The TR1985/6/7 and TR1998 series of Airband Transceivers

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Examples of this series of radio transceivers have been floating around on the surplus markets quite cheaply for as long as I can remember, yet they have never been popular with amateurs. Searches of the internet have revealed very little information: this article is compiled mainly from a manual kindly loaned to me by John Coggins G3TFC and from experiences gained from the examples I have worked on.

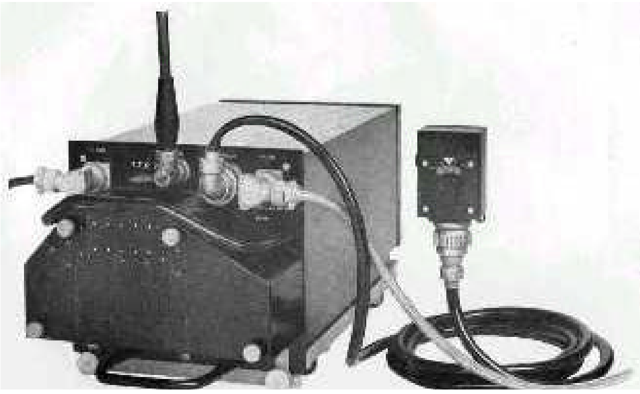

Fig.1 Overall view of the STR.9-X

Compact, of modular construction and quite easy to work on the various models differ mainly in their frequency coverage and IF bandwidth. There are both military and civilian versions: there are differences in the type of connectors between the two but apart from the RF units, the modules appear to be interchangeable between versions. Most are 10 channel units, but there are four and 20 channel units about as well. The versions I'm aware of are listed in table 1. No doubt there are more and any further information would be appreciated.

Military		Civilian	
Model	Freq coverage Mc/s	Model	Freq coverage Mc/s
TR1985	100 - 125	STR.9-X	115 - 145
TR1986	124.5 -156	STR.9-X.1	112 - 142
TR1987	115 – 145*	STR.9-X.2	100 - 125
TR1998	100 – 156	STR.9-X.3	124.5-156
TR192x	Four channel versions		
*The TR1987 was designated for Naval use.			

Table 1

Manufactured by STC and badged "Standard Radio" in civilian guise, the earliest example I have is dated 1950 and the latest, 1960, this latter has a "fit for service" label attached to it dated 1985, so they appear to have had a long operational life. One military set I have has the initials "E.K.C." on the serial number plate, which suggests that it could have been manufactured by Ekco.

Service

The equipment is intended for telephony (AM) communication on any one of 10 preset channels that can be remotely selected. RF power output is approximately four watts and the receiver requires a maximum of 10µV to lift the muting.

Power Supply

The equipment is designed to operate on a nominal power supply of 26 volts at a maximum of 9 amps when transmitting. The valve heaters are fed directly from the DC supply via a carbon pile regulator, the HT and bias supplies are provided by a built-in rotary transformer which also provides forced-air cooling and mechanical drive for the channel selector mechanism.

Description

The equipment consists of two assemblies as follows:-

Main Assembly

This consists of a main chassis housing five interconnected units. These are designed so that they may be easily removed from the main chassis and are:-

- Receiver Unit.
- Transmitter Unit.
- IF Amplifier unit.
- Modulator unit.
- Power unit.

Control Unit Assembly

This assembly incorporates the selector switch for remote control of the equipment and has built-in dial lighting with dimmer control.

Fig.2 Control unit

Technical Description

General

A main crystal oscillator circuit, capable of operating on any one of 10 frequencies within a range of 5682 – 8148 kc/s (depending on version) is incorporated as the source of excitation. It controls both the transmitter and receiver operating frequency. The oscillator is built into the receiver unit and is permanently coupled to both the transmitter and receiver. An additional crystal oscillator, operating on a single frequency is used in the transmitter unit to 'sidestep' the main crystal frequency to compensate for the intermediate frequency of the receiver. A block diagram of the complete set is shown in fig. 12.

Receiver

The receiver unit incorporates two principal circuits. One consists of an oscillator-harmonic generator chain and the other a receiver input circuit. The tuning of the various circuits is carried out by a five gang variable condenser mounted on the lower half of the unit and driven via a flexible coupling from the channel selector mechanism. The oscillator and harmonic generator consist of valves 3V1, 3V2 and 3V3. The first is the oscillator and frequency tripler, the second a frequency tripler and the third a doubler. The total multiplication is therefore x18. This frequency (signal

Fig.3 Receiver unit

frequency – 9.72) is applied to the receiver mixer 3V4 to produce the intermediate frequency of 9.72 Mc/s.
The incoming signal is applied, via the aerial changeover relay, and tuned input circuit to the grid of the RF amplifier valve 3V5, and after amplification is fed to the grid of the frequency changer valve 3V4. From the anode of 3V4 the resultant 9.72 Mc/s I.F. is fed via coaxial cable to the IF amplifier unit. AVC voltage from the IF unit is applied to the grid of 3V5.

Transmitter

The transmitter is of similar construction to the receiver and consists of an oscillator operating at a fixed frequency of 4.86 Mc/s (4V1), a balanced mixer (4V2 and 4V3), a frequency doubler (4V4) an amplifier (4V5) and a power amplifier (4V6).
As with the receiver the tuning is achieved by a five gang variable condenser driven from the channel selector mechanism. A signal at nine times the main crystal frequency derived from the receiver multiplier chain is applied to the grids of the balanced mixer valves 4V2 and 4V3. A signal at 4.86 Mc/s is applied to the screens of these valves, the resulting beat in the anode circuit is at the sum of these two frequencies. This is then doubled by 4V4 to the final frequency and amplified to output level by 4V5 and 4V6.

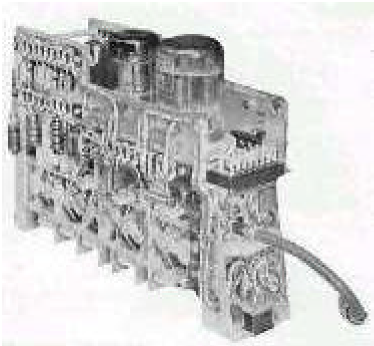

Fig.4 Transmitter unit

The following example should make it clear how the frequency conversion is obtained:-
A crystal of frequency 6.96 Mc/s is placed in circuit by the channel change mechanism. This is multiplied by 18 in the receiver unit to give a frequency of 125.28 Mc/s which beats with an incoming signal on 135 Mc/s to give the intermediate frequency of 9.72 Mc/s.
9 x 6.96 = 62.64 Mc/s is fed to the transmitter mixer circuit, together with the local 4.86 Mc/s oscillator, these are mixed to give a frequency of the sum of the two, 67.5 Mc/s. This is then doubled to give the transmitter operational frequency of 135 Mc/s.

IF Amplifier, noise limiter and muting

The IF amplifier consists of an oblong chassis unit mounting four IF transformers and six valves. Input to the IF amplifier at 9.72 Mc/s is fed via coaxial cable to the grid of 1V1 via the first IF transformer. 1V1 is coupled to 1V2 via the second IF transformer. Both valves are variable-mu types and have AVC voltage fed to their respective grids via the IFT secondaries and decoupling components. Bias is obtained from the –50 volt winding of the rotary transformer and may be adjusted from the front panel to vary the overall gain.
1V2 is coupled via transformer 1T3 to a high slope pentode valve 1V3, which in turn feeds the diode detector valve 1V4, ,

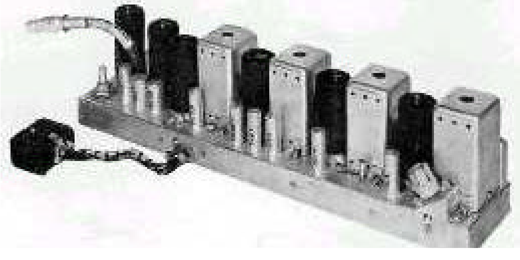

Fig.5 IF amplifier unit

through the medium of transformer 1T4. Associated with the detector circuit is a noise limiter and audio muting valve 1V5 and an A.V.C. amplifier valve 1V6.
In the detector circuit condensers 1C17, 1C20 and resistance 1R11 form an I.F. filter and resistors 1R18, 1R19, and 1R23 the diode load. The load is coupled to the anode of valve 1V5. The cathode of valve 1V5 is connected to condenser 1C24 and resistance 1R16, via potentiometer 1R24 and resistance 1R28. Potentiometer 1R24 serves as an output level control for application of the rectified signal to 2V1 in the separate modulator unit. The anode and grid circuits of 1V5 are linked by condenser 1C25; this link reduces the series impedance of 1V5 to A.C. currents. 1V5 is series connected with the audio supply to the A.V.C. amplifier valve 1V6 and audio volts appear across potentiometer 1R24 and resistance 1R28 when conduction is effected in lV5.
The cathode potentials of valves 1V4, 1V5 and 1V6 are dependent upon the voltage developed across resistance 1R20 which is connected to the 50-volt negative supply line. In turn the voltage across resistance 1R20 is governed by the current consumed in valve 1V6 and accordingly by the grid bias applied to valve 1V6 from the diode load circuit.
Upon receipt of a signal a negative bias is developed across the diode load and applied to valve 1V6 via resistor 1R22 thereby reducing the anode current of the valve and the voltage drop across 1R20. As the voltage across resistance 1R20 becomes small the cathodes of 1V4, 1V5 and 1V6 become increasingly negative and consequently conduction is effected at the A.V.C. diode of 1V4 and at 1V5. Accordingly the voltage available for A.V.C. is produced by the amplification of valve 1V6. Also audio voltage appears across 1R24, 1R28.
The circuit of valve 1V5 is so arranged that a large incoming noise peak will temporarily render the anode potential negative with respect to cathode and, since the valve under these circumstances will be non-conductive the noise will not be applied to the audio channel.

Modulator unit

The modulator unit comprises three stages: a microphone amplifier (2V1), driver – telephone amplifier (2V2) and an output stage (2V3 and 2V4).
The microphone is connected via screened cables and terminals 11 and 12 in the unit to the balanced input circuit of transformer 2T1. A bridge circuit is used to connect the audio output of the I.F. amplifier to the microphone amplifier stage.
The output of transformer 2T1 is fed to 2V1, the latter being resistance capacity coupled, via condenser 2C5, to the grid of the telephone amplifier and driver valve 2V2. Bias for 2V2 is developed across the cathode resistor 2R11 and is applied to the grid via resistance 2R8. To ensure good regulation on the telephone winding of transformer 2T2 and to reduce distortion, negative feedback is applied between the anode of valve 2V2 and the cathode of valve 2Vl via resistance 2R9.

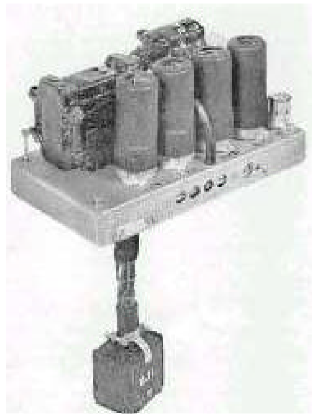

Fig.6 Modulator unit

The anode of valve 2V2 is coupled, via transformer 2T2, to the grid circuits of the modulator valves 2V3, 2V4, operating in push-pull. Telephone output is taken from an individual winding on transformer 2T2 via terminal 9 to the control point.
The grid circuits of valves 2V3, 2V4 receive their bias supply from the rotary transformer via the centre tap of transformer

2T2 and have anode circuits connected in push-pull to the output transformer 2T3.
The secondary winding of 2T3 is series connected in the supply line to the transmitter output stages in the separate transmitter unit via a screened line. Accordingly, modulated H.T. voltage is fed to the transmitter output stages.

Power Supplies

The valve heaters are fed directly from the DC supply via a carbon pile regulator. They are arranged in three groups of 6.3 volts connected in series to give a total of 18.9 volts as is standard practice in d.c. powered aircraft equipment. Fig.7 will make the arrangement clear.

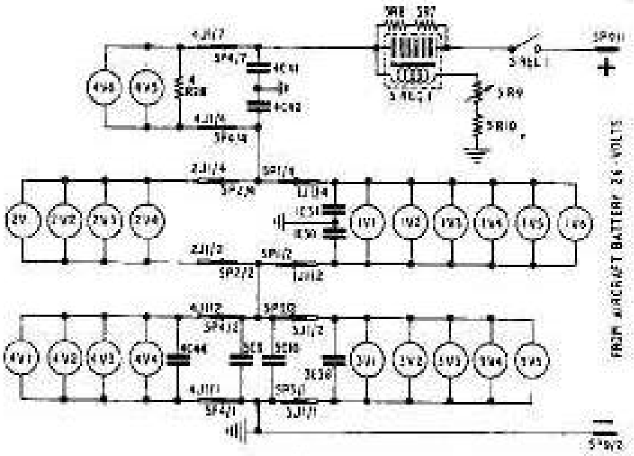

Fig.7 Heater circuits

HT and bias supplies are derived from a rotary transformer which carries the cooling fan on one end and an electrically operated clutch and 480:1 reduction gearbox on the other end. This drives the channel change mechanism.
The rotary transformer unit can be removed from the chassis by first disconnecting the flexible coupling to the channel change assembly then removing the two screws (usually red painted) in the side of the mounting plate and sliding the unit out of the side of the main chassis. Note that there are two fuses and two spares fitted on the mounting plate and a third HT fuse is located on the front panel of the set.

Channel Change Mechanism

The channel-change mechanism is mounted on the front panel of the main chassis assembly and has three principal functions to perform as follows:-

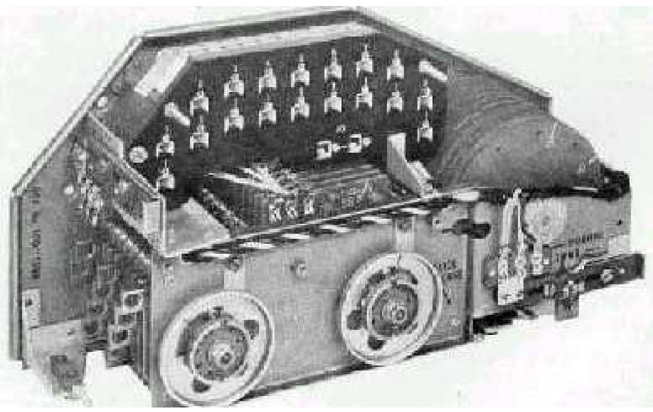

Fig.8 Channel change mechanism

(i) Select the appropriate crystal for operation in the receiver unit.
(ii) Set the ganged tuning condenser assembly in the transmitter unit to its correct relative position for a given frequency.
(iii) Set the ganged tuning condenser assembly in the receiver unit to its correct relative position for a given frequency.
Since the equipment is designed to operate on any one of ten frequencies the channel-change mechanism is arranged to carry out the above set of operations in ten combinations.
The mechanism consists of ten spring-returned metal slides mounted in a framework and actuated horizontally by rollers (mounted on the driving spindle assembly) which engage with levers attached to the slides. The driving spindle assembly is rotated by the drive from the reduction gearbox mounted on the rotary converter and its angular stopping positions, corresponding to the operation of particular slides, is determined by the setting of the switch in the remote control box. Each slide is responsible for selecting one preset frequency, and is moved into its setting position (extreme left) by its appropriate roller and lever mechanism, and is retained there until a different frequency is selected by remote control.
An aperture permits each slide to move freely in a horizontal direction across the extensions of the transmitter and receiver tuning condenser assembly shafts which protrude through the slides. Attached to each ganged condenser shaft extension is a bank of ten cams, each cam being free to take up a different relative position on the shaft to any other unless locked by a knurled fitting on the front of the assembly.
Mounted on each slide are locating spring "fingers" which are designed to engage with the appropriate cams on the extension- shafts of the two condenser assemblies.
In so doing they move their respective cams to a common plane, and since each cam may be initially set up in a different relative position to the condenser vanes, the condenser shafts will move to different positions as the slides are individually actuated.
Each slide carries a striker which operates its own crystal switch forming part of a bank of switches mounted immediately above the slides, thus bringing the appropriate crystal into circuit when a slide is operated. For initial setting up purposes the slides may be manually placed in the operating position and locked by means of a manual control situated on the right hand side of the assembly. Located above the channel change mechanism is the crystal panel (carrying duplicate sockets for the different types of crystal) and a push-pull slide switch for tuning the transmitter and receiver during frequency alignment.

Remote operation of the selector mechanism

It will be observed in Fig. 9 that the movable section of switch 6S1, in the control unit, has an open segment and that contact will be broken at the point where this segment rests. In the diagram the switch is shown in the OFF position. When, for example, the switch on the control unit is placed to frequency position B, the lines from terminals 1 and 2 on plug 6P1 in the control unit are short circuited, causing relay 5.Rel.1 in the main chassis assembly to close and start up the equipment.
Simultaneously, the circuit is completed to the magnet coil in the clutch mechanism of the rotary transformer reduction gear via switch 6S1 and terminal 3 on plug 6P1 in the control unit, fixed contact A and the rotary arm and wiper blade of switch 5S3 and the closed contacts of the manually operated switch 5S6 (in the NORMAL position).
When energization of the magnet coil is effected the reduction gear engages the rotary transformer shaft and the bank of discs in the channel-change mechanism commence to rotate.
Mechanically operated by 10 evenly spaced segments on two of the discs are two sets of contacts 5S4 and 5S5. At the commencement of rotation contacts 5S5 are closed and are synchronised to re-open briefly on each occasion that the

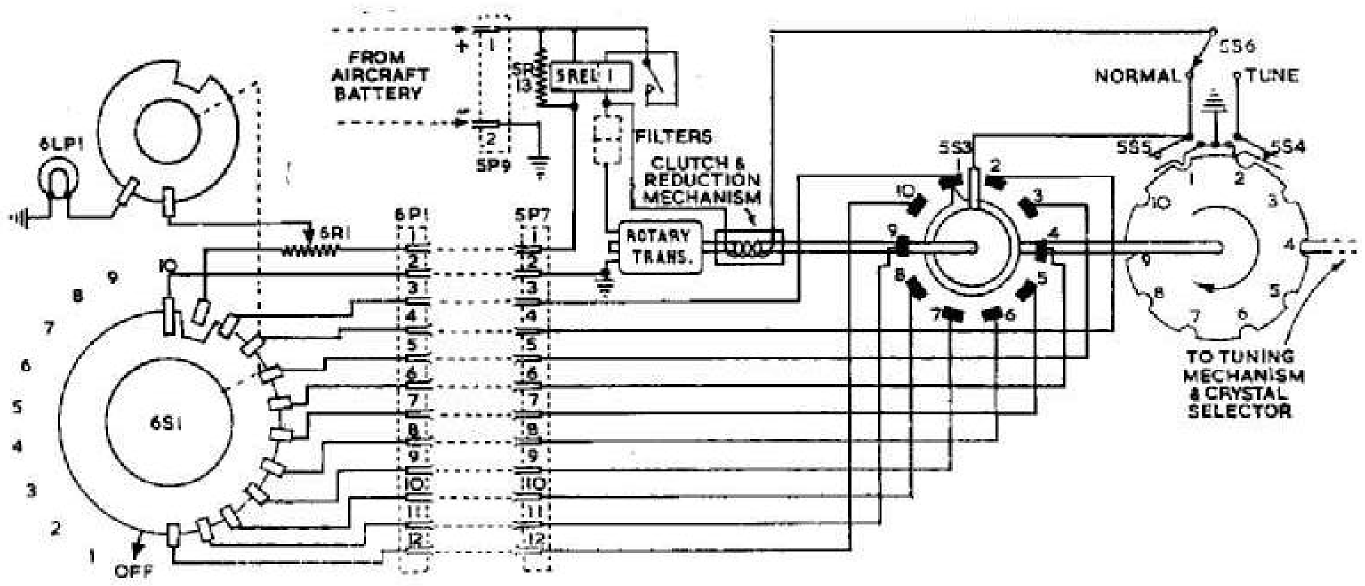

Fig.9 Channel change circuit

rotary arm of switch 5S3 reaches the fixed contact points (1-10). If the fixed contact points are connected to the supply line, via switch 6S1 in the control unit, the supply to the magnet coil will remain unbroken and the bank of discs will continue to rotate. When, however, a contact point is reached where the supply is disconnected by virtue of the position of switch 6S1, i.e. in this case, due to the contact connected to 4 (of 6P1) being open, the current will be broken and the motor will disengage. The timing of the break contacts (5S5) is so arranged that a positive halt of the discs in correct relation to the position of the slides in the channel-change mechanism is obtained.

As previously explained, contacts 5S4 are mechanically operated by a segmented disc, but it should be noted that these contacts are only used for local operation of the channel change mechanism.

For example, when, during normal service, a channel-change slide has been driven to the operated position it may be electrically "homed" by moving the manual switch 5S6 to TUNE (i.e. connecting the magnet coil to switching contacts 5S4). This switch completes the magnet coil circuit via contacts 5S4 which are automatically re-opened when the slide returns to the non-operating condition.

Control System

(A simplified diagram of the control circuit is given in Fig. 10.)

The field circuit of the starting relay 5.Rel.1, in the main chassis assembly, is connected to the L.T. supply via switch 6S1 in the control unit when the latter is in any one of the ten frequency selection positions. It will be noted that the lamp and potentiometer are in the starting lead circuit in series with 5.Rel.1, which itself is shunted by a resistance 5R13 in order to pass enough current for the control-unit dial lamp.

On the closing of the relay contacts, a secondary field of the relay is series connected in the supply line to the rotary transformer. This additional field is only effective during the initial surge caused by starting of the motor and is designed to prevent the possibility of the relay falling out through a momentary drop in supply voltage.

In addition to connecting the supply to the motor the relay also places all valve heaters in circuit via the carbon regulator 5.Reg.1 and resistance 5R7, 5R8. Simultaneously the supply is connected to the magnet coil of the channel-change mechanism and to one side of relays 5.Rel.2 and 5.Rel.3. The circuits of both relays are simultaneously completed by the operation of the " Press to Talk " button at the remote point. A local "Pull-to-Tune" slide switch 5S1-2 is provided for setting-up purposes. When pulled out to its full extent, it connects earth to the windings of relays 5.Rel.2 and 5.Rel.3 and puts the equipment into the "transmit" condition. On closing, relay 5.Rel.2 removes the H.T. from the I.F. and receiver circuits and applies it to the modulator and transmitter circuits. Simultaneously 5.Rel.3 applies H.T. to the modulator circuit and changes over the aerial connections. It also short circuits a high resistance 2R10 in the modulator unit, thus permitting valves 2V3, 2V4 to become operative. The slide switch 5S1-2, when operated to its first click position, connects the cathodes of valves 1V4, 1V6, in the I.F. amplifier unit, to earth, via resistance 5R12, and permits the receiver to be locally tuned for noise.

Valves used.

Unit	Ref	Stage	Type	Equiv
Transmitter	4V1	Oscillator	CV136	EL91
	4V2/3	Bal mixer	CV138	EF91
	4V4	Doubler	CV136	EL91
	4V5	Amplifier	CV309	QV04-7
	4V6	Output	CV415	TT15
Receiver	3V1	Osc/treb	CV136	EL91
	3V2	Trebler	CV136	EL91
	3V3	Doubler	CV138	EF91
	3V4	Freq changer	CV138	EF91
	3V5	RF Input	CV138	EF91
IF Amplifier	1V1	1st IF amp	CV131	EF92
	1V2	2nd IF amp	CV131	EF92
	1V3	3rd IF amp	CV138	EF91
	1V4	Diode detector	CV140	EB91
	1V5	NL/ muting	CV138	EF91
	1V6	AVC amp	CV138	EF91
Modulator	2V1	Mic amp	CV131	EF92
	2V2	Tel amp	CV136	EL91
	2V3/4	Mod output	CV133	EC90

Control unit

The control unit consists of a small black finished aluminium-alloy box containing a miniature rotary switch for starting up the equipment and for simultaneously selecting the required frequency. The switch shaft carries a dial made up of a front disc of dense white opal Perspex cemented to a back disc of translucent coloured Perspex. The front disc is finished black except for the channel lettering, which in daylight will therefore show up as white letters on a black background. When illuminated from behind, the letters will show the colour of the coloured back disc. Internal lighting is provided by means of a miniature screw lamp which is carried in a removable holder having a coil-slotted head. This inserts and withdraws at the left side of the unit by a 90° rotation of the lamp holder. The intensity of illumination of the dial is controlled by means of a dimmer knob operating a potentiometer which gives a range from maximum to zero illumination. The dial is covered by a detachable front plate having a Perspex window which displays the selected channel letter and one on either side of it. At the rear of the box is fitted a spare dial with alternative channel lettering, which can be used to replace the dial normally fitted if desired. At the base of the unit is a twelve-way Plessey plug for connections to the main unit.

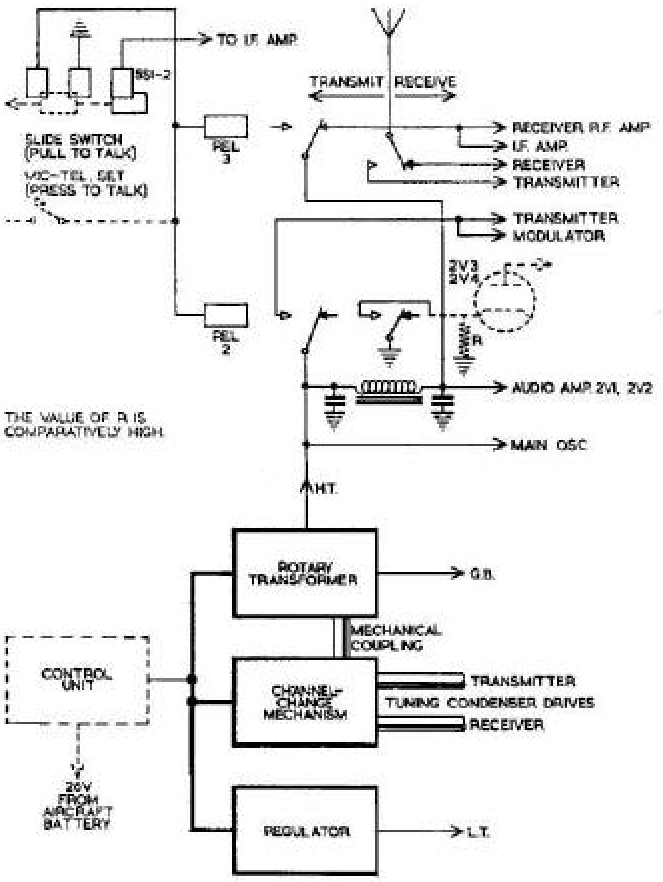

Fig. 10 Control circuit

Crystal

The crystal frequency for any given operating frequency can be calculated from the following formula:

$$F_x = \frac{F_c - 9.72}{18}$$

Where F_x is the crystal frequency and F_c is the final carrier frequency.

The channel change unit is designed to accept either 10XAJ or HC6U type crystals. It should be noted that there are no channel trimmers fitted, the wide IF bandwidth made this unnecessary in the original application, but if the set is to be configured to work with more modern equipment a higher degree of frequency accuracy will be required. If you are ordering a crystal from Quartslab, ask for a 40pF parallel type, this will come very close to the required frequency.

Connectors

To connect the set to the control box you will need a 12 way male – female lead of suitable length with Plessey Mk4A (fine thread) connectors. (It is possible to use the more common Larkspur lead if the inserts are re-oriented and the coarse thread locking ring disregarded). Power input is via a 2-pin female W plug and the audio in-out is via a 6 pin female W plug. The connections for this are as below.

Pin	Function
1	Audio Earth
2	Mic (balanced)
3	PTT Earth
4	Phones
5	PTT (earth to transmit)
6	Mic (balanced)

It should be noted that there is no external volume control and the audio output level is quite high, therefore some form of volume control will be required on the headset. The output impedance on most models is 50 – 150Ω but can be changed internally to 600Ω.

The aerial connector is a unique type as far as I know and I've never been able to find a plug to fit it.. However, the inner pin is identical to that in the "Pye" aerial plug used on the 19 set and by turning a suitably sized extension piece for the outer of the plug, I've been able to adapt the Pye plug to fit, see fig. 11. The dimensions for the extension piece are: length 7mm, inside dia 13mm, outside dia. 15mm.

Fig.11. Adapted Pye plug

Cooling

As mentioned elsewhere, a cooling fan is fitted on the rotary transformer, and air is drawn in and exhausted via a pair of filter units on the rear of the casing. It is worth checking that the filters are clean and allow a good airflow as there are a lot of valves in that compact case.

Putting into service

As mentioned in the introduction, given a working set that covers the required frequency range, alignment is very simple indeed. As with all my highband VHF AM sets, I use 145.8 Mc/s for demonstration purposes though this is becoming a little politically incorrect nowadays. For this frequency you will require a crystal on 7.56 Mc/s. You will also need a control box and lead as described above, and a headset wired to a W –plug. As suitable source of power will be needed – the Plessey PS112 serves admirably, or you can use two car batteries in series. If you haven't got a control box/lead just earth pin 'A' of the control socket and the set will start.

Remove the front cover plate and ensure that the frontmost slide plate is engaged – with the set running operate the 'normal – tune slider repeatedly until this is the case, finishing with it in the 'tune' position. Insert the crystal in socket 1 and slacken off the knurled locking discs in the centre of the transmitter and receiver tuning controls. With the tuning control slider (on the left hand side of the mechanism) pulled out to its first position, rotate the receiver tuning control for maximum noise, which should correspond approximately with the correct frequency on the control. The knurled locking disc may then be tightened down, taking care not to disturb the setting. The transmitter may then be tuned by pulling the tuning control slider out to it's second position to place the set in 'transmit'. The transmitter tuning control may then be rotated for maximum output indicated by a power meter or small lamp connected to the aerial socket. The control should then be locked down as before. Return the sliders to their normal positions and check for power out put and receiver sensitivity. If necessary, the muting control on the front panel may be adjusted to give the required level of sensitivity.

In use

These sets produce a good quality of transmission, I use mine with a Larkspur headset modified for balanced mic operation. The receiver is very deaf, even by vintage standards – the manual states that 10μV is needed to open the muting – and it means it. To be really useful, a preamp is needed and a modern miniature one can be fitted inside next to the aerial relay without causing any problems. However, if you have a colleague not too far away it is possible to obtain a ground to ground range of several miles using dipole aerials, and probably further using a beam. The rotary converter is noisy and wearing for long periods of monitoring – it is tempting to put the set in another room and use a long control lead!

Servicing and faults

The modules are connected to the main chassis via standard 'Jones' plugs. It is useful to make up short extension leads so that the units can be powered up whilst removed from the chassis if necessary. The only faults I have encountered have been poor audio caused (as you might expect) by leaky coupling capacitors, and no transmission audio which turned out to be an o/c mic transformer secondary. One set had an open circuit clutch solenoid, which I rewound easily after removing the gear unit from the rotary converter.

The chassis of the modules are made of an alloy plated with cadmium, in sets which have suffered from corrosion this plating may be found to be flaking off in places – if so, make very sure that no loose pieces are floating around in the equipment to cause unexpected short circuits.

Source of supply

J. Birkett of Lincoln (01522 520767) has a stock of various models of these sets and the control boxes, but unfortunately no leads or connectors last time I enquired. There are various types of control boxes available, including ones for controlling more than one set. Before choosing a set, it is best to look inside, as some have been stored in poor conditions and though look OK externally have suffered from internal corrosion. They can be extracted easily from the case by releasing the Dzus fasteners on the rear of the case – if it won't come out easily, suspect bad corrosion. All the sets I have collected from Birketts have had 'Fit for Service' labels on them and have worked on power up, some even still contain crystals and will receive civilian aircraft transmissions!!

Circuits and info

A copy of the complete manual for the STR.9-X, including full circuit diagrams in electronic form is available from the Archive free to members by email, or on paper at the usual rates.

Acknowledgements

My thanks to John Coggins G3TFC who loaned me the manual from which much of the above was derived, and to Gordon Whiting G3MMS who maintained many of these sets during their working life and loaned me his training notes from which the information on the various models was derived.

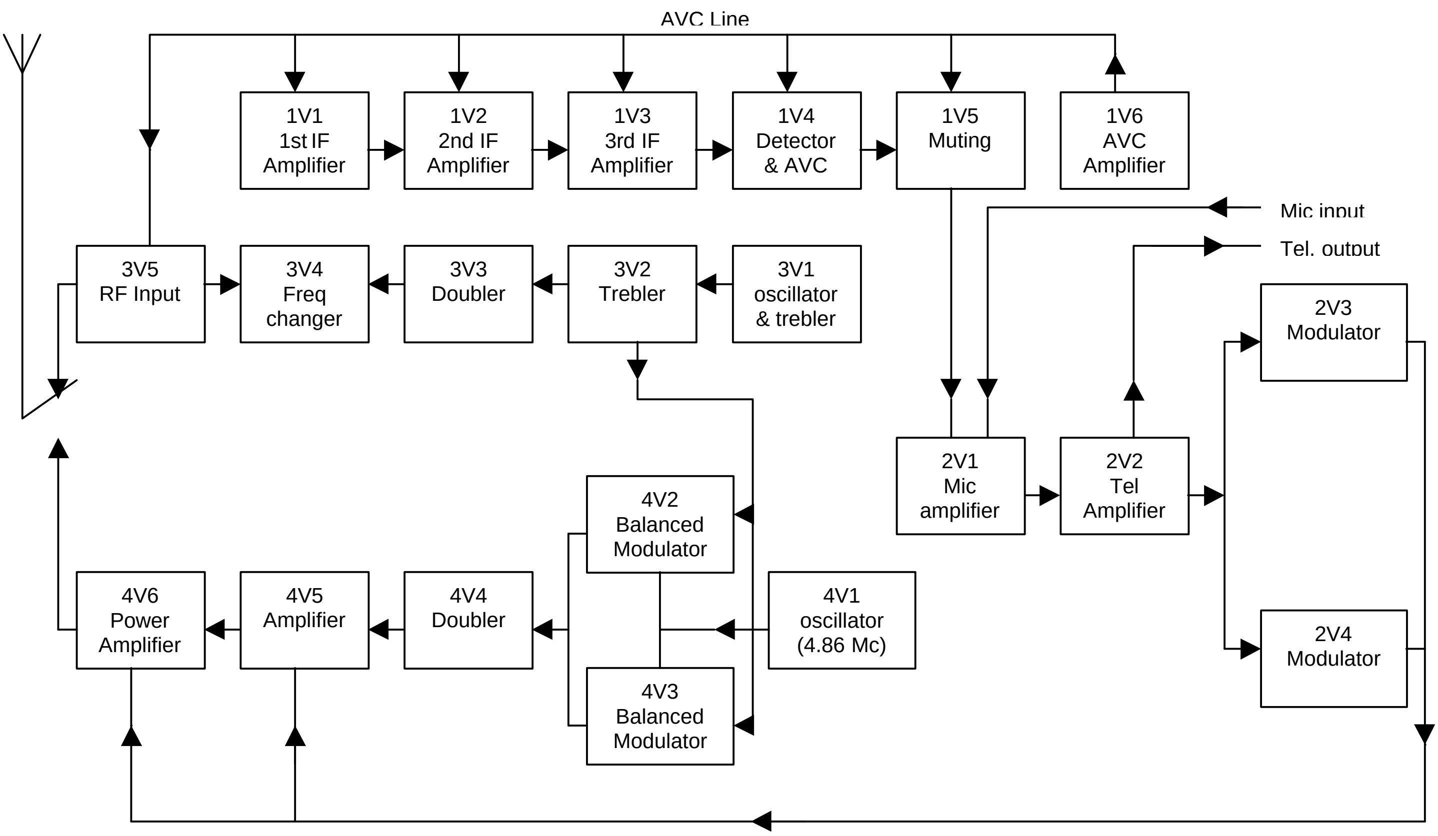

Fig.12 Block diagram of STR.9-X