRATNOID, BIRMINGHAM



THE EDDYSTONE MODEL '960'

TRANSISTORISED

COMMUNICATIONS RECEIVER

INTRODUCTION

The EDDYSTONE Model 960 is a fully transistorised single conversion communications superhet receiver covering the frequency band 500 kc/s to 30 Mc/s. The unit can be powered either from eight standard 1.5V cells which are housed within the receiver itself or alternatively from any external 12V source. The receiver is suitable for both CW and AM reception.

An internal loudspeaker is fitted but this can be disconnected when an external unit is more convenient. Connection can be made to 600Ω lines and a 2000Ω telephone output is available on the front panel. The speaker output is cut automatically on insertion of the telephones. Two positions of IF selectivity are provided, one of which employs a bandpass crystal filter for CW reception under conditions of severe adjacent channel interference.

Certain stages can be desensitised when an associated transmitter is in operation and this facility can be controlled either by a switch on the panel or by an external relay contact wired to terminals at the rear. The level to which the receiver is desensitised can be adjusted by means of an external control. A built-in meter provides a convenient means of comparing carrier levels and can also be switched to check the state of the supply batteries.

The Model 960 employs printed wiring techniques, is strongly made, has a diecast aluminium panel and is housed in a well finished steel cabinet. All controls are positioned for ease of operation and the unit can be supplied for either rack or surface mounting. Normal operation is maintained over the ambient temperature range $-20^{\circ}\text{C}.$ to $+55^{\circ}\text{C}.$

LIST OF CONTENTS

<u>Section.</u>	<u>Page.</u>
Technical Data	2
Circuit Description	4
Constructional Details	6
Installation	8
Tuning Instructions	10
Maintenance (including 'Re-alignment')	11
Appendix 'A' List of Component Values, Tolerances and Ratings . .	20
Appendix 'B' Table of Voltage Values	24
Appendix 'C' List of Battery Equivalents	25
Appendix 'D' Spares	25
Plan and Underside Views of Receiver	28/29
Circuit Diagram	inside rear cover

The Company reserve the right to vary without notice the information contained in this publication.

Sole Manufacturers:- STRATTON & CO., LTD., ALVECHURCH RD., BIRMINGHAM, 31.

TECHNICAL DATA

GENERAL

Frequency Coverage.

500 kc/s to 30 Mc/s in six ranges as follows:-

Range 1	. .	20 - 30 Mc/s.	Range 4	. .	2.2 - 4.2 Mc/s.
Range 2	. .	9 - 20 Mc/s.	Range 5	. .	1.13 - 2.2 Mc/s.
Range 3	. .	4.2 - 9 Mc/s.	Range 6	. .	0.5 - 1.13 Mc/s.

Overlaps are provided at the ends of each range.

Intermediate Frequency.

465 kc/s with bandpass crystal filter.

Transistor and Diode Complement.

TR1	. .	OC171	. .	RF Amplifier.
TR2	. .	OC170	. .	Mixer.
TR3	. .	OC171	. .	Local Oscillator.
TR4	. .	OC45	. .	1st IF Amplifier.
TR5	. .	OC45	. .	2nd IF Amplifier.
TR6	. .	OC45	. .	3rd IF Amplifier.
TR7	. .	OC45	. .	AGC Amplifier.
TR8	. .	OC45	. .	Beat Frequency Oscillator.
TR9	. .	OC71	. .	Audio Amplifier.
TR10	. .	OC83	. .	Audio Driver.
TR11	. .	OC83	. .	Push-pull Audio Output.
TR12	. .	OC83	. .	
D1	. .	OAZ204	. .	Voltage Stabiliser.
D2	. .	OA70	. .	Detector.
D3	. .	OA70	. .	AGC Rectifier. (IF)
D4	. .	OA70	. .	AGC Rectifier. (RF)
D5	. .	GEX23	. .	BFO Pitch Control.
D6	. .	OA70	. .	Noise Limiter.
D7	. .	DD006 or 2E1	. .	Reverse Polarity Protection.

Power Supply.

12V DC from 8 x 1.5V dry cells or a high capacity external source.

Current drains at 12V under various conditions of operation are as follows:-

35mA quiescent.

65mA at 50mW output.

210mA at 1W output.

Aerial Input Impedance.

75Ω nominal (balanced or unbalanced).

Audio Output Impedances.

Loudspeaker : 3Ω (available for use with external speaker).

Lines : 600Ω balanced or unbalanced.

Telephones : $2,000\Omega$ nominal.

PERFORMANCE

Sensitivity.

The absolute sensitivity is better than $3\mu\text{V}$ except on Range 6 where a figure of $6\mu\text{V}$ obtains.

Sensitivity for a 15dB signal-to-noise ratio is better than $6\mu\text{V}$ on all ranges except Range 6. On this range the sensitivity is better than $20\mu\text{V}$ for a 15dB signal-to-noise ratio.

Selectivity.

The following figures are indicative of the IF selectivity with the crystal filter switched 'OUT'.

6dB down at 2.5 kc/s off.

30dB down at 6 kc/s off.

60dB down at 14 kc/s off.

With the crystal filter switched 'IN' the 6dB bandwidth is of the order 500 c/s and the 40dB bandwidth 4 kc/s.

Image Rejection.

20dB at 18 Mc/s.

50dB at 1.65 Mc/s.

Calibration Accuracy.

1%.

Frequency Stability.

Drift does not exceed 1 part in 10^4 per $^{\circ}\text{C}$ change in ambient temperature.

AGC Characteristic.

The audio output level does not change by more than 16dB when the input level is increased 90dB above $5\mu\text{V}$. (taken at 6 Mc/s)

Audio Output and Response.

Maximum audio output to a 3Ω loudspeaker is 1 watt with 10% distortion at 1,000 c/s.

The telephone output is of the order 2mW in $2,000\Omega$.

Frequency response is level within $\pm 3\text{dB}$ over the range 50 c/s to 8,000 c/s. (taken from AF Gain control)

CIRCUIT DESCRIPTION

The RF Section.

This portion of the receiver comprises a tuned RF Amplifier and a Mixer Stage with separate Local Oscillator. The transistors employed are of the following types:- TR1 : OC171, TR2 : OC170, TR3 : OC171.

TR1 functions as a grounded base RF Stage and operates with AGC and/or manual gain control. Gain adjustment in either case is by variation of the base voltage and the arrangements are such that the automatic control can overcome the manual control on strong signals.

Balanced or unbalanced feeders having a nominal impedance of 75Ω can be connected to the aerial terminals at the rear. Low impedance coupling coils are provided on each tuned input circuit and an IF breakthrough filter L7/C14 and L8/C15 is brought into circuit by S1a when Range 6 (500-1130 kc/s) is selected. Signal voltage at S1c derived from taps on the tuned input coils is applied to the emitter of TR1 via the coupling capacitor C17.

The amplified signal available at S1f is fed to the base of TR2 (Mixer) via C34. Low impedance taps are used on all coils except L14 (Range 6) and in this case a low impedance link winding is employed to avoid instability in the Mixer circuit. The base voltage of TR2 is reduced by S1g on Range 6 to prevent overloading when taking extremely strong signals on this range.

Local oscillator injection is derived from low impedance coupling windings on the oscillator coils and is applied across the $1,500\Omega$ resistor in the emitter circuit of TR2. The Local Oscillator Stage functions as a grounded-base tuned-collector oscillator and operates above the signal frequency on all ranges.

All three stages in the RF Section of the receiver are operated from the stabilised supply obtained across the Zener diode D1 (OAZ204). The actual stabilised voltage is 6.8V and this also supplies the first two IF Stages and the Beat Frequency Oscillator.

A high degree of mechanical stability is afforded by the rugged diecast sectionalised chassis which houses all the tuned circuits associated with TR1, TR2 and TR3.

The IF Section.

This portion of the receiver is built upon a printed wiring board and utilises transistors TR4-TR8 and the germanium diodes D2-D5. The transistors are all of the OC45 type and all diodes except D5 are OA70. D5 is a GEX23.

IF output is taken from the collector of the Mixer Stage TR2 to the first 465 kc/s IF Amplifier TR4. The interstage coupling employs one double-tuned transformer (IFT1) which provides balanced output for the dual crystal bandpass filter which is brought into circuit by the Crystal Switch S2. Input to TR4 is via IFT2 which is a single-tuned transformer with a low impedance secondary to feed the base of the transistor.

TR4 is the first of three similar stages all of which are coupled by double-tuned transformers to achieve a high degree of adjacent channel rejection. The first two stages are supplied from the stabilised voltage across D1 while the last stage operates from the full 12V supply via a suitable decoupling network. TR4 and TR5 are controlled by the IF AGC line, the second stage being used to operate the carrier level meter which is connected in series with the collector feed.

The meter is calibrated in arbitrary divisions 0-10 and since the collector current decreases with increasing signal, the meter used has a right-hand zero. The calibration is such that maximum carrier level (10) occurs at the right-hand end of the scale. Zeroing of the meter is achieved by adjusting RV2 for full scale deflection (i.e. needle at left-hand end of scale). The meter will read '10' when the receiver is switched off.

A switch is provided so that the meter can be connected across the 12V supply to check the battery state. Satisfactory operation will be obtained down to an end voltage of 8V and this is indicated by suitable marking on the meter scale.

The receiver can be desensitised by closing the Standby switch S4 or by shorting the two desensitising terminals at the rear. In both cases the IF AGC line is directly grounded with a consequent reduction in the base voltage of TR4 and TR5. A 3,000 Ω variable resistor can be connected across the external circuit to provide a means of varying the level to which the receiver is desensitised. The variable resistor should, of course, be wired in series with the switch or relay contact which is used to complete the external circuit.

The last IF Stage (TR6) feeds the diode detector from a tap on the secondary winding of IFT5 while a low impedance link is used to feed the base of the AGC Amplifier TR7. The diode D2 which functions as the Detector is held in a slightly forward conducting condition by the bleed through R32 and this improves the detection efficiency with weak signals. The Detector output is filtered by R36/L21 and applied across the AF Gain control RV3.

The AGC Amplifier employs a similar circuit to that used in the normal IF Stages and feeds the two AGC diodes D3 and D4 which are connected across the untuned secondary winding of IFT6.

In the absence of a signal both D3 and D4 conduct and help maintain the correct base voltages at TR1, TR4 and TR5. On receipt of a signal, both diodes act as half-wave rectifiers and the voltages developed across them have a polarity which opposes that of the normal supply. As a result, the AGC lines sink towards earth potential and the gain of the controlled stages is reduced. The effective AGC voltage applied to the RF Stage will be affected by the setting of the RF Gain control RV1 and this should always be set to maximum when AGC is in use.

The Beat Frequency Oscillator (TR8) employs a grounded-base circuit and is tuned by the diode D5 which derives its control voltage from the potentiometer RV4. Output from the BFO is taken via the coupling capacitor C102 to the collector of TR5. The complete BFO circuit is housed in a small screening can to prevent direct radiation.

The AF Section.

Like the IF Section, this portion of the receiver is also built upon a printed wiring board. A total of four transistors and one OA70 germanium diode is involved. The transistor types are:- TR9 : OC71, TR10/11/12 : OC83.

TR9 is the first audio stage and like the other audio stages operates with grounded emitter. Audio is applied to the base of TR9 from the slider of the AF Gain control RV3. The germanium diode D6 is connected across the base circuit to act as a shunt limiter when S7 is closed. Impulse noise is considerably reduced when the limiter is in operation.

Output from TR9 is resistance-capacity coupled to the Audio Driver Stage TR10 and this in turn is transformer coupled to the two output transistors which are operated in Class B. The push-pull output transformer has two secondary windings, one of 3 and one of 600Ω. The 3Ω output is taken to a pair of sockets at the rear of the set and the internal loudspeaker will normally be plugged into these. If an external speaker is to be used, the internal speaker is disconnected and the external speaker is plugged into the same sockets.

The 600Ω output is available at the transformer and a suitable aperture is provided in the back-plate to facilitate connection. The telephone output is taken from the collector of TR10 and the circuit arrangements are such that the speaker output is interrupted when telephones are in use. The 3Ω secondary is then loaded with a 3.3Ω resistor to prevent damage to the two output transistors.

Power Supply.

Although the receiver is provided with its own internal 12V supply (8 x 1.5V cells in series), provision is made for connection of an external supply when prolonged operation is required. A polarised socket is fitted to prevent reversal of the battery connections and a 0.5A fuse is wired in series with the negative lead of the supply. Reversal of the battery connections will not damage the receiver but will blow the fuse due to conduction of the silicon diode D7. This is wired directly across the supply (in series with the fuse) and is intended solely as a protective device. Its operation is independent of the receiver supply switch.

CONSTRUCTIONAL DETAILS

Overall Dimensions and Weight.

Width . . .	16 $\frac{3}{4}$ " (42.5 cm.)	Depth . . .	11" (27.9 cm.)
Height . . .	8 $\frac{3}{4}$ " (22.2 cm.)	Weight . . .	32lb. (14.5 kg.)

Cabinet.

The type of cabinet fitted to the Model 960 depends on the method of mounting which is to be employed. Cabinets are available for rack or surface mounting. Both types are basically the same but the rack-mounting version

has cut-outs along the leading edges of the vertical sides. These cut-outs extend approximately $\frac{1}{2}$ " back from the panel and give clearance for the two angled brackets which are attached to the rear of the panel to allow the receiver to be mounted in a rack. The brackets are provided with fixing slots which conform to the Post Office standard for racks of 19" width.

Ventilation areas are provided in the rear and on one side of the cabinet. On the other side a matching grille is provided for the internal loudspeaker. Three apertures at the rear allow access to the various terminals, sockets etc. and the cabinet is held in place by four screws which locate with bushes in the chassis end-plates. Cabinets are made of steel, suitably rustproofed and sprayed grey enamel.

Front Panel.

The front panel is an aluminium diecasting, attached to the rear of which are two end-plates which serve to support the 'chassis' assembly. All controls are located for operating convenience along the lower half of the panel and their functions are indicated on a clearly marked finger plate. Chromium plated panel handles are provided for convenience in lifting the receiver and these also allow it to be placed 'face-down' without damage to the panel controls when the cabinet is removed to allow the batteries to be changed or servicing to be carried out.

Internal Layout.

The complete RF Section is built on a diecast aluminium sub-chassis which is attached to four fixing points at the rear of the front panel. The underside of the chassis is divided into three parallel compartments which house all the tuned circuits associated with TR1, TR2 and TR3.

On the right-hand side of the central RF Section is the printed wiring board which carries all the IF circuitry. The board is supported on the one side by the RF sub-chassis and on the other side by a bracket which is attached to the side-plate at the right-hand side of the receiver.

In the same relative position as the IF board, but to the left of the RF unit is the printed board which carries the audio circuits. Like the IF board, the audio board is supported on one side by the RF chassis but is narrower than the IF board to allow clearance for the built-in loudspeaker. The free edge is supported at the front by a small bracket fitted to the side-plate which carries the loudspeaker unit. The rear edge of the audio board obtains support from the heat sink for one of the output transistors. This is fixed to the rear-plate which runs the whole width of the receiver and carries the various sockets, terminals etc. at the rear of the set. The plate is attached to the rear of the central RF chassis and also to the rear of the two side-plates.

Two angled brackets are fitted, one at each side of the RF chassis and these serve to support the battery box when this is fitted inside the cabinet.

Drive Mechanism and Dial Assembly.

A high grade spring-loaded split-gear drive is used for the main tuning

gang and the flywheel-loaded control knob requires almost 60 revolutions to take the pointer from end to end of its traverse, a distance of some 13 inches. A vernier scale, visible through an aperture at the top of the scale plate can be used in conjunction with the bottom horizontal scale to provide 2,300 arbitrary divisions for station logging.

Battery Box.

This is arranged to take eight standard 'U2 type' 1.5V dry batteries and though normally located within the receiver, can be mounted externally on the rear of the cabinet.

INSTALLATION

The receiver leaves the factory complete with a set of batteries and can be put into operation immediately an aerial is connected.

EXTERNAL CONNECTIONS

Aerial Input.

The receiver input impedance is nominally 75Ω and performance will be optimum when the aerial feed impedance approximates to that value. Quite satisfactory performance will be obtained with aerials of random length but it should be appreciated that improved results can be obtained from such aerials if they are used in conjunction with an external matching device.

When 75Ω coaxial cable is used to feed the receiver, the outer braid of the cable should be connected to the 'A2' terminal which is then strapped to the 'E' terminal to suit the unbalanced input. The inner conductor is connected to the 'A1' terminal.

If a twin 75Ω cable is used, this should be connected to the 'A1' and 'A2' terminals with the link between 'A2' and 'E' removed.

Random single wire aerials are connected to the 'A1' terminal with a strap between 'A2' and 'E'.

Earthing.

Improved results will sometimes be obtained, especially on the lower frequencies if the 'E' terminal is connected to a suitable earthing point. This can be a normal copper earth stake or plate or alternatively it may be more convenient to make connection to a water pipe if this happens to be within easy reach of the receiver. The earth lead should be kept as short as possible.

Connecting an External Loudspeaker.

The Model 960 is capable of extremely good quality when used with one of the larger types of loudspeaker mounted in a suitable enclosure. The speaker should be a standard 3Ω type and if fitted with an output transformer, this should be disconnected to allow connection direct to the speech coil.

A length of insulated twin flex is adequate for connection and one end of this should be soldered to the tags provided on the speaker. The other end is terminated in standard banana plugs to plug into the 2.5Ω sockets at the rear of the receiver. (the internal speaker plugs are removed to allow this)

IMPORTANT The receiver should be switched off while changing speakers since damage may otherwise be caused to the two output transistors.

Connecting an external 600Ω Line.

600Ω lines feeding remote listening points can be connected directly at the output transformer. First remove the cabinet by taking out the retaining screws at the rear and then free the battery box (four screws) to allow access to the output transformer. Pass the 600Ω line through the right-hand aperture in the rear of the cabinet (viewed from the rear) and then through the small hole provided for this purpose in the receiver back-plate. The hole is adjacent to the loudspeaker output lead.

Feed the cable round the outer edge of the printed wiring board and across between the two heat sinks to the output transformer. This is the one nearest to the central RF chassis and the appropriate tags are labelled 600Ω centre-tapped (CT). The external line should be connected to the first and third tags counting from the front of the receiver. If a balanced output is required, the second tag should be wired to a suitable earthing point on the underside of the printed board. The earth terminal ('E') must be connected to earth to provide a proper balance.

Desensitising.

Although the receiver can be desensitised by means of the Standby switch on the front panel, it may be desirable to have some control of the level to which the sensitivity is reduced. This can be achieved by wiring across the desensitising terminals a 3,000Ω variable resistor in series with an external switch or relay contact.

The switch must close to desensitise the receiver and adjustment of the variable resistor will allow for a wide variation in the desensitised level.

Alternatively, when such control is not required, the external switch or relay contact can be wired directly across the two desensitising terminals to duplicate the function of the Standby switch.

Power Supply.

In most cases the receiver will be operated from its internal battery pack but when prolonged operation is anticipated it may be more convenient to employ an external 12V accumulator. This can be connected to the supply socket at the rear either with the existing plug which can be removed from the internal battery lead or with a separate plug which is available to special order. The plug is a polarised type and care should be taken to connect the positive side of the accumulator to the thickest pin. If the internal batteries are left in position the free plug (or leads) should be taped to avoid any possibility of short circuiting the battery supply.

When the receiver is rack-mounted and a 12V accumulator is not available it may be desirable to mount the battery pack externally in the interest of greater accessibility. To remove the battery pack first unsolder the red and black leads at the left-hand end of the battery box. Now remove the four screws which retain the box and lift it clear of its support brackets. The leads which were previously unsoldered can now be passed through the hole in the back-plate and then re-soldered to the appropriate tags. Two of the four screws which held the box internally can be used to attach it to the rear of the receiver cabinet. The hank bushes provided for this purpose will be found near the top edge of the cabinet. If required, a spare battery box complete with lead and plug is available to special order.

Changing Batteries.

Access to the internal battery box calls for removal of the receiver cabinet and this is achieved quite simply by first taking out the four retaining screws at the rear. The slotted heads can be turned with a small coin if a screwdriver is not to hand.

To remove the existing batteries, take out the chromium plated screw which lies at the centre of the battery pack. The top half of the box can now be lifted clear to expose the batteries which are held in position by springs at the negative end of each group. After removing the old cells from the battery troughs, slide off the polythene sleeves and place the cells in a group to avoid confusion with the replacements.

Feed the new batteries into the polythene sleeves and take care to observe the correct polarity when fitting into the battery troughs. Replace the top cover of the box and then check the receiver for normal operation before replacing the cabinet.

Standard 'U2' batteries can be used for replacement but the leak-proof variety are much preferred.

TUNING INSTRUCTIONS

The receiver is brought into operation by rotating the AF Gain control in a clockwise direction to operate the battery supply switch which is ganged to it. A check should be made to see that the Standby switch is in the 'down' position or otherwise the receiver will be in a desensitised condition.

To tune to a specific channel, locate the appropriate frequency on the calibrated scales and refer to the left-hand side of the dial to determine the range setting for the Wavechange switch. In tuning to the correct frequency it is quite permissible to 'spin' the Tuning control to obtain rapid pointer movement. The control is flywheel-loaded to allow rapid change of frequency but at the same time operates a high reduction gear drive which provides extremely fine tuning.

For telephony reception, the BFO should be switched 'OFF' and the AGC brought into operation by moving the AGC switch to the 'ON' position. The RF Gain should be set to maximum and the relative carrier level can be read from the built-in meter if the Meter switch is placed at 'CARRIER'. The output level is adjusted with the AF Gain and impulse noise if troublesome can be reduced by bringing the noise limiter into operation.

To change over to receive CW signals, the AGC should be switched 'OFF' and the BFO 'ON'. The RF Gain is reduced as necessary to prevent overloading and the AF Gain advanced to provide adequate output. Adjustment of the beat note is by means of the BFO control in the top right-hand corner of the finger plate. If adjacent channel interference is severe, this can be reduced by switching in the bandpass crystal filter.

The state of the battery can be checked at any time by moving the Meter switch to 'BATTERY'. Satisfactory operation should be obtained down to an end voltage of 8V and this is indicated by an arc on the meter scale. Batteries should be replaced immediately they fall below 8V.

When making a check of relative carrier level, always ensure that the meter reads '0' under 'no-signal' conditions. Any slight deviation from zero can be corrected by adjustment of the pre-set control at the rear of the receiver. AGC should be switched 'ON' when making this adjustment.

MAINTENANCE

The Model 960 is so designed that it will require very little in the way of routine maintenance. General cleaning of the exterior and periodic checking of the battery condition are about the only two items worthy of note. All moving parts are lubricated with a permanent lubricant (molybdenum disulphide) and with normal use will never require attention. Likewise the switches; these are of the self-cleaning type and it is unlikely that trouble will be forthcoming from this direction.

Batteries should always be removed if the receiver is stored for any length of time and when the 960 is used as a standby receiver, battery state should be checked at weekly intervals.

Normal precautions applicable to working on transistorised equipment should be observed when carrying out fault finding. Heat shunts should be used when making soldered connections to transistors or small components and the iron should be of a type suited for this kind of work, i.e. small bit and low thermal capacity.

When using a mains operated test instrument, always check that its case is well bonded to the receiver earth terminal to avoid possible damage to transistors due to earth currents. Transistors must not be changed while the receiver is switched on.

A 'Table of Voltage Values' is given in Appendix 'B' and this will be found useful should voltage checks become necessary. A high resistance meter should always be used for measurements on transistorised equipment.

The supply socket is fused at 0.5A in the negative line and the circuit arrangements are such that the fuse will blow immediately if the supply is connected with reversed polarity. Always check the polarity of the supply first when investigating a report of a blown fuse. Accidental reversal of the supply will normally only occur when the receiver is powered from an external source. Standard $1\frac{1}{4}$ " cartridge fuses should be held as spares.

Re-alignment.

In the unlikely event of a complete re-alignment being necessary, the instructions given on the following pages should be followed in full. In the more usual case of partial alignment required to compensate for ageing components etc. the relevant instructions can be extracted as required.

It must be stressed that alignment adjustments should not be tampered with unless there is a clear indication that re-alignment is in fact required. Alignment should only be carried out by fully skilled technicians equipped with suitable test instruments.

All dust cores are self-locking (rubber string and silicone core retaining compound). Concentric trimmers in the RF and Mixer stages and also the two crystal phasing capacitors are sealed with hard wax. The latter can be removed quite easily by applying gentle pressure with a pair of pliers. Under this treatment the wax cracks and breaks away leaving the trimmer free for re-adjustment. Trimmers must be re-sealed after alignment. In all but the earliest models, 'Nylor' trimmers are used in the Oscillator Section. These have a finer 'pitch' than the standard trimmers and are self-locking.

Re-alignment of the IF Transformers, Crystal Filter and BFO.

Test Equipment Required	Standard Signal Generator covering the IF of 465 kc/s with provision for modulation at 400 c/s. Sweep Generator with a centre sweep frequency of 465 kc/s together with a suitable oscilloscope. Output Meter matched to 3Ω . Trimming tools (Neosid H.S.1. and Phillips).
----------------------------------	--

Re-alignment of the transformers IFT1-IFT5 will be considered first. After taking off the cabinet, remove the battery box by taking out the four screws which retain it. This will allow easier access to all parts of the chassis and is in fact necessary to allow adjustment of the AGC Transformer.

Connect the output lead from the Signal Generator via a $0.25\mu\text{F}$ capacitor to the base of the Mixer transistor TR2. An insulated crocodile clip should be used to make connection and reference can be made to Fig. 1. for location of TR2 and the positioning of the turret lugs to which the transistor is wired. The centre lug of the three which are grouped closely together is the base connection.

The receiver should remain switched off until this connection has been made but the Signal Generator can be switched on to allow it adequate time to reach operating temperature so that drift during the alignment period is

kept within the smallest possible limits. Heating effects in the receiver are negligible and no warming-up period is required. Check that the de-sensitising terminals at the rear are open-circuited and then set the controls as follows:-

RF Gain	. .	Minimum.	BFO/NL	. .	Off.
Wavechange		Range 4.	Standby	. .	On.
Tuning	. .	3 Mc/s.	AGC	. .	On.
AF Gain	. .	To any convenient level.	Crystal	. .	In.
		(to maximum when checking sensitivity)	Meter	. .	Carrier.

Tune the Signal Generator to approximately 465 kc/s with the modulation switched off and adjust the attenuator for a convenient output. Now tune the Generator very slowly across the IF passband and watch closely the reading on the built-in carrier level meter. If the crystal filter is aligned correctly the reading on the meter will show a sharp rise to maximum, will dip very slightly and then rise again to maximum before falling very sharply to minimum. The clarity with which the slight trough is seen will depend largely on the tuning rate of the generator which is used. Extremely fine tuning will be required to detect it. The attenuator should be set to give a reading of 4-5 on the carrier level meter with the signal tuned to the slight dip between the crystal peaks.

If the filter is out of alignment it may be found that the dip is more pronounced than normal and that the crystal peaks have different amplitudes. Do not attempt to rectify this condition now but proceed as indicated and set the tuning midway between the two peaks. Once the tuning has been adjusted in this manner, switch off the AGC, switch out the crystal and apply modulation to the generator. A suitable output meter should be connected in parallel with the loudspeaker which may remain in circuit to provide aural monitoring during alignment.

Adjust the AF Gain control to obtain a convenient reading on the output meter and then the cores in IFT1-IFT5 for maximum reading (start at IFT5 and work backwards). It should be noted that in all transformers except IFT2 the top core tunes the secondary winding. Both the primary and secondary cores are adjusted from the top, the bottom cores being accessible when the long shank of the trimming tool is passed right through the hexagonal bore of the upper core. Some cores are set to the 'inner' and some to the 'outer' peak and this information is tabulated below.

IFT	TOP	BOTTOM
IFT1	Inner	Outer
IFT2*	Inner	-
IFT3	Outer	Outer
IFT4	Outer	Outer
IFT5	Outer	Inner
IFT6*	Inner	-

* IFT2/IFT6 have single tuned windings with untuned secondaries.

IFT6 is in the output of TR7 (AGC Amplifier) and feeds the two AGC Rectifiers D3 and D4. In adjusting this transformer, the built-in carrier level meter is used to provide an indication of the correct tuning point. The AGC must be brought into operation and all that is required is to adjust the core on its 'inner' peak for maximum reading on the meter.

The Signal Generator can now be disconnected and the alignment continued by adjustment of the bandpass crystal filter. It is possible to align this circuit with a standard generator but the process is both lengthy and tedious; it is far simpler to employ a sweep generator and visual display for this part of the alignment.

Output from the Sweep Generator should be connected to the base of TR2 via a 0.25 μ F capacitor as before, while the output for the Y plate amplifier can be taken from tag 20 at the rear of the IF printed wiring board. Screened lead should be used for this connection and the braid can be conveniently earthed at tag 19 adjacent to the other connection.

Initial adjustment of the generator and oscilloscope to give a suitable display is best carried out with the crystal filter switched out. The sweep speed should be kept as slow as possible to reduce any tendency for the trace to distort. Some residual distortion is inevitable when dealing with selective filters but this will be easily recognised by the experienced engineer.

It is recommended that the sweep width control is set to give a fairly narrow display since this will simplify adjustment of the phasing capacitors if this is found necessary. Initially, and for that matter at any stage of the alignment, the display can be widened temporarily to allow careful inspection of the nose of the response. The crystal peaks should be visible and a shallow trough (of the order 1-2dB) indicates accurate alignment of the IF transformers to the centre of the two crystal frequencies. Misalignment of the IF transformers will show up clearly as a tilting of the nose of the response and this can be checked by adjustment of the crystal filter output circuit IFT2. This transformer will exhibit more influence on the nose shape than any of the other transformers in the strip.

With the width control set for a narrow display, examine carefully the lower extremities of the skirts to determine the relative level of the side lobes due to the crystals. If the lobes are of negligible proportions and the sides of the response are reasonably steep, then adjustment of the phasing capacitors is not required and alignment of the filter can be assumed to be correct.

If on the other hand the side lobes are well defined and of such a height that the rejection notches show up with sharp definition (i.e. both sides are very steep), this is an indication of an incorrect phasing adjustment. To correct this condition proceed as follows:-

Use a concentric trimming tool and set both phasing capacitors so that there is a gap of about 1/16" between the upper and lower portions (i.e. the trimmer is set effectively to less than minimum capacity). Now adjust each trimmer in turn to determine which has the greater effect on the shape of the response. Call this trimmer 'A'. This trimmer should be set so that the trace shows as little of the side lobes as possible. The other trimmer ('B')

will to a large extent duplicate the variations obtained with trimmer 'A' but the changes will be less pronounced. Although complete elimination of the side lobes is possible it will be found that this results in some widening of the skirts and it is best to set trimmer 'B' slightly off the setting which gives complete neutralisation.

Once the adjustments have been corrected as described above, the height of the display in the crystal position should be adjusted to coincide with that which obtains when the filter is switched out. This can be done by slight mistuning of either phasing control. The adjustment calls for a very small change in the setting of the trimmer and ample control of the display amplitude is possible without affecting to any noticeable extent the shape of the response.

The settings of the two phasing capacitors when alignment is completed should be such that trimmer 'B' is virtually at minimum capacity. Trimmer 'A' will have slightly more capacity but this will not normally amount to more than about half a turn of the trimming tool.

A final check should be made to ensure that IFT2 is tuned to the centre of the two crystal peaks.

This completes the alignment of the bandpass crystal filter and the sweep generator should be disconnected to allow alignment of the Beat Frequency Oscillator. To do this, switch off the AGC, switch on the BFO and arrange the Signal Generator to provide an unmodulated signal in the dead centre of the IF passband. Rotate the BFO (Pitch) control to the centre of its travel and ascertain that this occurs with the index mark on the control knob at 12 o'clock. If necessary, slacken the grub screw and re-set the knob to avoid confusion in later use. The dust core in the BFO Unit (IFT7) is now adjusted for zero-beat against the generator signal. As a final check, swing the control over its full travel and ensure that a reasonably linear coverage of at least 3 kc/s to either side of the centre frequency is available. Switch off the BFO.

Checking IF Sensitivity.

To check the sensitivity of the receiver IF stages, set the controls as for IF alignment with the AGC off and the crystal filter switched out. Connect the Signal Generator to the base of TR2 via a 0.25 μ F capacitor as before and wire the Output Meter in place of the internal loudspeaker. Adjust the generator to provide a signal modulated 30% at 400 c/s and centred in the receiver passband. With the AF Gain control at maximum vary the attenuator setting to obtain an output of 50mW. Check the generator output to see whether the sensitivity falls within the range 6 to 16 μ V. (Gen. O/P Z = 50 Ω)

If the sensitivity appears to be low, stage by stage checks should be carried out with the generator applied via the 0.25 μ F capacitor to the base of each IF transistor in turn. All transistor connections are marked on the printed wiring board and average sensitivities are as follows:-

From base of TR4	. .	4-14 μ V.	Greater sensitivities will be
From base of TR5	. .	45-110 μ V.	obtained if a generator of
From base of TR6	. .	600 μ V-1.2mV.	lower O/P Z is employed.

If the sensitivity appears to be low from the base of TR6, check the AF sensitivity by applying a 1,000 c/s audio signal between tag IF/20 and earth. An output of 50mW should be obtained for an input of between 1.2 and 1.5mV.

RF Alignment.

- Test Equipment Required
- Crystal Calibrator giving markers at 1 Mc/s and 100 kc/s intervals over the range 0.5 - 30 Mc/s.
 - Standard Signal Generator covering the range 0.5 - 30 Mc/s with an output impedance of 75Ω and modulation at 400 c/s.
 - Output Meter matched to 3Ω.
 - Trimming tools (screwdriver and Phillips type).

The first step in re-alignment of the RF Section is a check on the accuracy of the scale calibration to ascertain whether adjustments are required in the Local Oscillator Stage. Set up the receiver for CW reception with the BFO in the centre of the IF passband and connect the Crystal Calibrator to the aerial input terminals at the rear. Check the scale accuracy at 100 kc/s intervals throughout each of the six ranges, tuning the receiver to zero-beat against each marker and using the 1 Mc/s harmonics to verify the megacycle points. Calibration accuracy should be within 1% (i.e. 50 kc/s at 5 Mc/s., 150 kc/s at 15 Mc/s., etc.). If the indications are that the accuracy is outside the limits quoted, re-alignment should be carried out using normal tracking procedure. Trimming is by concentric air-spaced trimmers on the oscillator coils and padding by adjustment of the appropriate cores.

It is recommended that the Crystal Calibrator is used as the signal source for this operation though it will be necessary to use the Signal Generator when adjusting the core on Range 6. In this case, the generator calibration should be standardised against the Crystal Calibrator at say 500 kc/s. If a calibration corrector is not fitted, then allowance should be made for any error which may be present when setting to 550 kc/s.

Range	Trimming Freq.	Trimmer	Padding Freq.	Core
1	28.0 Mc/s	C38	20.0 Mc/s	L15
2	18.0 Mc/s	C42	10.0 Mc/s	L16
3	8.5 Mc/s	C46	4.5 Mc/s	L17
4	3.9 Mc/s	C50	2.3 Mc/s	L18
5	2.0 Mc/s	C54	1.2 Mc/s	L19
6	1000 kc/s	C57	550 kc/s	L20

In addition to the individual trimmers provided for each range (C38, C42, C46, etc.), there is a common oscillator trimmer C63a. This is in circuit on all ranges and is located above the chassis across the oscillator section of the 3-gang tuning capacitor. Its function is to provide a means of adjusting

the stray circuit capacity so that the correct tuning points on the individual trimmers fall well within their capacity swing. Normally there will be no need to adjust C63a since it is set during initial alignment to suit the particular transistor which is fitted in the TR3 position. Replacement of this transistor may necessitate adjustment of the common trimmer. The need for adjustment will become obvious as alignment proceeds since it will be found that one or more of the individual trimmers has too much or too little capacity to resonate the oscillator circuit correctly. It must be realised that adjustment of C63a during alignment will call for re-adjustment of any trimmers which have been aligned up to that time regardless of the fact that originally they may have tuned correctly.

Although the oscillator tracks 'high' on all ranges, there is a possibility on the higher frequency ranges of setting the oscillator on the low frequency side of the signal. This can be easily verified by using the generator to check that the image frequency lies some 930 kc/s higher than the signal channel. If the image falls on the low side, set the trimmer at half-capacity, tune to the low frequency alignment point and adjust the core in an anti-clockwise direction to the higher of the two points of resonance.

Trimmer and core adjustments will interact when either or both are set some way from the correct alignment point. Repeated alternate adjustment of both will result in the interaction becoming progressively less until eventually the correct alignment settings are reached. In re-alignment of the 960 receiver, making each adjustment twice will usually suffice unless TR3 has been changed. In this case, repeat the adjustments as required until the alignment is correct.

Once the scale calibration has been checked and corrected if necessary, alignment of the RF and Mixer circuits can be commenced. Arrange the output impedance of the generator to match the receiver input impedance (75Ω) and connect the output cable to the A1 and E terminals at the rear (strap A2 and E). Modulation should be 30% at 400 c/s and the receiver gain controls should be advanced to maximum if sensitivity measurements are to be made. The BFO and AGC switches should be at off.

Wire the Output Meter across the loudspeaker connections at the rear and remember that the speaker must be disconnected when carrying out sensitivity checks. Adjust the trimmers and cores on each range in turn, repeating each

Range	Trimmers			Cores		
	Freq.	RF	Mixer	Freq.	RF	Mixer
1	28.0 Mc/s	C1	C20	20.0 Mc/s	L1	L9
2	18.0 Mc/s	C4	C23	10.0 Mc/s	L2	L10
3	8.5 Mc/s	C6	C25	4.5 Mc/s	L3	L11
4	3.9 Mc/s	C8	C27	2.3 Mc/s	L4	L12
5	2.0 Mc/s	C10	C29	1.2 Mc/s	L5	L13
6	1000 kc/s	C12	C31	550 kc/s	L6	L14

adjustment at least twice to ensure accurate alignment. When making adjustments to the Mixer cores and trimmers on the higher frequency ranges, some slight pulling will be experienced. To overcome this difficulty, the tuning capacitor should be rocked from side to side to keep the signal in tune while the Mixer circuit is adjusted for maximum output. Alignment frequencies are listed in the Table at the foot of the previous page.

Alignment of the IF Rejection Filter (L7/L8)

On completion of the RF alignment as detailed above, select Range 6 and tune to 500 kc/s. Tune the Signal Generator to the IF channel (generator still connected to aerial input) and adjust the attenuator for a convenient reading on the output meter. All that is required is to reduce this reading to the lowest possible level by alternate adjustment of the two filter coils L7 and L8. It should be noted that L7 is immediately below L8 and is adjusted by passing the trimming tool through the core of L8.

Pointer Drive Cord Replacement.

In the unlikely event of the drive cord either breaking or slipping out of the pulley grooves, replacement will be much simplified (even when the original cord is undamaged) if a new length is obtained. This can be made longer than the length actually required (approximately 4') and will therefore be easier to handle. Replacement will present no problems if the instructions given below are followed carefully.

NOTE: In these instructions, left and right are as viewed from the rear of the receiver.

1. Remove the cabinet and take off the battery box to allow easy access to the drive.
2. Take off the old drive cord by slackening the 8BA screws which are let into the drive pulleys.
3. Set the tuning control so that the gang is fully meshed.
4. Secure one free end of the replacement cord to the 8BA screw in the left-hand drive pulley.
5. Feed the cord through the pulley slot and into the groove nearest to the panel (cord leaving pulley from right to left).
6. Pass cord around jockey pulley (under then over) and across the dial between the pointer guide rods. Sufficient tension should be applied to cause the jockey pulley to take up a position one quarter of an inch from the guide rod support bracket.
7. Move the pointer to the right-hand end of the guide rods (past tuning meter) and then slide the cord up and over the retaining spring. The spring may be depressed slightly to simplify this operation.
8. Pass cord over top right-hand guide pulley, under bottom right-hand guide pulley, under meter and across towards the right-hand drive pulley.

Pointer Drive Cord Replacement. (contd.)

9. Lay the cord in the groove nearest to the panel and wind three complete turns in an anti-clockwise direction. Ensure that the cord lies snugly in the pulley grooves and that tension is maintained at the jockey pulley.
10. Press cord into pulley slot and secure to 8BA screw. (If screw is not immediately accessible, rotate tuning control to unmesh gang so that screw comes into a more convenient position. The cord should be held firmly in line with the pulley groove whilst doing this).
11. Check that the jockey pulley is correctly tensioned and then cut off the surplus cord at the right-hand drive pulley.
12. Move gang to fully meshed position and set pointer to '0' on logging scale. Check drive for free and normal operation and correct vernier tracking.
13. Check the dial calibration against a convenient frequency standard (MSF, WWV, etc.).
14. Replace battery box and cabinet.

Cleaning Scale and Scale Window.

1. Locate the three screws disposed vertically at each end of the rear of the scale plate. Take out the centre screw at each end and remove the small side castings at the extremities of the glass window.
2. Remove the four countersunk screws along the top edge of the panel and take out the long scale support.
3. The glass is now free and can be removed by lifting up and tilting back slightly.

APPENDIX 'A'

LIST OF COMPONENT VALUES, TOLERANCES AND RATINGS

Capacitors.

Ref	Value	Type	Tol.	Wkg. V.
C1	3-30pF	Air Trimmer	-	-
C2	100pF	Silvered Mica	5%	350V
C3	400pF	Polystyrene	2%	125V
C4	3-30pF	Air Trimmer	-	-
C5	60pF	Silvered Mica	5%	350V
C5a	3625pF	Silvered Mica	10%	350V
C6	3-30pF	Air Trimmer	-	-
C7	40pF	Silvered Mica	10%	350V
C8	3-30pF	Air Trimmer	-	-
C9	390pF	Polystyrene	2%	125V
C10	3-30pF	Air Trimmer	-	-
C11	390pF	Polystyrene	2%	125V
C12	3-30pF	Air Trimmer	-	-
C13	390pF	Polystyrene	2%	125V
C14	0.022μF	Polystyrene	2%	125V
C15	0.001μF	Polystyrene	2%	125V
C16	11.5-366pF	3-gang Air Spaced Variable	-	-
C17	0.01μF	Tubular Ceramic	-20% +80%	250V
C18	25μF	Tubular Electrolytic	-20% +100%	25V
C19	0.1μF	Plate Ceramic	-20% +80%	200V
C20	3-30pF	Air Trimmer	-	-
C21	80pF	Silvered Mica	5%	350V
C22	400pF	Polystyrene	2%	125V
C23	3-30pF	Air Trimmer	-	-
C24	40pF	Silvered Mica	10%	350V
C24a	3625pF	Silvered Mica	10%	350V
C25	3-30pF	Air Trimmer	-	-
C26	25pF	Silvered Mica	10%	350V
C27	3-30pF	Air Trimmer	-	-
C28	10pF	Silvered Mica	10%	350V
C29	3-30pF	Air Trimmer	-	-
C30	20pF	Silvered Mica	10%	350V
C31	3-30pF	Air Trimmer	-	-
C32	0.1μF	Plate Ceramic	-20% +80%	200V
C33	350μF	Tubular Electrolytic	-20% +100%	12V
C33a	0.1μF	Plate Ceramic	-20% +80%	200V
C34	0.05μF	Plate Ceramic	-20% +80%	200V
C35	0.05μF	Plate Ceramic	-20% +80%	200V
C36	0.01μF	Tubular Ceramic	-20% +80%	250V

Ref	Value	Type	Tol.	Wkg. V.
C37	200pF	Polystyrene	2%	125V
C38	3-30pF	Air Trimmer	-	-
C39	70pF	Polystyrene	2%	125V
C40	400pF	Polystyrene	2%	125V
C41	390pF	Polystyrene	5%	125V
C42	3-30pF	Air Trimmer	-	-
C43	25pF	Silvered Mica	10%	350V
C44	0.1μF	Plate Ceramic	-20% +80%	200V
C45	390pF	Polystyrene	2%	125V
C46	3-30pF	Air Trimmer	-	-
C47	-	Reference not allocated	-	-
C48	0.0051μF	Polystyrene	2%	125V
C49	0.001μF	Polystyrene	2%	125V
C50	3-30pF	Air Trimmer	-	-
C51	10pF	Silvered Mica	10%	350V
C52	2790pF*	Polystyrene	2%	125V
C53	0.001μF	Polystyrene	2%	125V
C54	3-30pF	Air Trimmer	-	-
C55	-	Reference not allocated	-	-
C56	940pF	Polystyrene	2%	125V
C57	3-30pF	Air Trimmer	-	-
C58	20pF	Silvered Mica	10%	350V
C59	640pF	Polystyrene	2%	125V
C60	0.01μF	Tubular Ceramic	-20% +80%	250V
C61	10μF	Tubular Electrolytic	-20% +100%	16V
C61a	0.01μF	Tubular Ceramic	-20% +80%	250V
C62	10μF	Tubular Electrolytic	-20% +100%	16V
C63	10μF	Tubular Electrolytic	-20% +100%	16V
C63a	3-30pF	Air Trimmer	-	-
C64	0.04μF	Metallised Paper	20%	150V
C65	0.01μF	Tubular Ceramic	-20% +80%	250V
C66	350μF	Tubular Electrolytic	-20% +100%	12V
C67	390pF	Polystyrene	2%	125V
C68	790pF	Polystyrene	2%	125V
C69	790pF	Polystyrene	2%	125V
C70	3-30pF	Air Trimmer	-	-
C71	3-30pF	Air Trimmer	-	-
C72	10pF	Silvered Mica	5%	350V
C73	330pF	Polystyrene	2%	125V
C74	0.05μF	Plate Ceramic	-20% +80%	200V
C75	0.1μF	Plate Ceramic	-20% +80%	200V
C76	25μF	Tubular Electrolytic	-20% +100%	25V
C77	390pF	Polystyrene	2%	125V

* Made up of 2000pF and 790pF wired in parallel.

Ref	Value	Type	Tol.	Wkg. V.
C78	390pF	Polystyrene	2%	125V
C79	60pF	Polystyrene	2%	125V
C80	0.01 μ F	Tubular Ceramic	-20% +80%	250V
C81	0.01 μ F	Tubular Ceramic	-20% +80%	250V
C82	60pF	Polystyrene	2%	125V
C83	390pF	Polystyrene	2%	125V
C84	390pF	Polystyrene	2%	125V
C85	0.05 μ F	Plate Ceramic	-20% +80%	200V
C86	1 μ F	Tubular Electrolytic	-20% +100%	15V
C87	0.1 μ F	Plate Ceramic	-20% +80%	200V
C88	100 μ F	Tubular Electrolytic	-20% +100%	18V
C89	20pF	Tubular Ceramic	10%	750V
C90	390pF	Polystyrene	2%	125V
C91	390pF	Polystyrene	2%	125V
C92	1 μ F	Tubular Electrolytic	-20% +100%	15V
C93	0.01 μ F	Tubular Ceramic	-20% +80%	250V
C94	1 μ F	Tubular Electrolytic	-20% +100%	15V
C95	0.01 μ F	Tubular Ceramic	-20% +80%	250V
C96	0.1 μ F	Plate Ceramic	-20% +80%	200V
C97	100 μ F	Tubular Electrolytic	-20% +100%	18V
C98	390pF	Polystyrene	2%	125V
C99	390pF	Polystyrene	2%	125V
C100	390pF	Polystyrene	2%	125V
C101	0.25 μ F	Metallised Paper	20%	150V
C102	3pF	Tubular Ceramic	10%	750V
C103	390pF	Polystyrene	2%	125V
C104	180pF	Polystyrene	2%	125V
C105	0.01 μ F	Tubular Ceramic	-20% +80%	250V
C106	0.01 μ F	Tubular Ceramic	-20% +80%	250V
C107	10 μ F	Tubular Electrolytic	-20% +100%	12V
C108	100 μ F	Tubular Electrolytic	-20% +100%	18V
C109	10 μ F	Tubular Electrolytic	-20% +100%	12V
C110	100 μ F	Tubular Electrolytic	-20% +100%	18V
C111	100 μ F	Tubular Electrolytic	-20% +100%	18V
C112	100 μ F	Tubular Electrolytic	-20% +100%	18V
C113	0.25 μ F	Metallised Paper	20%	150V
C114	350 μ F	Tubular Electrolytic	-20% +100%	12V

Resistors.

Ref	Value	Tol.	Rating
R1	68,000 ohms	10%	1/4 watt
R2	1,000 ohms	10%	1/4 watt
R3	560 ohms	10%	1/4 watt
R4	470 ohms	10%	1/4 watt
R5	47,000 ohms	10%	1/4 watt
R6	1,500 ohms	10%	1/4 watt
R7	1,000 ohms	10%	1/4 watt
R8	3,300 ohms	10%	1/4 watt
R9	1,500 ohms	10%	1/4 watt
R10	560 ohms	10%	1/4 watt
R11	33,000 ohms	10%	1/4 watt
R12	4,700 ohms	10%	1/4 watt
R13	270 ohms	10%	1/4 watt
R14	68,000 ohms	10%	1/4 watt
R15	270 ohms	10%	1/4 watt
R16	560 ohms	10%	1/4 watt
R17	12 ohms	10%	1/4 watt
R18	1,200 ohms	10%	1/4 watt
R19	68,000 ohms	10%	1/4 watt
R20	1,000 ohms	10%	1/4 watt
R21	12 ohms	10%	1/4 watt
R22	1,200 ohms	10%	1/4 watt
R23	10,000 ohms	10%	1/4 watt
R24	390 ohms	10%	1/4 watt
R25	4,700 ohms	10%	1/4 watt
R26	22,000 ohms	10%	1/4 watt
R27	12 ohms	10%	1/4 watt
R28	1,000 ohms	10%	1/4 watt
R29	3,300 ohms	10%	1/4 watt
R30	3,300 ohms	10%	1/4 watt
R31	2,200 ohms	10%	1/4 watt
R32	0.27 megohm	10%	1/4 watt
R33	22,000 ohms	10%	1/4 watt
R34	3,300 ohms	10%	1/4 watt
R35	6,800 ohms	10%	1/4 watt
R36	470 ohms	10%	1/4 watt
R37	4,700 ohms	10%	1/4 watt
R38	1,000 ohms	10%	1/4 watt
R39	3,300 ohms	10%	1/4 watt

Ref	Value	Tol.	Rating
R40	10,000 ohms	10%	1/4 watt
R41	33,000 ohms	10%	1/4 watt
R42	10,000 ohms	10%	1/4 watt
R43	1,000 ohms	10%	1/4 watt
R44	1,000 ohms	10%	1/4 watt
R45	22,000 ohms	10%	1/4 watt
R46	4,700 ohms	10%	1/4 watt
R47	4,700 ohms	10%	1/4 watt
R48	82,000 ohms	10%	1/4 watt
R49	3,300 ohms	10%	1/4 watt
R50	15,000 ohms	10%	1/4 watt
R51	1,200 ohms	10%	1/4 watt
R52	5,600 ohms	10%	1/4 watt
R53	3,300 ohms	10%	1/4 watt
R54	47,000 ohms	10%	1/4 watt
R55	12,000 ohms	10%	1/4 watt
R56	680 ohms	10%	1/4 watt
R57	0.18 megohm	10%	1/4 watt
R58	2,200 ohms	10%	1/4 watt
R59	39 ohms	5%	1/4 watt
R60	120 ohms	10%	1/2 watt
R61	5 ohms*	10%	3 watt
R62	3.3 ohms*	10%	3 watt

* wirewound.

Potentiometers.

Ref	Value	Type
RV1	20,000 ohms	Carbon
RV2	1,000 ohms	Carbon
RV3	5,000 ohms	Carbon
RV4	50,000 ohms	Carbon

APPENDIX 'B'

TABLE OF VOLTAGE VALUES

The following 'Table of Voltage Values' will prove useful in the event of the receiver developing a fault which necessitates carrying out voltage checks.

All readings are typical and were taken with a meter having a sensitivity of 20,000 Ω /V and a battery voltage of 12V (batteries in new condition). A nominal tolerance of 10% will apply to readings taken with a meter of this sensitivity and the tolerance should be increased accordingly when using meters of lower sensitivity. Allowance should also be made for the state of the batteries.

Readings should be taken under 'no-signal' conditions with the controls set as follows. The desensitising terminals at the rear should be 'open-circuit.' All readings are NEGATIVE with respect to chassis.

Range switch	. . . .	Range 1.
Tuning	. . . .	20 Mc/s.
RF Gain	. . . .	Maximum.
AF Gain	. . . .	Half maximum.
AGC/BFO/NL	. . . .	Off.
Standby	. . . .	On.

Stage	Collector	Base	Emitter
TR1	5.9V	1.6V	1.4V
TR2	7.0V	0.55V	0.35V
TR3	7.0V	0.85V	0.65V
TR4	7.0V	0.55V	0.4V
TR5	7.0V	0.55V	0.4V
TR6	8.0V	1.35V	1.3V
TR7	8.2V	1.35V	1.2V
TR8*	-	-	-
TR9	3.1V	1.15V	1.1V
TR10	11.6V	1.85V	1.8V
TR11	11.8V	0.2V	0.05V
TR12	11.8V	0.2V	0.05V

* Not accessible for voltage checks.

The zener diode stabilised voltage should be in the range 6.8-7.2V and the voltage at the junction of R32 and R35 (detector bias) should be 0.07V.

APPENDIX 'C'

LIST OF BATTERY EQUIVALENTS

Any of the following 1.5V units can be used to power the Model 960. Leak-proof versions are preferred when available.

EVER READY	U2	OLDHAM	K532
VIDOR	V0002	PERTRIX	601
DRYDEX	T20	SIEMENS	T1
G.E.C.	BA6103		

APPENDIX 'D'

SPARES

Spare parts should be ordered by quoting the circuit reference (where applicable) and the part number given in the lists below. Enquiries should be addressed to Stratton & Co., Ltd., Sales and Service Dept., Alvechurch Rd., Birmingham, 31.

Inductors.

L1	Range 1 Aerial (RF) coil	. . . . .	D2784
L2	Range 2 Aerial (RF) coil	. . . . .	D2787
L3	Range 3 Aerial (RF) coil	. . . . .	D2790
L4	Range 4 Aerial (RF) coil	. . . . .	D2793
L5	Range 5 Aerial (RF) coil	. . . . .	D2796
L6	Range 6 Aerial (RF) coil	. . . . .	D2799
L7	IF Filter coil (1)	. . . . .	D2840
L8	IF Filter coil (2)	. . . . .	D2839
L9	Range 1 Mixer coil	. . . . .	D2785
L10	Range 2 Mixer coil	. . . . .	D2788
L11	Range 3 Mixer coil	. . . . .	D2791
L12	Range 4 Mixer coil	. . . . .	D2794
L13	Range 5 Mixer coil	. . . . .	D2797
L14	Range 6 Mixer coil	. . . . .	D2800
L15	Range 1 Local Oscillator coil	. . . . .	D2786
L16	Range 2 Local Oscillator coil	. . . . .	D2789
L17	Range 3 Local Oscillator coil	. . . . .	D2792
L18	Range 4 Local Oscillator coil	. . . . .	D2795
L19	Range 5 Local Oscillator coil	. . . . .	D2798
L20	Range 6 Local Oscillator coil	. . . . .	D2801
L21	Filter choke . . . . .	. . . . .	D2412

IF Transformers and BFO Unit.

IFT1	1st IF Transformer	. . . . .	D2779
IFT2	2nd IF Transformer	. . . . .	D2780
IFT3	3rd IF Transformer	. . . . .	D2781
IFT4	4th IF Transformer	. . . . .	D2781
IFT5	5th IF Transformer	. . . . .	D2782
IFT6	AGC Transformer	. . . . .	D2783
IFT7	BFO Unit (includes transistor and diode)	. . . . .	D2778

AF Transformers.

T1	Driver Transformer (OC83 to push-pull OC83)	. . . . .	5980P
T2	Output Transformer (push-pull OC83 to 3Ω and 600Ω CT)	. . . . .	5979P

Crystal.

XL1	Style E bandpass crystal. (spaced 200 c/s., centred 465 kc/s ±.05%)		6243P
-----	---	--	-------

Switches.

S1	Range switch : Wafer LP 6W with shorting plate	. . . . .	3257P
	Clicker mechanism	. . . . .	4464/1P
	Extension spindle	. . . . .	5431/1P
	Coupler	. . . . .	4279P
S2	Crystal Filter switch : 5-pole 2-way complete	. . . . .	5978P
S3/S5	Meter/AGC : Toggle type DPDT	. . . . .	5788P
S4/S6/S7	Standby/BFO/NL : Toggle type SPST	. . . . .	5789P

Variable Capacitors and Associated Items.

C16	3-gang tuning capacitor (11.5-366pF each section)	. . . . .	4839P
	Flexible coupler for tuning capacitor	. . . . .	D1680

Potentiometers.

RV1	20,000Ω carbon	. . . . .	5982P
RV2	1,000Ω carbon (miniature pre-set)	. . . . .	6076P
RV3	5,000Ω carbon (with switch)	. . . . .	5983P
RV4	50,000Ω carbon	. . . . .	5981P

Knobs.

Large	(state whether Tuning or Wavechange)	. . . . .	5817P
Small		. . . . .	5816P

Drive Assembly.

	Condenser gear spindle assembly	. . . . .	D2077
	Drive disc assembly	. . . . .	D1562/1
	Vernier spindle assembly	. . . . .	D1559/1
	Control spindle assembly	. . . . .	BP953

Miscellaneous.

Chromium plated panel handles	. .	. .	. .	. .	. .	5826P
Scale plate	. .	. .	. .	. .	. .	5984P
Pointer assembly	. .	. .	. .	. .	. .	D2873
Pointer guide rails	. .	. .	. .	. .	. .	5801P
Glass window	. .	. .	. .	. .	. .	5847P
Carrier level meter	. .	. .	. .	. .	. .	6045P
Finger plate	. .	. .	. .	. .	. .	5962P
Terminal (Aerial input etc.)	. .	. .	. .	. .	. .	6102P
Battery plug	. .	. .	. .	. .	. .	6246P
Speaker plug	. .	. .	. .	. .	. .	6247P
Fuseholder	. .	. .	. .	. .	. .	6103P
Fuse ($\frac{1}{2}$ Amp)	. .	. .	. .	. .	. .	6244P
Phone jack	. .	. .	. .	. .	. .	6091P
Vernier dial (complete with hub)	. .	. .	. .	. .	. .	5867P
Drive pulleys	. .	. .	. .	. .	. .	5837P
Guide pulleys	. .	. .	. .	. .	. .	6125P
Loudspeaker unit	. .	. .	. .	. .	. .	6245P
Rack-mounting cabinet	. .	. .	. .	. .	. .	5802P
Rack-mounting brackets	. .	. .	. .	. .	. .	5912P
Battery box assembly (complete)	. .	. .	. .	. .	. .	D2962

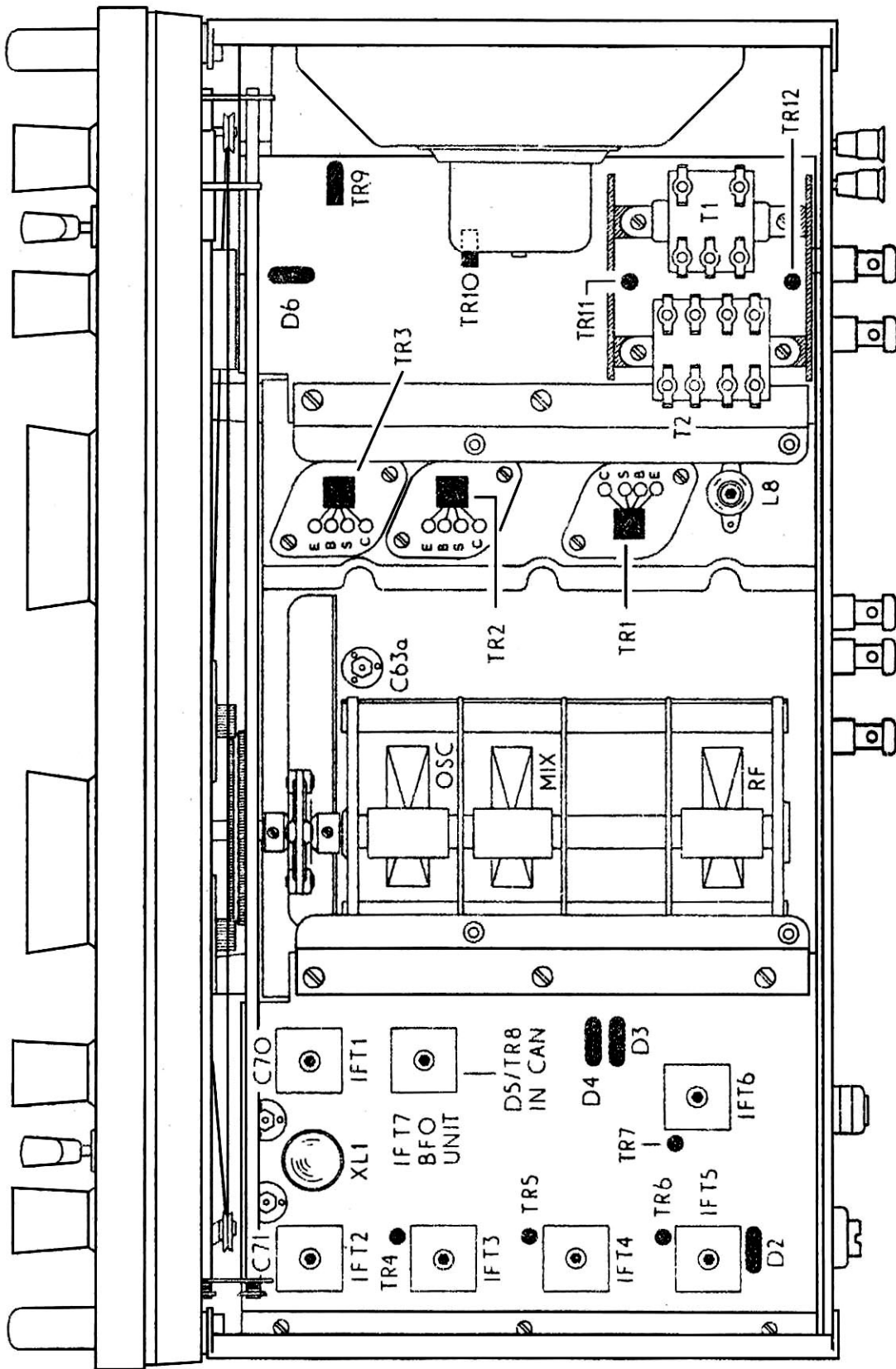


Fig. 1. Plan view of Model 960.

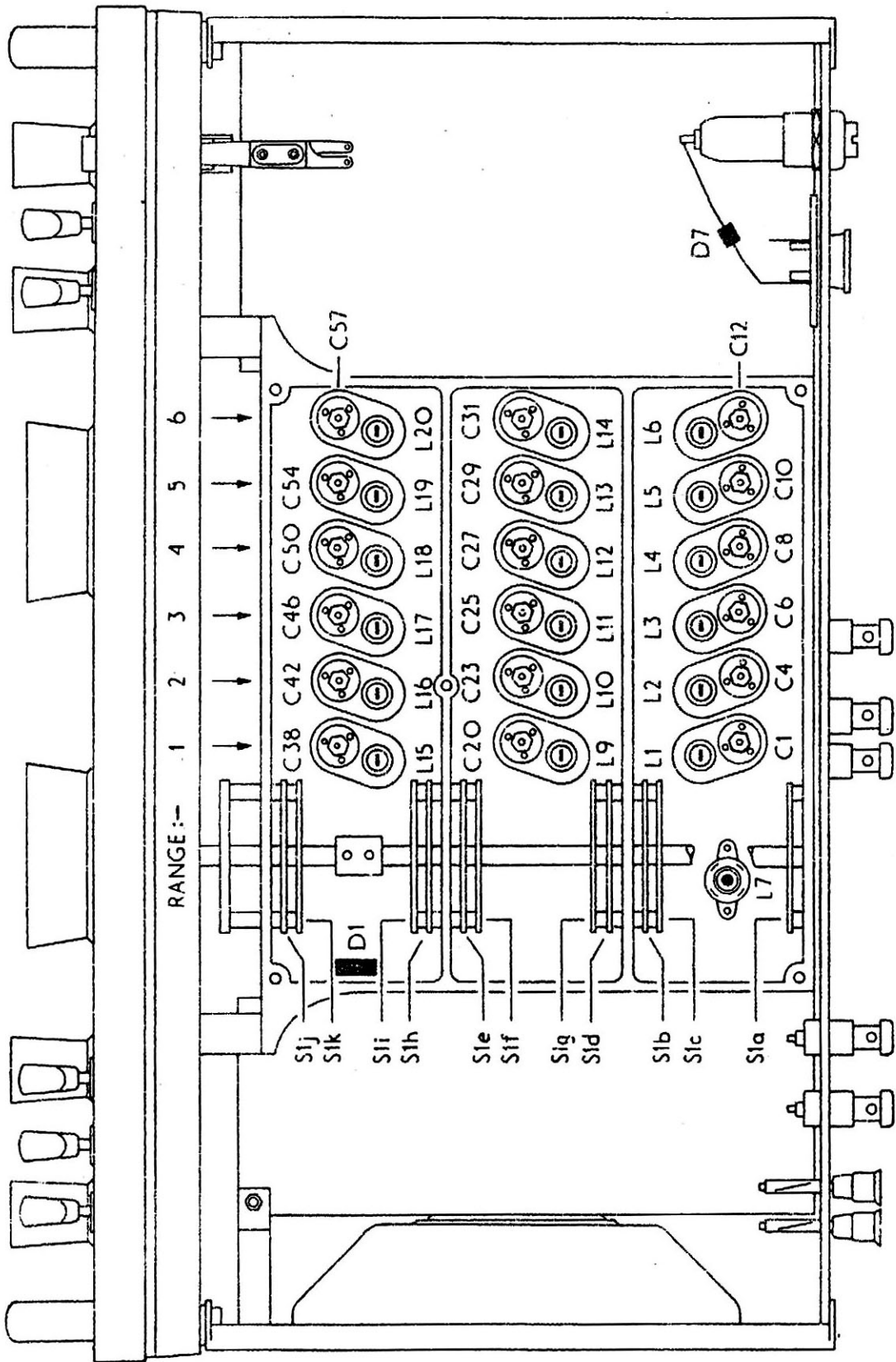
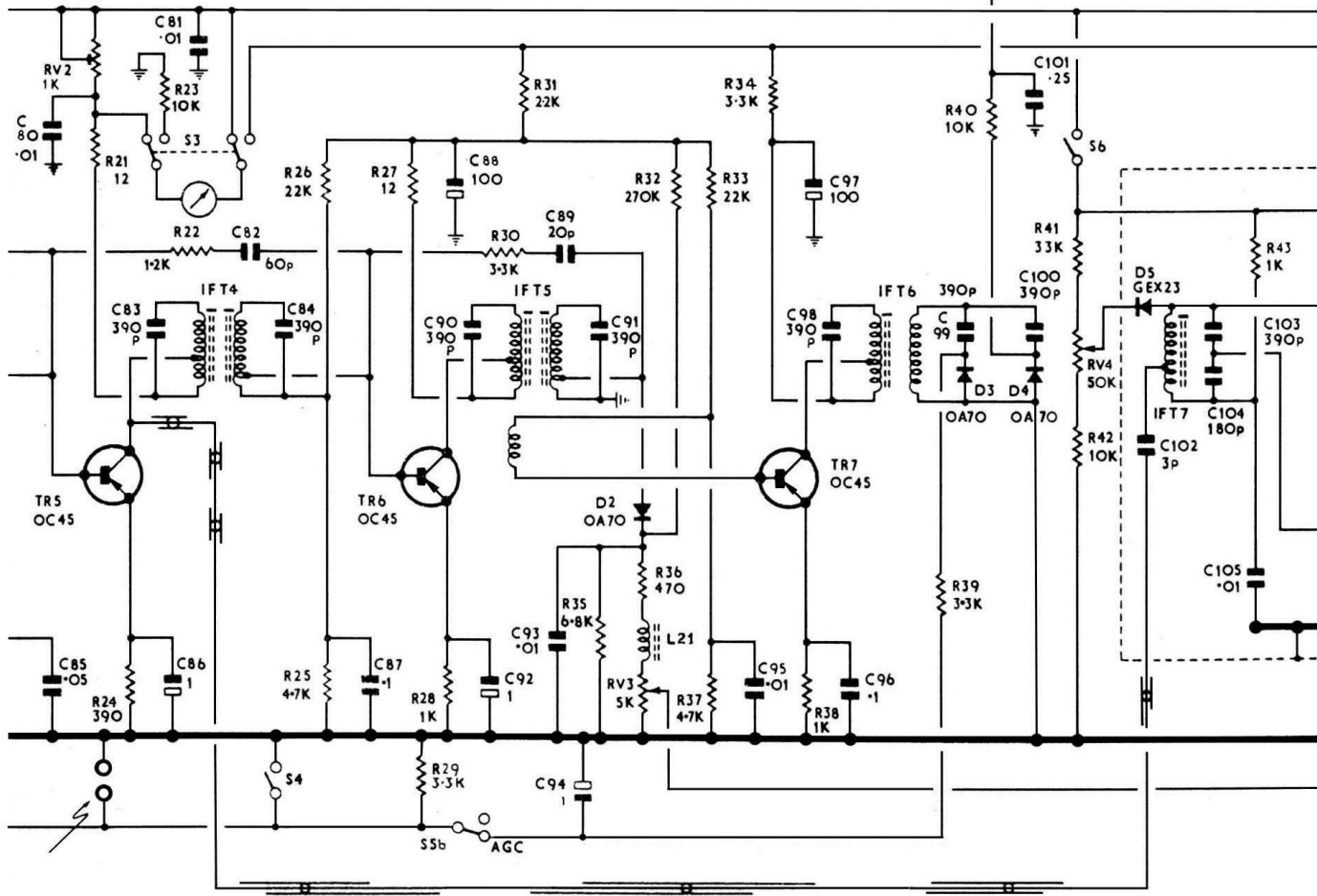
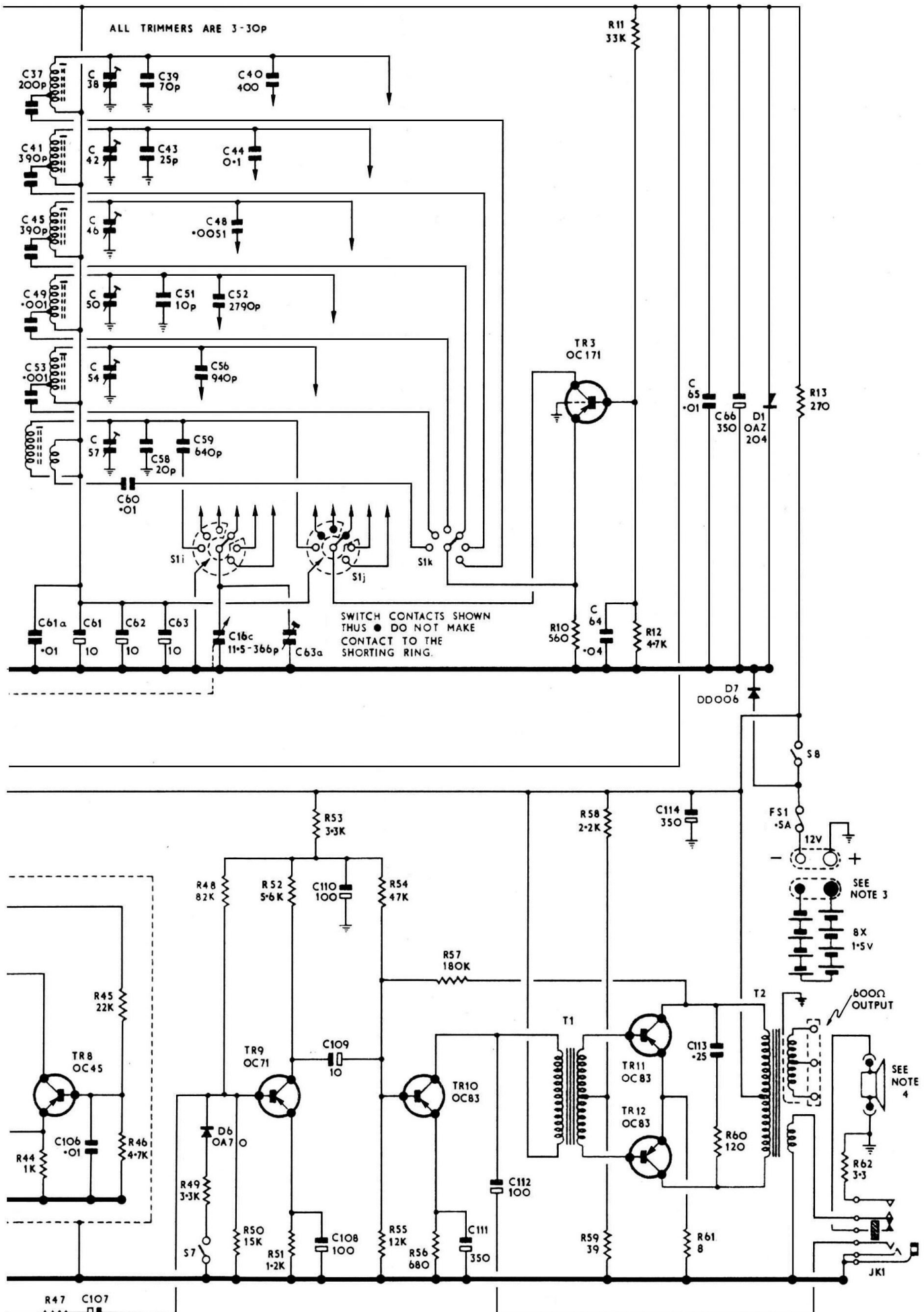


Fig. 2. Underside view of Model 960.





ALL TRIMMERS ARE 3-30P

SWITCH CONTACTS SHOWN
THUS ● DO NOT MAKE
CONTACT TO THE
SHORTING RING.

NOTE 5 AN EXTERNAL 12V SUPPLY CAN BE USED TO POWER THE RECEIVER IF THE INTERNAL BATTERY PACK IS DISCONNECTED FROM THE SOCKET AT THE REAR

NOTE 4 AN EXTERNAL 2.5/3Ω LOUDSPEAKER CAN BE CONNECTED IN PLACE OF THE INTERNAL SPEAKER IF THE SPEAKER PLUGS ARE REMOVED FROM THE SOCKETS AT THE REAR