e2v technologies

Assembly Manual MA2776A for IOT amplifier types IOTD3100W, IOTD3130W in circuit assembly IMD3000W Series

Issue 5

Printed in England

Assembly manual MA2776A for IOT amplifier types IOTD3100W, IOTD3130W

IOTD3100W, IOTD3130W wide frequency coverage, high efficiency amplifiers for digital or analogue UHF TV transmitters

Liquid-cooled collector and body with air-cooled gun and cavities operating in circuit assemblies of the simple plug-in tube exchange type, with continuously tunable cavities.

The tube is electromagnetically focused and the circuit assembly is designed to reduce tube replacement time to a minimum. The IOT can be removed without disturbing the cavities, so that the replacement is coarse tuned at switch-on and requires only coupler loop setting and trimming adjustments to meet the full transmission specification.

The electron gun and cavities require forced-air cooling; the circuit assembly incorporates a distribution manifold.

Important:
Refer only to the manual supplied with the IOT.
Any other manual may be out of date. See page 3.

MA2776A, Issue 5 - Page Check List

Introduction

This publication describes the installation procedure for the UHF Television IOTs listed below. Brief details of the performance of the IOTs and the type numbers of the appropriate Circuit Assemblies are also given below.

Full data sheets on these IOTs are supplied with each tube at the time of sale and further copies are available from the IOT Sales Department of e2v technologies. Copies are also available from the e2v technologies website.

Digital Operation

IOT Type	Circuit Assembly	Mean Power (kW)	Peak Power (kW)	Frequency Range (MHz)
IOTD3100W	IMD3000W Series	26	120	470 to 810
IOTD3130W	IMD3000W Series	32	140	470 to 810

Analogue Operation

IOT Type	Circuit Assembly	Combined Power (kW)	Frequency Range (MHz)
IOTD3100W	IMD3000W Series	55 + 5.5	470 to 810
IOTD3130W	IMD3000W Series	77 + 7.7	470 to 810

This manual was shipped with IOT/~~circuit~~ assembly type . . D3100W . . . .

Serial Number . . . 623 . . . .

In . . MAY . . . . (month) . . . . . 2008 . . . . (year)

Users should refer only to the manual shipped with the particular IOT or circuit assembly. Any other manual, whilst generally applicable, may differ in detail due to product improvement.

This product is subject to one or more of the US patents US5239272, US5536992, US5548245, US5581153, US5606221, US5629582, US5691667, US5872428, US5796322, US5684364, US5736820, US5990621, US6407495, US6781313 and corresponding patents in other countries.

1 Health and Safety Hazards

High power IOTs can be hazardous to life and health if they are not installed, operated and maintained correctly, or if a tube is damaged. e2v technologies cannot accept responsibility for damage or injury resulting from the use of e2v technologies tubes. Equipment manufacturers and IOT users should ensure that precautions are taken. Appropriate warning labels and notices must be provided on equipment incorporating IOTs and in operating manuals.

High Voltage

Equipment must be designed so that operators cannot come into contact with high voltage circuits. IOT enclosures should have fail-safe interlocked switches to disconnect the primary power supply and discharge all high voltage capacitors before allowing access.

RF Radiation

Personnel must not be exposed to excessive RF radiation. All RF connectors and cavities must be correctly fitted before operation, so that there is no leakage of RF energy. IOTs must not be operated without a suitable RF load at the output cavity and coupler. It is particularly dangerous to look into open coaxial feeders or transmitter antennas.

X-Ray Radiation

All high voltage devices produce X-rays during operation and may require shielding. When e2v technologies IOTs are operated normally with the RF cavities fitted, some protection is provided but further shielding may be required. A suitably designed equipment cabinet will provide sufficient additional shielding. However, it is strongly recommended that all complete equipments containing operating IOT systems should be measured to establish that external X-ray levels comply with local regulations.

Mechanical

The circuit assembly has been designed to occupy the minimum of floor space in the transmitter. The wheel base is, therefore, short in relation to the height of the assembly, which has a high centre of gravity. Care is required when wheeling the magnet frame, and in particular, the IOT assembled in the magnet frame, over uneven surfaces or gradients which could cause the assembly to over-balance.

Hot Surfaces

Surfaces of tubes (for example the input cavity or the tube envelope in the gun region can reach high temperatures (in some cases in excess of 100 °C) during operation and may remain at a high temperature for a considerable time after switch-off. Burns may be sustained if direct contact is made with hot surfaces.

Corrosive

The tube is supplied with Viton® O-rings between the collector and collector hoses. In the unlikely event that the collector cooling circuit loses coolant, or the tube is operated without any coolant, then there is the possibility that the temperature of the Viton® O-rings could exceed 316 °C (600 °F). Above this temperature, the material starts to decompose; toxic and corrosive vapours are evolved, including hydrogen fluoride, carbonyl fluoride and carbon monoxide. During all work on suspect components, safety glasses and Neoprene gloves must be worn. In the event of accidental contact of decomposed Viton® with the skin, wash the area under plenty of running water and obtain medical assistance.

Toxic

IOTs and ESCIOTs all contain industry standard cathode assemblies as part of the electron gun. The cathode assembly contains small quantities of various refractory metals. In normal operation, the presence of these materials requires no special precautions as they are sealed in vacuum. However, in the event of a catastrophic tube failure, resulting in loss of vacuum and exposure of a hot cathode to the atmosphere, these metals can form volatile oxides that are potentially hazardous to health. In such circumstances, operators should avoid inhaling vapours in close proximity to the tube and allow it to cool to room temperature before removing it from equipment. Broken tubes should be re-packed carefully in their original packaging and returned to e2v technologies for safe disposal.

Viton® is a registered trademark of DuPont.

2 Equipment and Personnel

Only one person is required to install the IOT in the circuit assembly. If only the IOT is to be lifted, then a hoist having a minimum lifting capability of 30 kg (66 lb) is needed. To lift the circuit assembly, a hoist having a minimum lifting capability of 130 kg (287 lb) is required. Any special tools required for the assembly of the IOT are supplied in the circuit assembly tool kit (see Fig. 1).

Personnel should familiarise themselves with the Health and Safety notes (page 4) and with the contents of this manual before starting work.

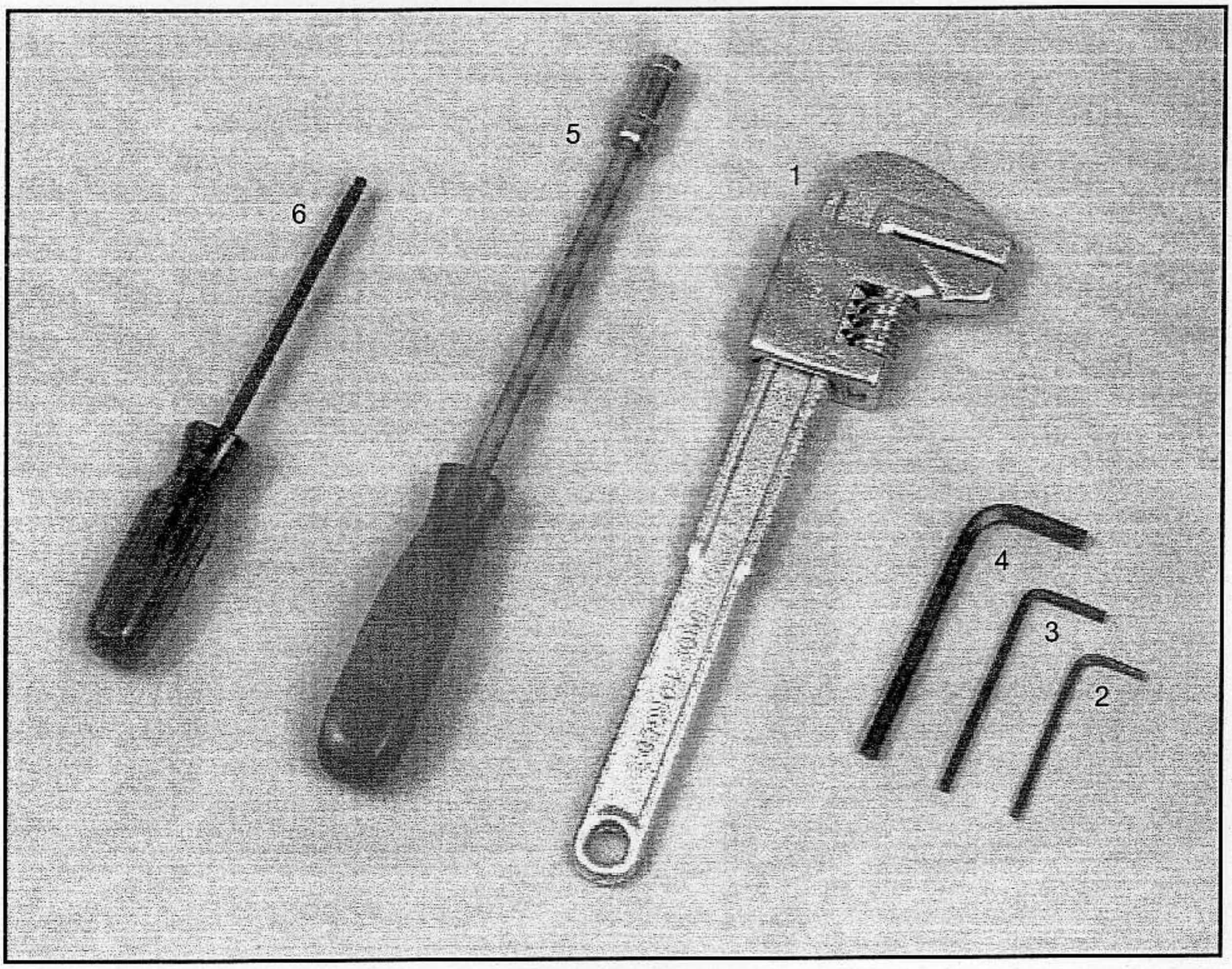

Fig. 1

Ref. No.	Description	Part No.
1	Spanner	
2	Allen key, 2.5 mm A/F	
3	Allen key, 3 mm A/F	part of MA3597A
4	Allen key, 5 mm A/F	
5	7 mm nut driver	
6	4 mm ball driver	

3 Identifying the Parts

The IOT and Circuit Assembly are shipped in two packs. These contain:

a) The IOT, associated parts and documents

b) The circuit assembly and associated parts.

These items are illustrated below and are numbered to cross-reference with the contents list (page 8).

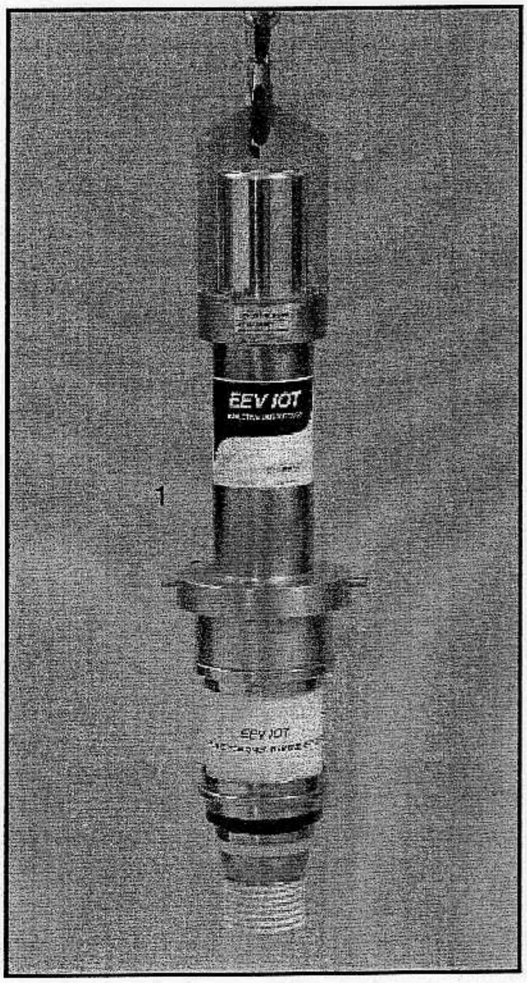

Fig. 2a

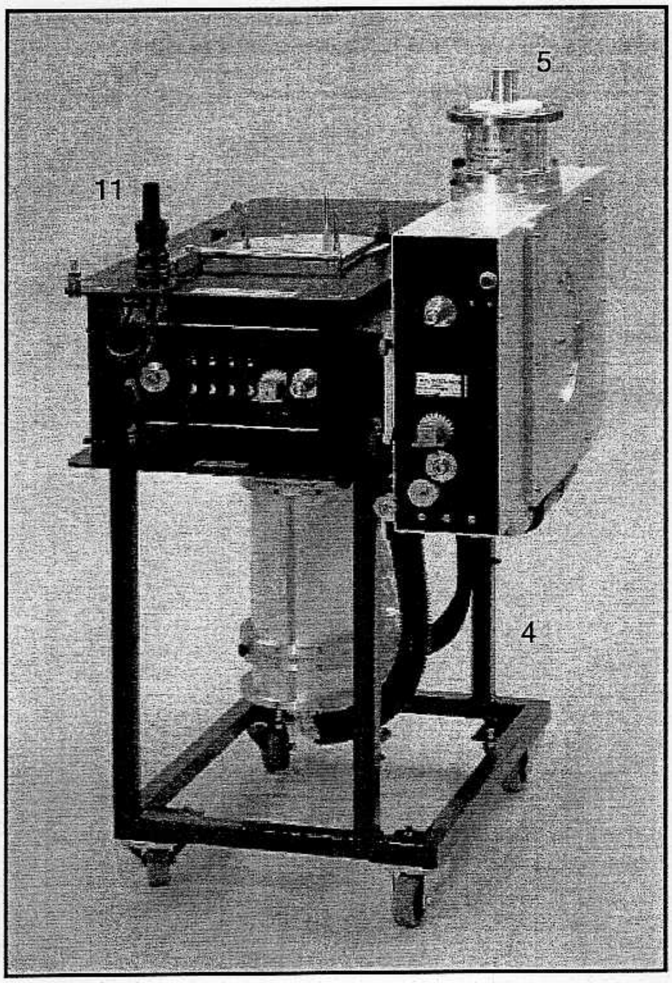

Fig. 2b

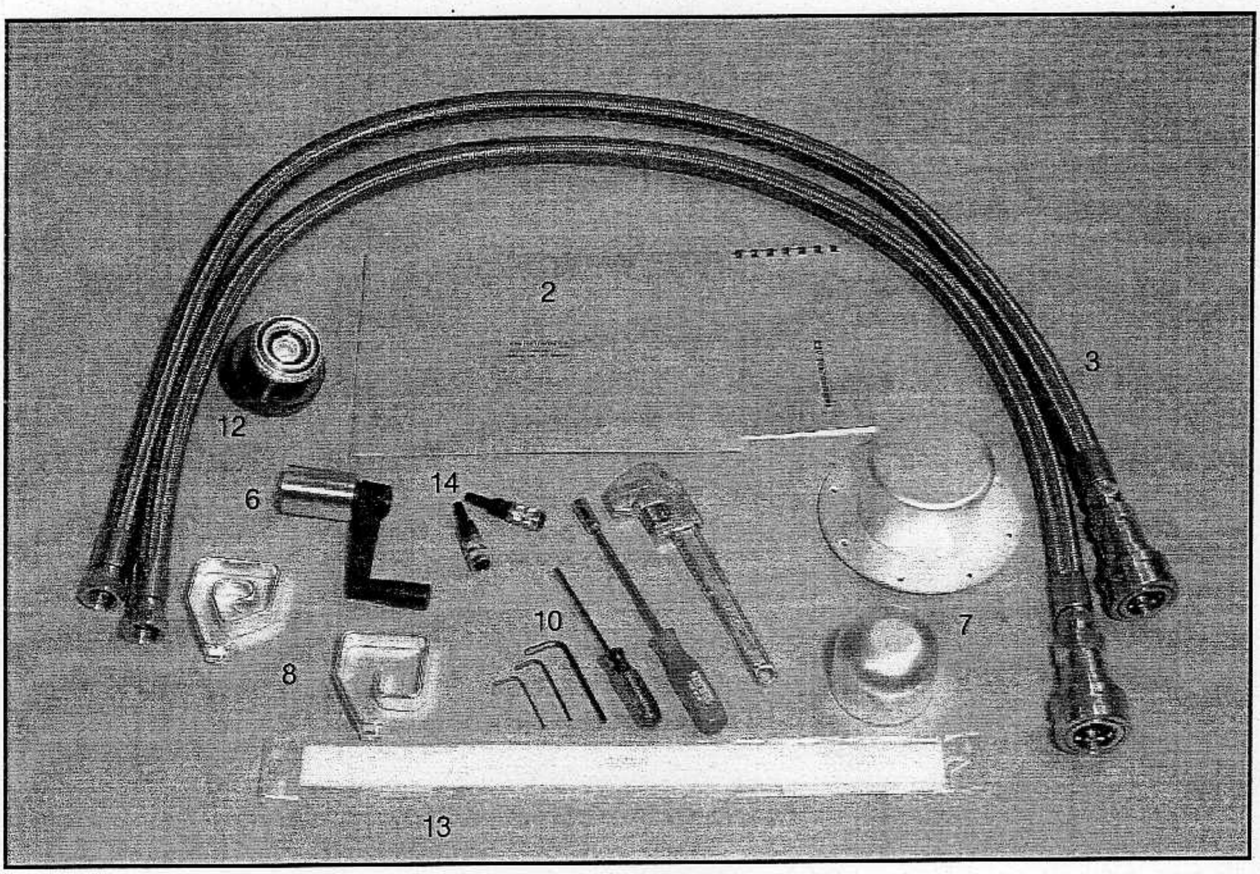

Fig. 2c

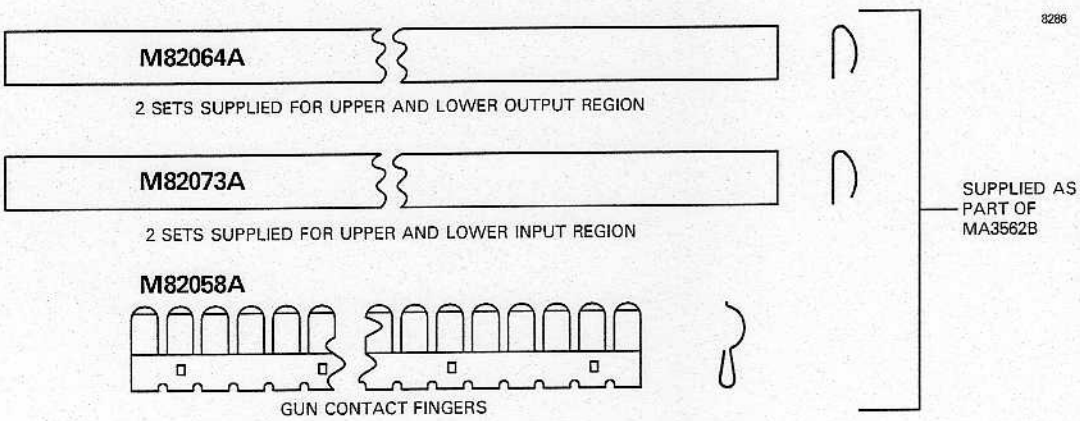

Fig. 2d MA3562B Contact Fingers

3.1 Contents of Packs

3.1.1 The IOT Pack

Fig. 2 Ref.	Description	Part Number	Qty.
1	Inductive Output Tube	IOTD3100W/IOTD3130W	1
2	Envelope containing:		
	Documents comprising:		
	Assembly manual	MA2776A	1
	Data sheet	A1A-IOTD3100W/ A1A-IOTD3130W	1
	Customer test record	11631A	1
	Spares comprising:		
	O-rings	M80329A	2
	Carbon anode gasket	G701178A	1

3.1.2 The Circuit Assembly Pack

Fig. 2 Ref.	Description	Part Number	Qty.
3	Flexible water hoses	MA726B	2
4	Circuit assembly and air distribution manifold with large dome nose and low channel loop (supplied fitted)	IMD3000W Series	1
5	Output coupler with bullet (supplied fitted)	MA2652B	1
6	Tuning handle	MA992D	1
7	Alternative tuning dome	MA2343D	1
8	Alternative coupling loop	MA2350B	1
9	Carbon anode gasket (supplied fitted)	G701178A	1
10	Tool kit	MA3597A	1
11	Focus plug (fitted where supplied)	FM701724A	1
12	Input cavity socket (supplied fitted)	MA3617A	1
13	Spare contact fingers (see Fig. 2d)	MA3562B	1 set
14	Arc detector connectors	MA2524A	2

4 IOT Checks and Storage

4.1 Preparing for Ion Pump Test

Open the pack and remove the documentation envelope. Remove the top cushion to gives access to the ion pump cable (see Fig. 3).

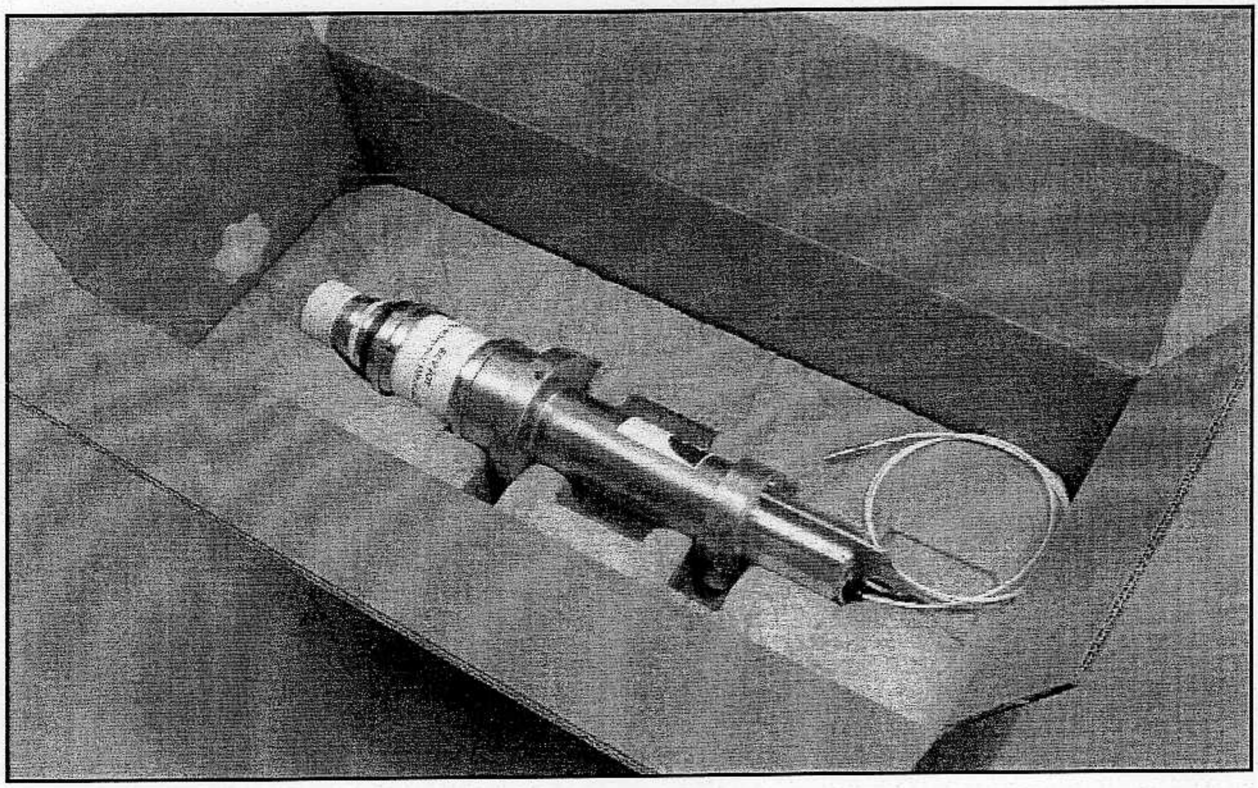

Fig. 3

4.2 Ion Pump Test

The ion pump mounted on the IOT collector is useful for checking the condition of the vacuum in the tube and pumping away any residual gas. The current drawn from its power supply decreases, typically to a value less than 1 µA, as the residual gas pressure is reduced. A zero ion current could be indicative, therefore, of an excellent vacuum (very low pressure).

Connect the ion pump (centre pin of SHV BNC connector) to the positive terminal of a high voltage DC power supply and the IOT collector (outer of the SHV BNC connector) to the negative (ground) terminal. The open circuit voltage should be in the range 3 to 4 kV and the supply should have an internal impedance not less than 500 kΩ. The power supply should incorporate a current metering system capable of indicating a full-scale deflection of 10 µA whilst withstanding an overload of several milliamps.

Observe High Voltage Safety Precautions

Switch on the ion pump power supply and note the current drawn. Typically an ion current of up to 2 µA which decays rapidly will be observed. If the ion current reading exceeds 2 µA and shows no sign of falling below 1 µA after 5 minutes, then do not proceed any further with the test; remove all voltages and contact the tube supplier. The ion pump supply should remain on until the pumping is complete, indicated by the ion current falling below 0.1 µA.

When the IOT is run in operational service, then the transmitter must incorporate a supply so that the ion pump can be run continuously.

4.3 Storage

During storage the IOT should remain inside the pack. It is suggested that the vacuum is checked periodically (every 3 to 4 months, or in accordance with the provisions of the Warranty Leaflet enclosed with the IOT) and if necessary, the tube should be pumped by means of the ion pump. See section 4.2 for procedures.

4.4 Preparing the Circuit Assembly

4.4.1 Unpacking the Circuit Assembly

i. Remove the screws circled on the top panel of the packing crate and remove the top (see Fig. 4a).

ii. Remove the screws circled on the front panel (see Fig. 4a).

iii. With the front panel removed it can be used to create a ramp (see Fig. 4b) by locating the two large holes over the screw heads found at the front of the sub-base (see Fig. 4c).

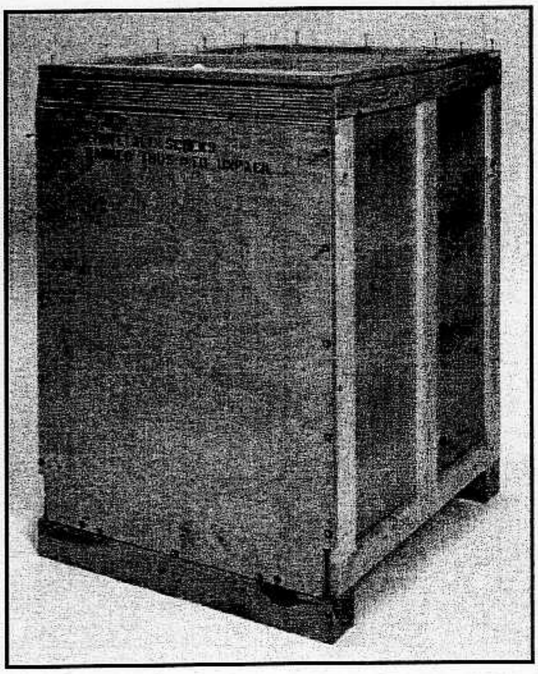

Fig. 4a

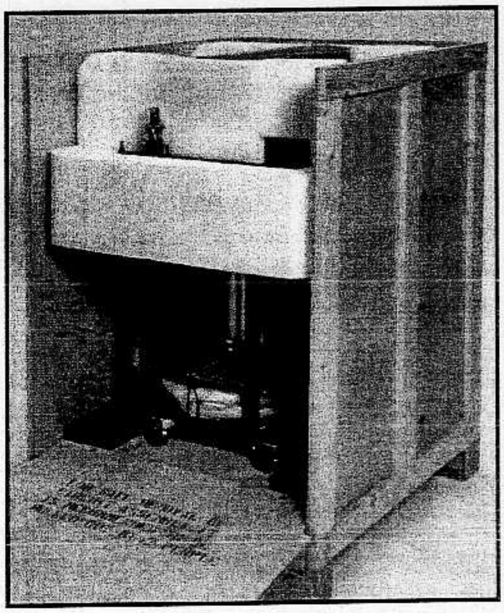

Fig. 4b

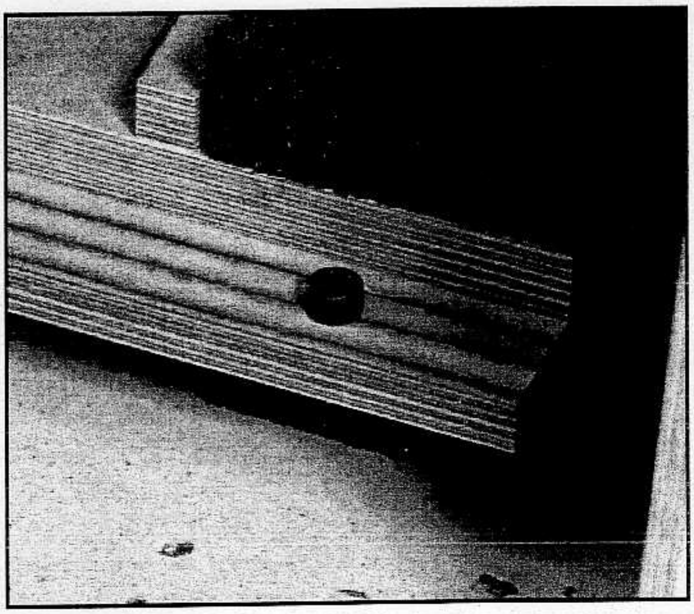

Fig. 4c

iv. Remove the accessory pack from the foam cap (see Fig. 4d), then remove the foam cap (see Fig. 4e).

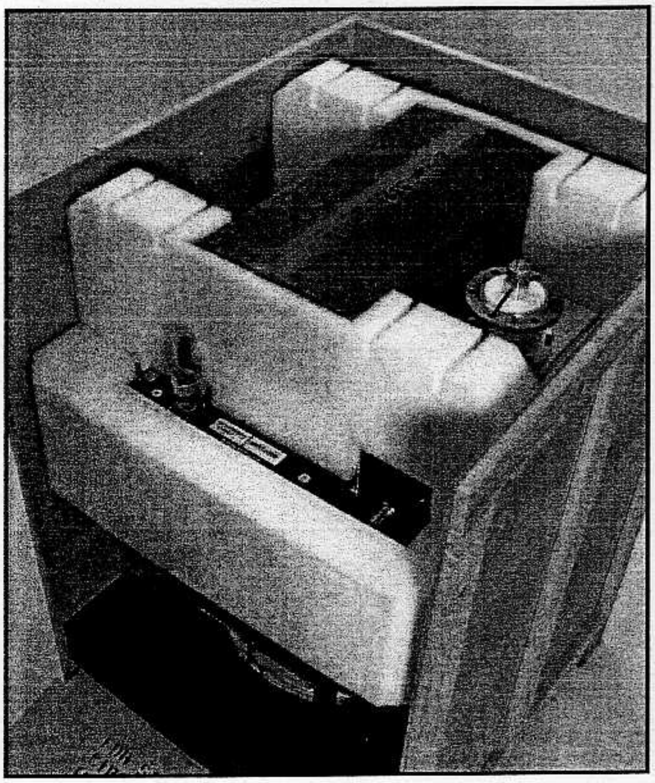

Fig. 4d

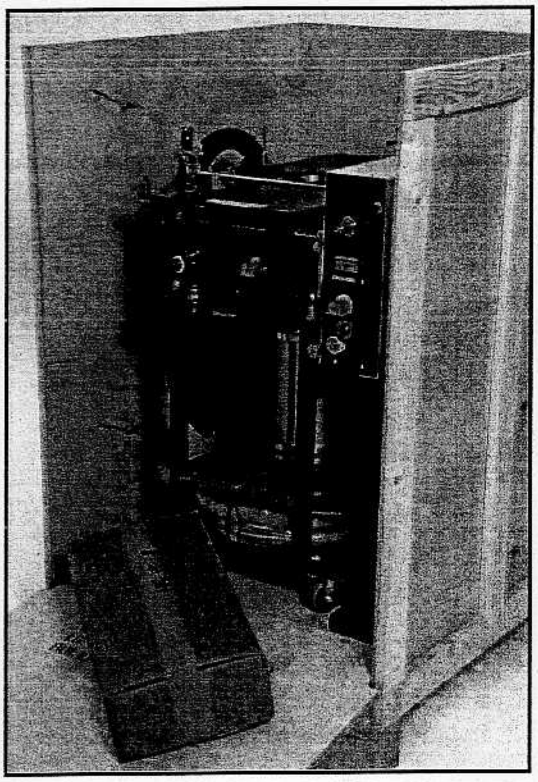

Fig. 4e

v. Remove the bottom locating foam block from beneath the trolley and carefully roll the magnet frame assembly out of the crate, ensuring that the top of the assembly is supported whilst it is on the ramp. Ideally two people should be used for this operation.

vi. Remove the output cavity dust cap. Remove the transit ties from the cable, hoses and output coupler. Remove the protective cable sleeving and the input cavity bracing pieces.

4.4.2 Visual Inspection

⚠ **When carrying out the following internal visual inspection of the tuning cavities, care must be taken to avoid injury on the tube guide pins.**

i. Check that all packaging material has been removed and that no other loose particles are present within the tuning cavities.

ii. Check that all contact fingers are in place and are undamaged (see Fig. 5). If replacement is required, refer to section 8.

iii. Check that the carbon anode gasket is in place and is undamaged (see Fig. 5). If replacement is required, refer to section 8.

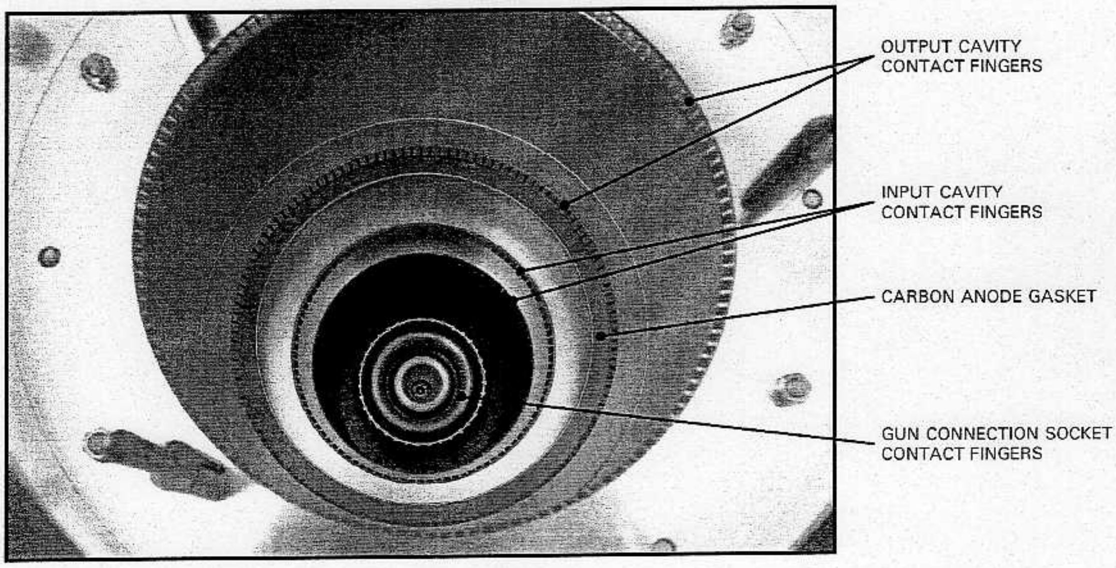

Fig. 5

4.4.3 Selection of Coupling Loop and Tuning Dome Nose

When a circuit assembly is supplied, the large dome nose (MA2343D) and inter-cavity loop (MA2350C) are already installed. The small dome nose and inter-cavity loop MA2350B are supplied in the accessory pack. The correct dome and inter-coupling loop to be used depends upon the frequency of operation and is as follows:

Operators using the ESCIOT at carrier frequencies between 470 and 518 MHz (US channels 14 to 21) should install the large dome nose and loop MA2350C.

Operators using the ESCIOT at carrier frequencies between 518 and 620 MHz (US channels 22 to 38) should install the large dome nose and loop MA2350B.

If the tube is to be operated between 512 and 584 MHz (US channels 21 and 32), refer to Appendix B.

Operators using the ESCIOT at carrier frequencies between 620 and 810 MHz (US channels 39 to 69) should install the small dome nose and loop MA2350B.

Operators must ensure that the inter-cavity loop and dome nose installed are correct for their channel of operation.

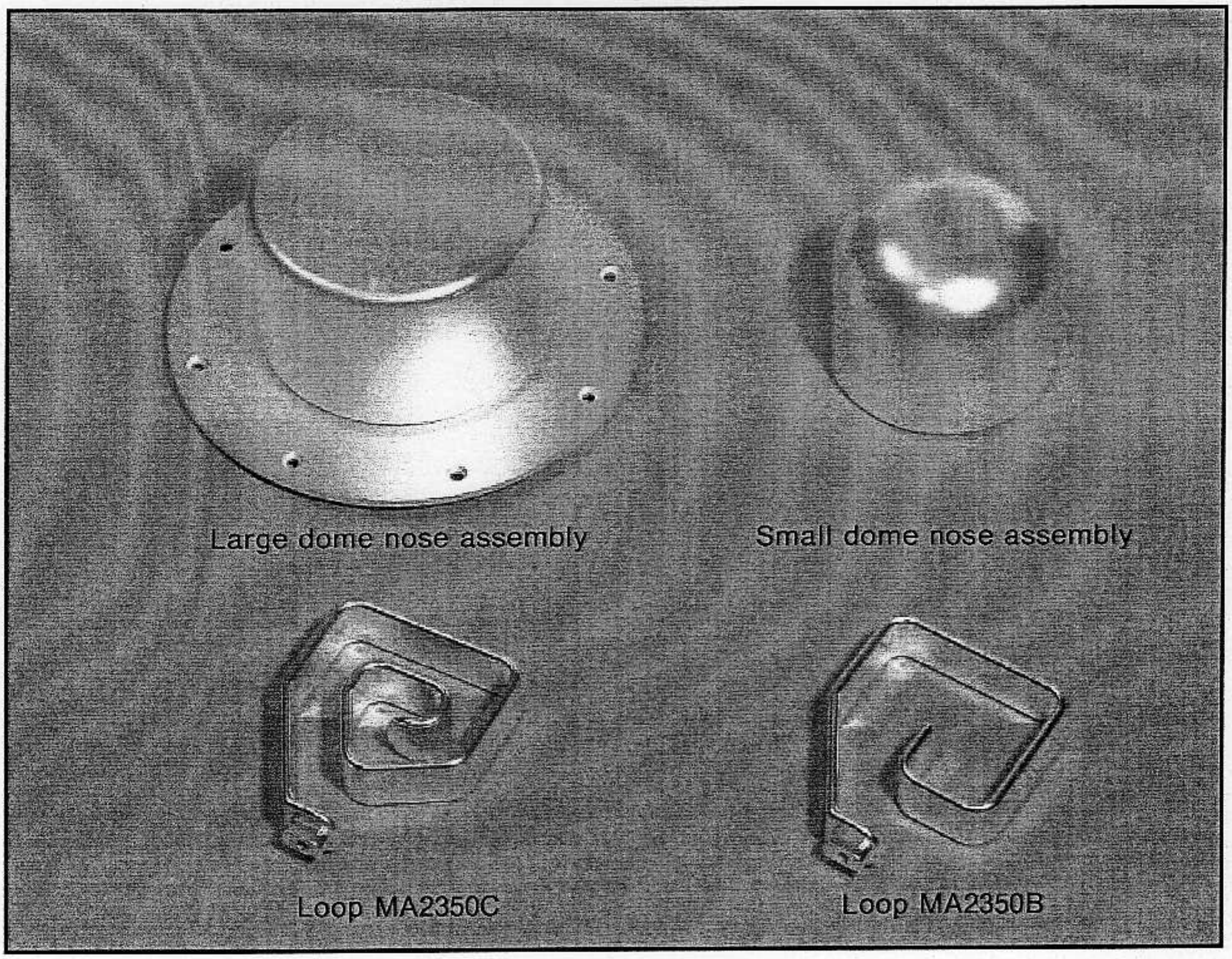

Fig. 6a

If an alternative loop and dome combination is required for correct operation, firstly remove the dome, which is held in place by eight nuts. Unscrew the ball that holds the loop in position inside the secondary cavity (see Fig. 6b).

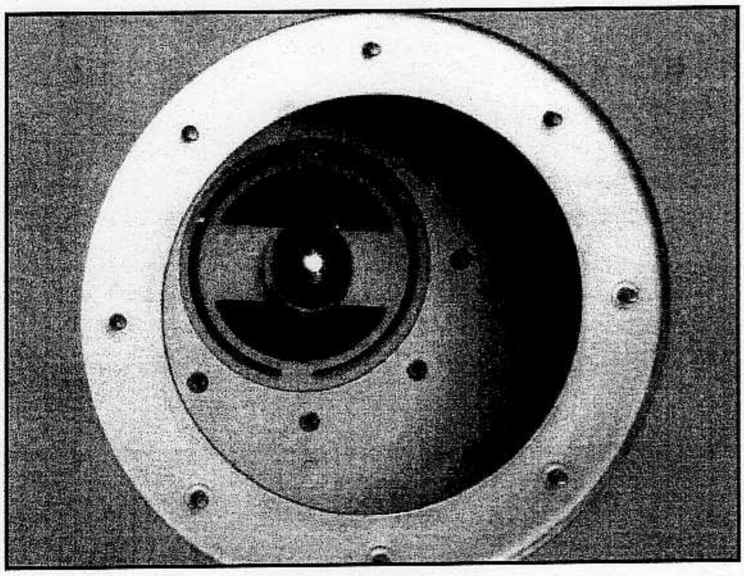

Fig. 6b

Replace the loop with the alternative and re-tighten the ball. Correct orientation is important; the 'open' side of the loop should face the front of the circuit, when in the horizontal (0°) position (see Figs. 6c and 6d) Replace the tuning dome with the alternative.

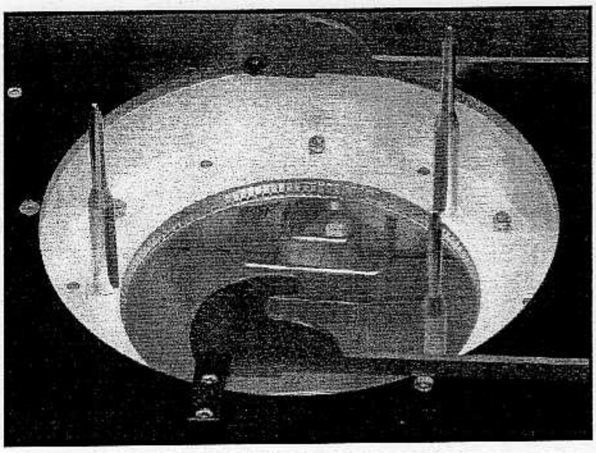

Fig. 6c

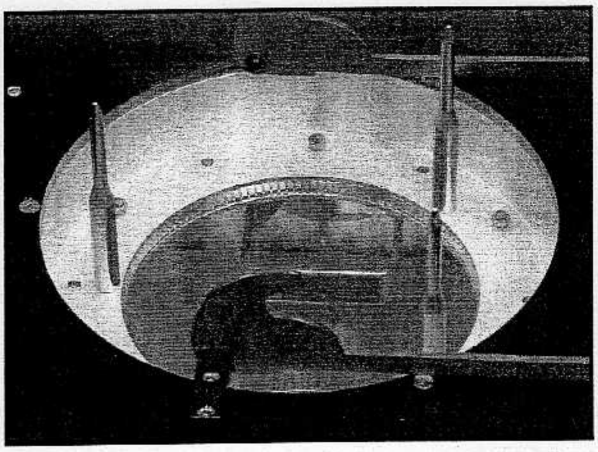

Fig. 6d

5 Assembling the IOT in the Circuit Assembly

5.1 Unpacking the IOT

Open the pack and remove the documentation envelope. Remove the top cushion to give access to the IOT lifting point. With a suitable hoist attached, support the tube as shown in Fig. 7 and begin to lift the tube from the pack. Keep the tube horizontal until the gun is clear of the pack. At no point should the tube be allowed to rest on, or be held or lifted by, the gun.

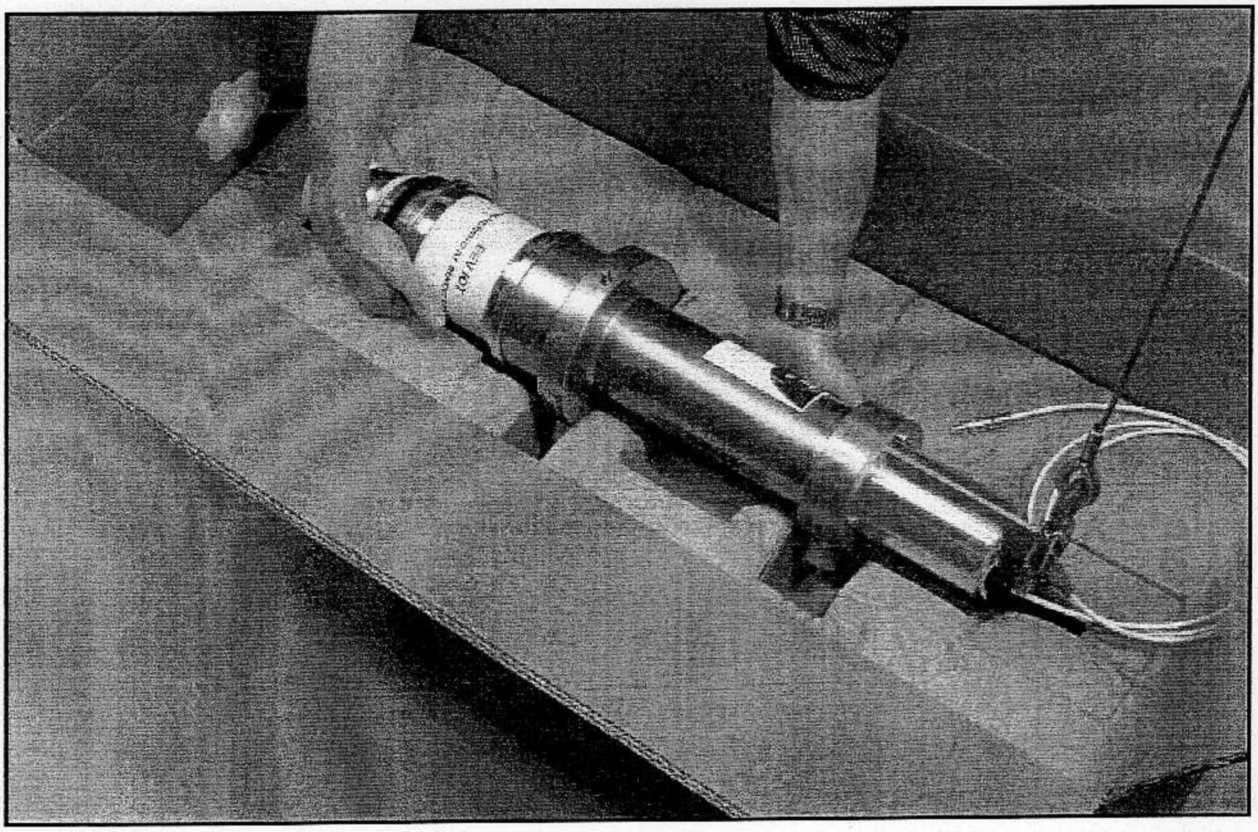

Fig. 7

5.2 Preparing the IOT

With the IOT suspended from a suitable hoist at a convenient height, remove the protective paper from the output ceramic. Use the pull-tab to do this; do not use any metallic tool, as this may leave an electrically conductive line on the ceramic. Do not touch any ceramic surfaces - finger marks can leave electrically conducting residues.

5.3 Lowering the IOT

Unscrew the locking screw which fixes the ejection lever to the top of the magnet frame (see Fig. 8a) and raise the handle by propping the arm in the locating hole provided (see Fig. 8b).

Orientate the IOT so that, observed from the front of the circuit, the labels on the tube are facing the front and the two horizontally opposing pins on the IOT are aligned with the mating areas of the ejection lever.

Carefully lower the IOT into the circuit assembly until the two pins rest on the ejection lever side-arms (see Fig. 8c). Allow the hoist to slacken, then lower the handle back into the magnet frame and secure it by re-tightening the locking bolt to engage the interlocking microswitch. Apply careful downward pressure on the IOT when lowering the handle, to ensure correct tube seating.

To raise the IOT from the frame, the above procedure must be reversed.

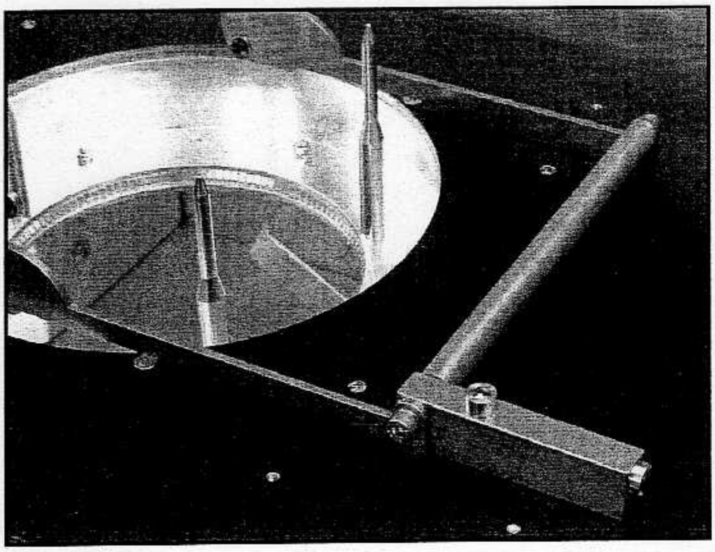

Fig. 8a

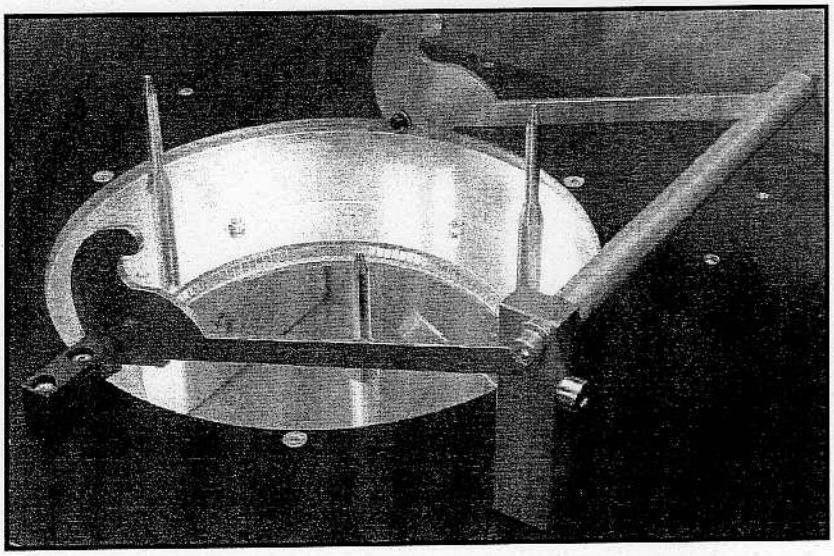

Fig. 8b

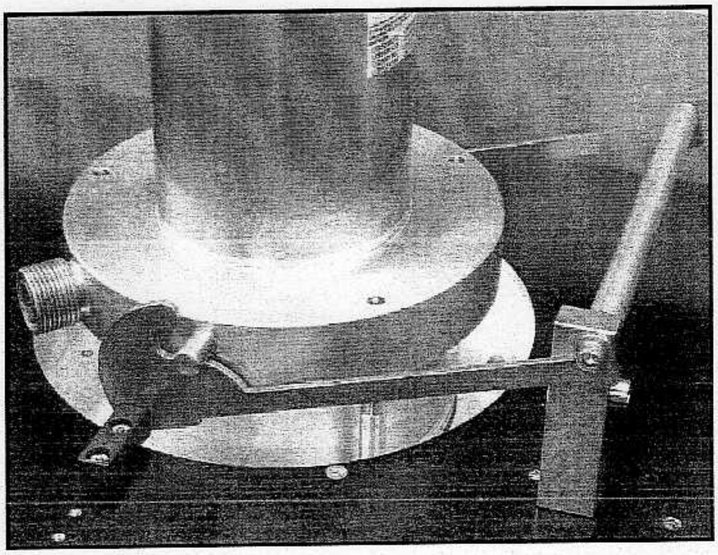

Fig. 8c

5.4 The Complete Assembly

With the tube fitted in the circuit (see Fig. 9a), unscrew the protection caps from the water fittings. Check that the O-rings are in place in both fittings (see Fig. 9b) and that neither is damaged. Spare O-rings M80329A can be found in the documentation envelope supplied with the tube. If the O-rings need to be replaced, fit one to each pipe connection on the water jacket before connecting the water pipes. Wet O-rings will stay in place while the pipes are fitted.

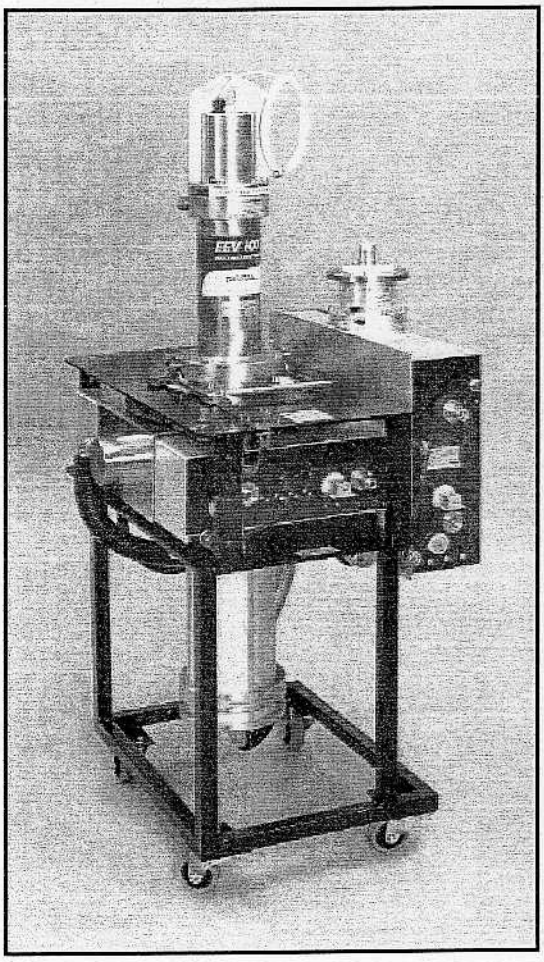

Fig. 9a

Fig. 9b

With the O-rings in place, attach the hoses supplied to the water fittings ensuring that the O-rings are not dislodged at any stage. Carry out a final tightening operation with the spanner provided (see Fig. 1 in section 2, and Figs. 9c and 9d), taking care to support the tube to avoid damage to the circuit contact fingers.

Important:

Where hoses are supplied with male and female end couplings, ensure that the hose with the FEMALE end coupling is connected to the tube INLET (see section. 6.2.1).

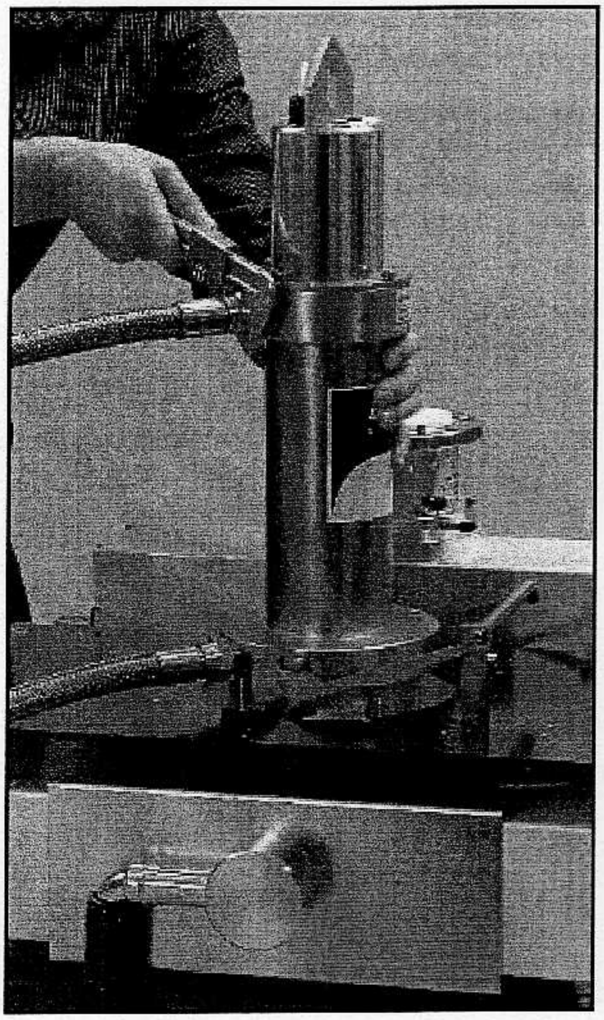

Fig. 9c

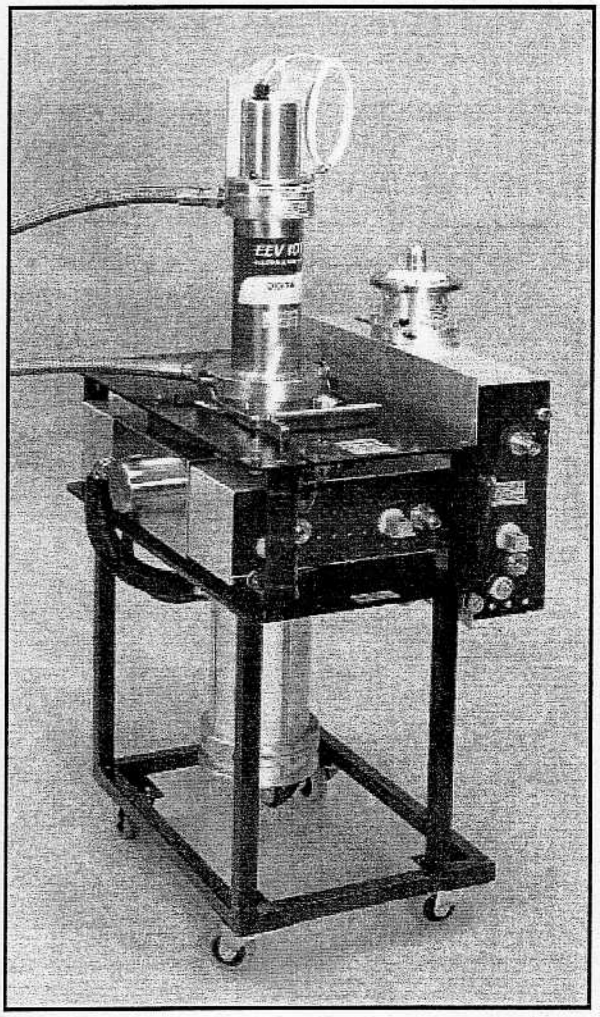

Fig. 9d

6 Installation and Operation of the IOT

Note: The following operations should be carried out in conjunction with the transmitter manufacturer's instructions and circuit diagrams.

6.1 Safety

Before commencing any installation, earth down all leads from the transmitter, using suitable grounding switches and grounding wands.

6.2 Installation of the IOT Assembly into the Transmitter

Note that for new installations, or where pipework has been renewed, it is essential that the cooling system be carefully cleaned before the IOT is installed and powered. Any oils, silicones or other contaminants that are present within the water system may cause damage to the IOT due to thermal runaway of the collector.

Wheel the assembly into the transmitter cabinet and align the output coupler directly underneath the transmitter output feeder. Note that the umbilical lead will have to be connected to the transmitter (see section 6.2.3 b)) before the assembly is wheeled into its final position.

6.2.1 Liquid Coolant Connections

Make the following liquid coolant connections:

a) Collector liquid coolant in (top connector)

b) Collector liquid coolant out (bottom connector)

c) Anode liquid coolant in and anode liquid coolant out - the direction of flow is unimportant.

6.2.2 Air Connection

Connect the transmitter blower to the air manifold of the circuit assembly. A pitot tube interlock point is provided close to the air inlet manifold on the underside of the circuit (see Fig. 10).

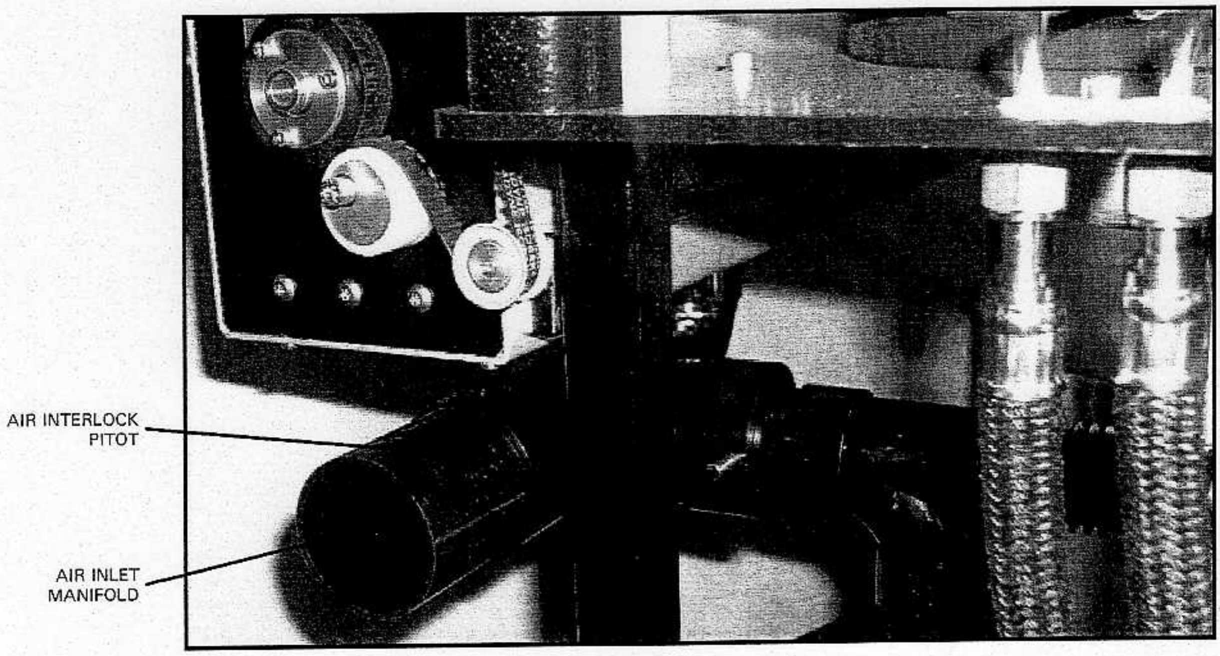

Fig. 10

6.2.3 Electrical Connections

Make the following electrical connections:

a) Bolt the ground connections from the transmitter to the grounding stud on the front left-hand side of the magnet frame.

b) Connect the HT supply lead to the transmitter. Note that there must be a minimum of 150 mm (6 inches) of silicone tubing beyond the main body of the umbilical to ensure that voltage hold-off is maintained. The free end of the flexible conduit that shields the silicone tubing must also be grounded. The connections required are as follows:

Grid:	Yellow lead
Heater Cathode (HK) supply:	Thick black lead
Heater Cathode (HK) monitoring:	Thin black lead
Heater supply:	Thick red lead
Heater monitoring:	Thin red lead

c) Connect the magnet focus supply – where the connector is provided, it can be found attached to the coil socket on the frame. See tube data sheet for wiring details.

d) Connect the two output cavity arc detectors – the connectors are provided in the accessory pack. See tube data sheet for wiring details.

e) Connect the transmitter HT+ lead to the collector of the tube using one of the ion pump cover screws (see Fig. 11).

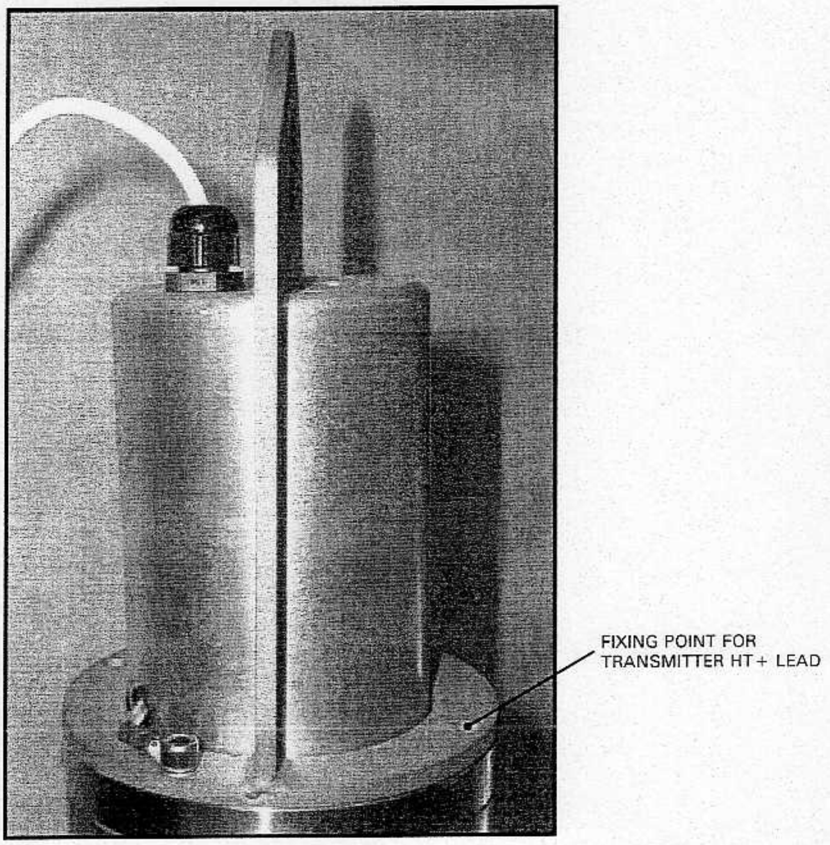

Fig. 11

f) Connect the ion pump lead.

g) Connect the transmitter output feeder to the output coupler of the IOT assembly. Take care to ensure that no strain is placed on the connection which may otherwise lead to RF leakage.

h) Connect the RF input cable to the N-type connector found on the uppermost band of the input cavity.

6.3 Pre-Operation Check-List

Before powering the IOT, ensure all necessary health and safety precautions have been taken in accordance with section 1 of this manual and any instructions provided by the transmitter manufacturer.

6.3.1 Check the liquid cooling system for possible leaks and for the correct operation of the coolant level/coolant flow trip circuits.

6.3.2 Check the air cooling system. Check that the interlock operates.

6.3.3 Check that all the electrical connections are correctly made and that all interlocks and trip circuits are functioning correctly. Set the focus current to 27 A.

6.3.4 If the IOT is a replacement tube, the cavities will be coarse tuned and the loops in approximately the correct position. However, for fine-tuning, the procedure given in section 6.4.2 or 6.4.3 must be followed before full power is applied.

For new installations, check that the cavities are provisionally tuned as described in section 6.4.1, that the output coupler is securely connected to the RF coaxial feeder and that the loop is provisionally set to 45°. The coupling loop between the primary and secondary output cavities should also be set to 45°.

6.3.5 Check that the ion pump supply is connected and that the voltage is 3 to 4 kV. Observe the ion current before and after the heaters are switched on. Check that the heater current lies within the specified range (see tube data sheet). Set the grid voltage to at least −150 V. Allow at least 10 minutes after switching on the heaters, and longer if necessary until the ion current has dropped to below 2 μA before applying beam voltage. **For heater voltage management, refer to note 4 of the IOTD3130W data sheet (or note 3 of the IOTD3100W data sheet) supplied with the tube.** Adjust the grid voltage to set the required quiescent current whilst ensuring the ion current remains below 2 μA. If the ion current exceeds this value, pause the adjustment of the grid voltage until the gas has been pumped to below the recommended level. Once the ion current is less than 2 μA, continue with the adjustment of grid voltage. Repeat in this fashion until the required quiescent current has been obtained. If the IOT is being operated for the first time (or has not been used for several months), it is prudent to run the tube for a short time (30 to 60 minutes) on quiescent current only, i.e. no RF drive.

6.4 Tuning Procedure for IOTs

The following steps will allow the IOT user to tune the complete IOT amplifier system in a safe, logical manner. It is important to adhere to these basic rules when tuning the system, since damage can occur if mistakes are made.

It will be assumed that the IOT has been assembled and installed correctly in the transmitter, that all interlock and protection systems are operating normally, and that the IOT has been powered to the correct HT voltage and quiescent current (typically 500 to 700 mA).

When tuning any IOT, it is important to remember that the collector CANNOT dissipate full beam power. Therefore, once the input cavity has been tuned, the output cavities and couplers must be at least coarse tuned before the IOT is driven to high beam power.

6.4.1 Coarse Tuning of IOT

The continuously tunable cavities are fitted with counters to aid the initial tuning of the IOT. The nominal counter readings for operation can be read from Figs. 12 and 13.

Note: These readings will not necessarily correspond to the exact settings required, so as a precaution against synchronously tuning the IOT it is advised that the secondary output cavity be set an additional three turns clockwise (towards higher frequencies) before applying the beam power.

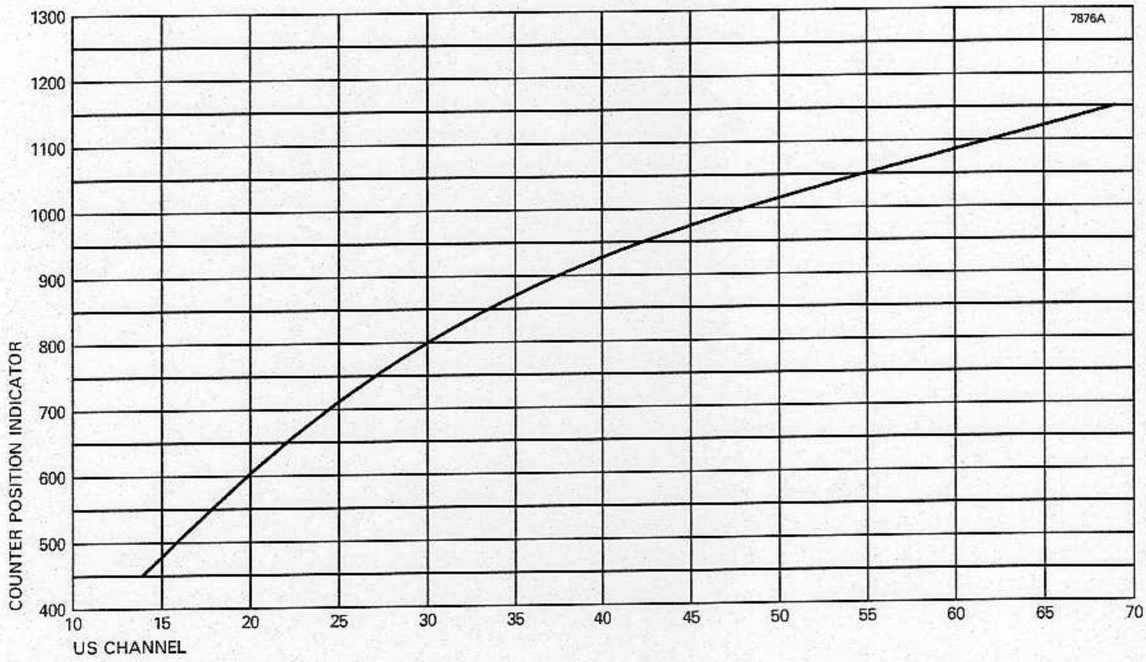

Fig. 12 Primary Cavity Tuning Curve

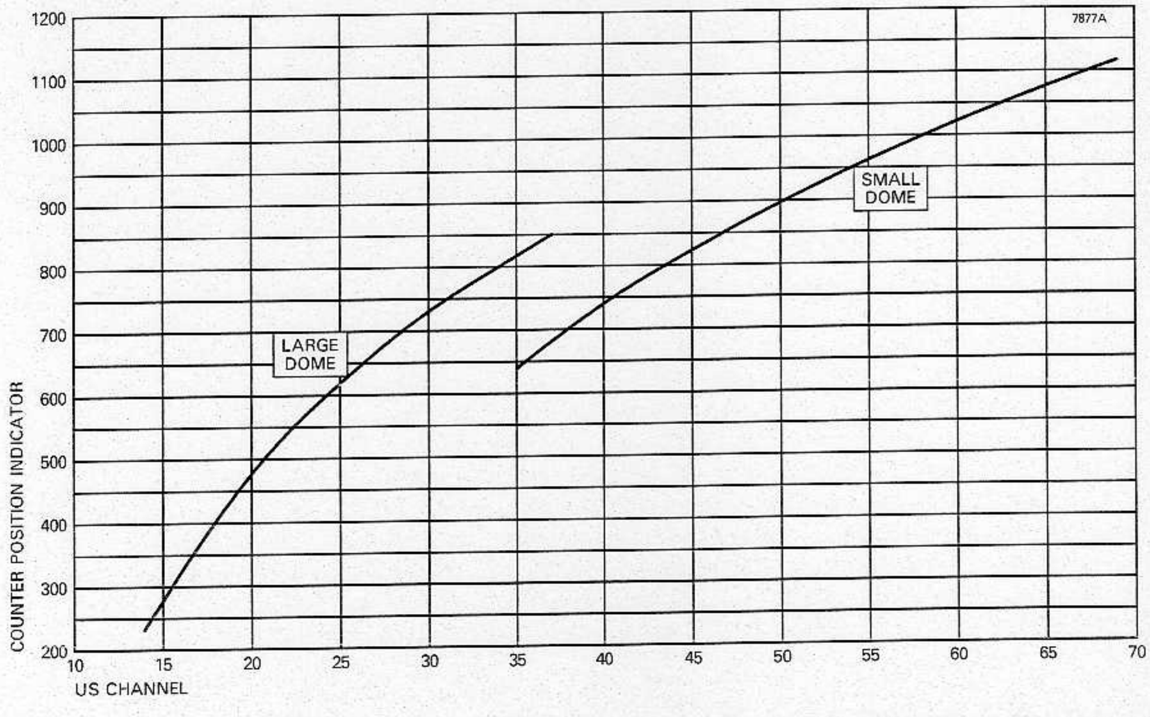

Fig. 13 Secondary Cavity Tuning Curve

6.4.2 Tuning the IOT for Digital Service

The most convenient way to tune an IOT is to use a network analyser to drive the transmitter. A tracking generator and spectrum analyser can perform the same function. The procedure to adopt is as follows:

a) Under DC conditions, rough tune the output cavities to the required positions by referring to Figs. 12 and 13 in section 6.4.1.

b) Ensure that the frequency span on the network analyser is set to no more than 10 MHz. Limit the drive power to the IOT to 30 W maximum. A lower drive power is acceptable. Tune the input cavity by adjusting the position of the lower of the two rings on the outside of the input cavity (marked 'frequency adjustment') while observing the reflected power from the input cavity on the network analyser, to produce a response with maximum absorption at channel centre frequency, Fig. 14 shows the response which will be obtained if the matching ring (marked 'impedance adjustment') is in the optimum position.

c) Set the input match by adjusting the upper of the two rings on the input cavity to produce a response as shown in Fig. 15. The required input cavity bandwidth is determined by the nature of the correction system used, and the matching adjustment should be set to take this into account.

d) **Note:** When tuning the output circuit, since the two output cavities are closely coupled, any adjustment made to one will have an effect on the other.

e) Before fine-tuning the IOT, both coupling loops should be set to about 45°. This will allow the relative positions of both the primary and secondary output cavities to be seen, by giving a 'double humped' response (see Fig. 16).

f) To fine-tune the IOT, adjust the frequency of the primary output cavity to give a peak approximately 4 MHz below centre frequency, and the secondary output cavity to give second peak approximately 4 MHz above centre frequency. It may be necessary to adjust the inter-cavity coupling to achieve this. The frequency response should resemble Fig. 17. The inter-coupling will result in movement of both peaks when either is tuned.

g) Adjust the output coupling to raise the centre portion of the frequency response to give the best flat overall response. Generally, moving the output loop towards 90° will raise the centre and towards 0° will achieve the opposite. This operation may also affect the bandwidth slightly, and this should be readjusted using the inter-coupling loop to obtain the required bandwidth. Adjustments of the primary cavity door will shift the frequency of the bandpass response and adjustments of the secondary cavity door will tilt the bandpass response (see Figs. 18 to 21).

h) Trim the tuning and loop position of the output cavities to flatten the output response and obtain the required bandwidth. Typically, a 6 MHz plateau is required for 8-VSB operation (see Fig. 22). The shoulders of the passband should not start to roll off before the band edge.

i) Increase the drive power to the IOT until the beam current is 1.5 A. This may result in the liberation of a small quantity of gas, which will be removed by the ion pump. This will result in a frequency shift of the tuned response because of the change in beam impedance (see Fig. 23). If the ion current exceeds 2 μA, do not increase the drive power until this has been reduced to below 2 μA.

j) Readjust the input tuning by repositioning the lower of the two rings on the input cavity (see Fig. 24) to regain the flat frequency response at the output of the tube as in Fig. 25. Fine-tuning of the output cavities may be necessary at this point.

k) It is possible to achieve a flat passband with many combinations of inter-cavity and output cavity coupling. However, not all of these combinations will result in efficient operation of the IOT. In general, the best combination of couplings is achieved by reducing the inter-coupling to as small an angle as possible whilst maintaining adequate bandwidth and passband flatness. Typically, the wider the tuned bandwidth, the more likely it is to have a small dip in the centre of the response. It is best to alter the couplings and door positions in small, progressive steps. Start adjusting the inter-cavity coupling slightly, then compensate for resultant 'non-flatness' in the passband by adjusting the output coupling. It may also be necessary to fine-tune the cavity doors at this point. When the tube is tuned correctly, it is possible to "rock" the frequency response about the centre frequency by moving the secondary doors in and out by a small amount.

l) Replace the network analyser with the digital drive source and connect a spectrum analyser to a suitable directional coupler on the IOT output. Drive the IOT to the beam current comparable to that required for on-air operation. This should produce a response as in Fig. 26 with small asymmetry in the shoulder amplitudes.

m) Readjust the input cavity tuning by a small amount (by small movements of the lower ring) to balance the shoulder amplitude (see Fig. 27).

n) Switch off the drive and check the quiescent current; adjust the grid voltage if necessary. Recheck the fine tuning using the network analyser.

o) Reconnect the digital drive source and apply pre-correction to the IOT to optimise the shoulder amplitude and other parameters (see Fig. 28). Further fine-tuning may be necessary to achieve optimum results.

p) The IOT is now ready for on-air use. If the ion current exceeds 2 μA at any time during operation, reduce the drive power to the tube until the level is below 2 μA.

6.4.3 Tuning the IOT for Analogue Service

The most convenient method of tuning an IOT for vision-only or common amplifier operation is with a sideband adaptor or video sweeper in conjunction with the transmitter's exciter and IPA, along with a spectrum analyser to view the frequency response. As an alternative, a scalar network analyser may be used. The procedure to adopt is as follows:

a) Bypass the SAW filter and all of the transmitter pre-correction circuits, and disable the aural drive. Under DC conditions, rough tune the output cavities to the required positions by referring to Figs. 12 and 13 in section 6.4.1.

b) Limit the peak drive power to the IOT to 30 W maximum. A lower peak drive power is acceptable.

c) Apply a low amplitude (white level) sweep to the input of the IOT and tune the input cavity by adjusting the position of the lower of the two rings on the outside of the input cavity (marked 'frequency adjustment') while observing the reflected power from the input cavity on the spectrum analyser, to produce a response with maximum absorption at channel centre frequency. Fig. 14 shows the response which will be obtained if the matching ring (marked 'impedance adjustment') is in the optimum position.

d) **Note:** When tuning the output circuit, since the two output cavities are closely coupled, any adjustment made to one will have an effect on the other.

e) Before fine-tuning the IOT, both coupling loops should be set to about 45°. This will allow the relative positions of both the primary and secondary output cavities to be seen, by giving a 'double humped' response (see Fig. 16).

f) To fine-tune the IOT, adjust the frequency of the primary output cavity to give a peak approximately 2 MHz below vision carrier frequency, and the second output cavity to give a second peak approximately 6 - 8 MHz above carrier frequency. It may be necessary to adjust the inter-cavity coupling to achieve this. The frequency response should resemble Fig. 17. The inter-coupling will result in movement of both peaks when either is tuned.

g) Adjust the output coupling to raise the centre portion of the frequency response to give the best flat overall response. Generally, moving the output loop towards 90° will raise the centre and towards 0° will achieve the opposite. This operation may also affect the bandwidth slightly, and this should be readjusted using the inter-coupling loop to obtain the required bandwidth. Adjustments of the primary cavity door will shift the frequency of the bandpass response and adjustments of the secondary cavity door will tilt the bandpass response (see Figs. 18 to 21).

h) It is possible to achieve a flat passband with many combinations of inter-cavity and output cavity coupling. However, not all of these combinations will result in efficient operation of the IOT. In general, the best combination of couplings is achieved by reducing the inter-coupling to as small an angle as possible whilst maintaining adequate bandwidth and passband flatness. Typically, the wider the tuned bandwidth, the more likely it is to have a small dip in the centre of the response. It is best to alter the couplings and door positions in small, progressive steps. Start adjusting the inter-cavity coupling slightly, then compensate for resultant 'non-flatness' in the passband by adjusting the output coupling. It may also be necessary to fine-tune the cavity doors at this point.

i) Repeating step h) completes the tuning.

j) Switch off the drive and check the quiescent current; adjust the grid voltage if necessary.

k) Re-insert the SAW filter in preparation for pre-correction.

l) Slowly raise the drive power to its full value, ensuring that all tube parameters are within specification, and that the ion pump is able to remove any residual gas. This is particularly important when tuning a new IOT. If the ion current exceeds 2 μA at any time during operation, reduce the drive power to the tube until the level is below 2 μA. Further fine tuning of the input and output cavities may be necessary to achieve optimum results.

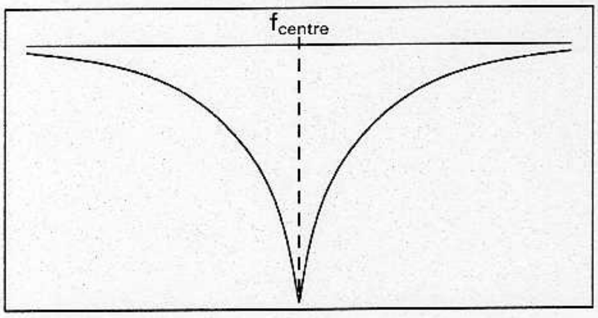

Fig. 14

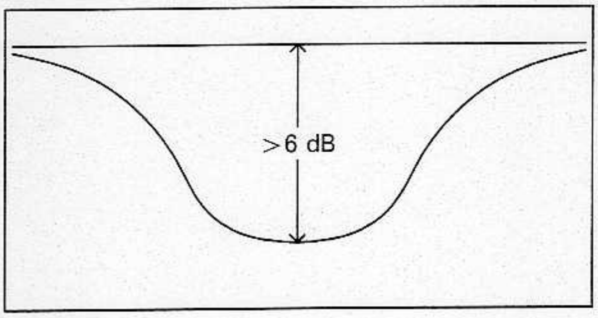

Fig. 15

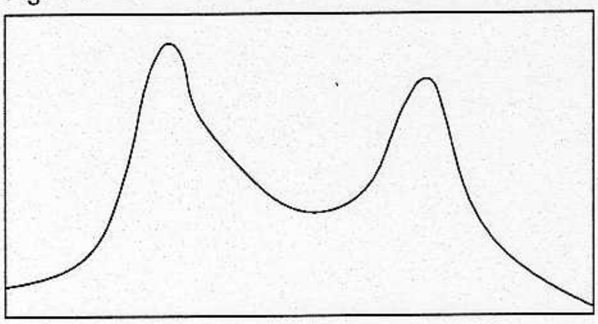

Fig. 16

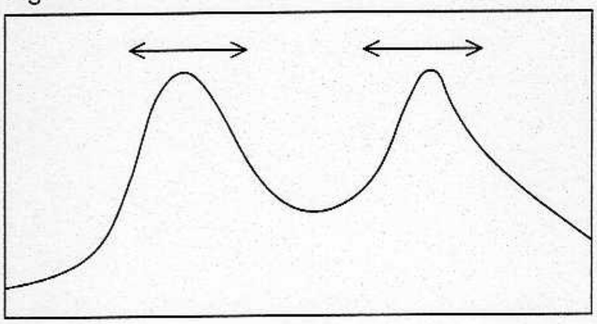

Fig. 17

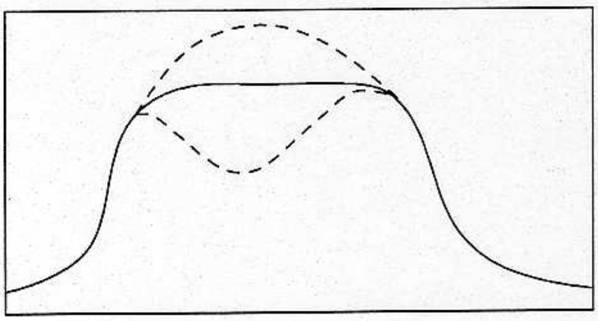

Fig. 18

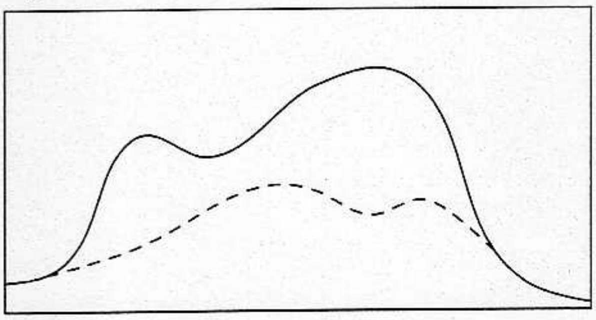

Fig. 19

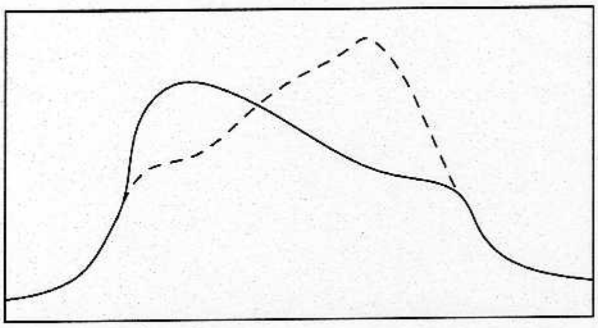

Fig. 20

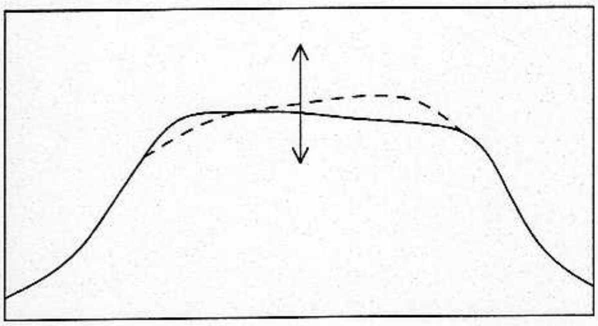

Fig. 21

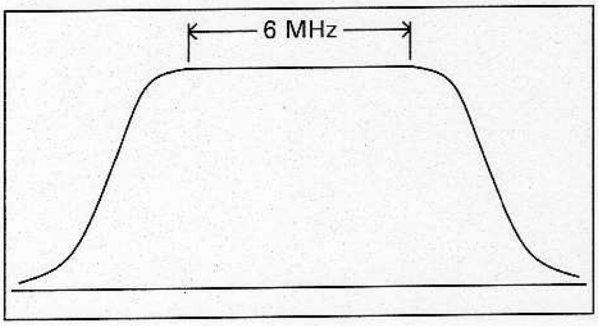

Fig. 22

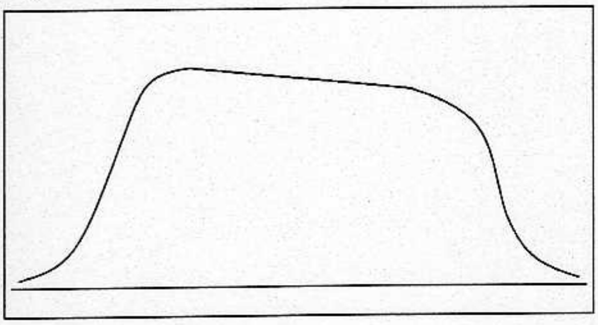

Fig. 23

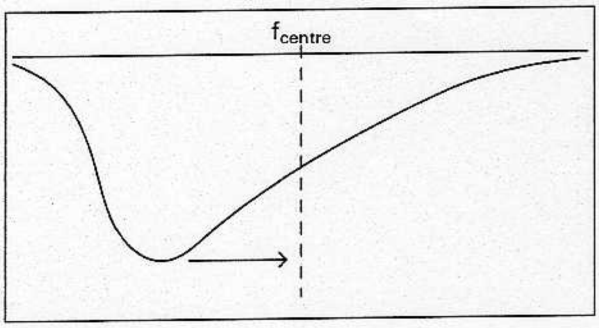

Fig. 24

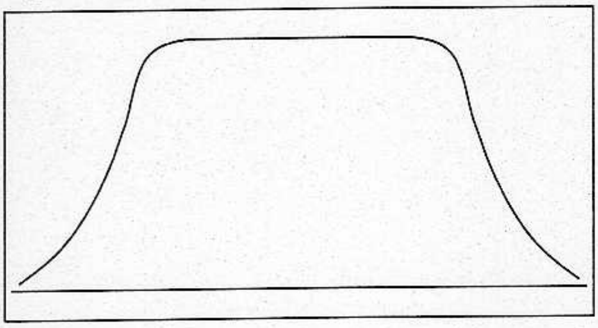

Fig. 25

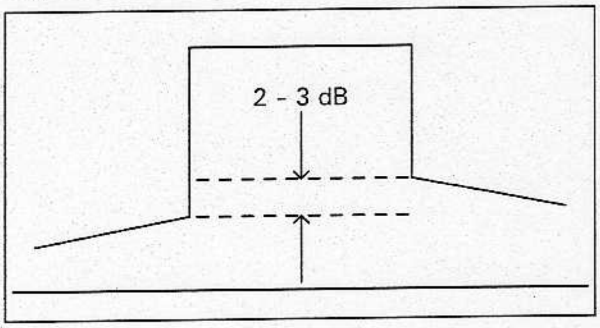

Fig. 26

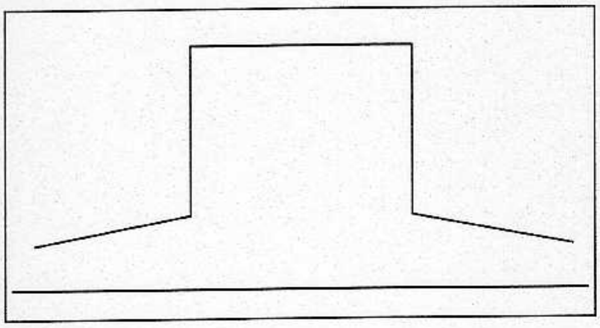

Fig. 27

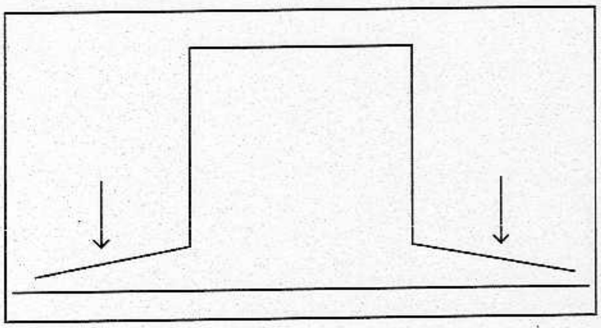

Fig. 28

7. Procedure for Exchanging Tubes

7.1 Removal of Original Tube

1. Turn off all electrical supplies, and earth down as per transmitter instructions.
2. Allow cooling air and water to run for another 5 minutes to lower the tube envelope temperature. See hazard warning note in the IOT data sheet supplied, and section 1 of this manual.
3. Disconnect the ion pump cable from the transmitter.
4. Ensure the collector water supply is switched off, and disconnect the quick release couplings on the tube cooling hoses. If non-sealing couplings have been used, a receptacle capable of holding 4.5 litres (1 imp. gallon) will be required in which to drain the water. If self-sealing couplings are fitted, proceed to step 5.
5. Unscrew the ejection lever lock down screw (see Fig. 8a in section 5.3). Lift the ejection lever crossbar and position the prop in the locating hole on the magnet frame top (see Fig. 8c in section 5.3).
6. Connect a suitable hoist to the lifting point at the top of the tube, and carefully raise the tube with the hoses supported to help keep the tube vertical (see Fig. 29a).
7. Drain coolant from the tube (see Fig. 29b). Where self-sealing hose end connectors are used, both ends must be fitted with the appropriate mating fittings to achieve this.

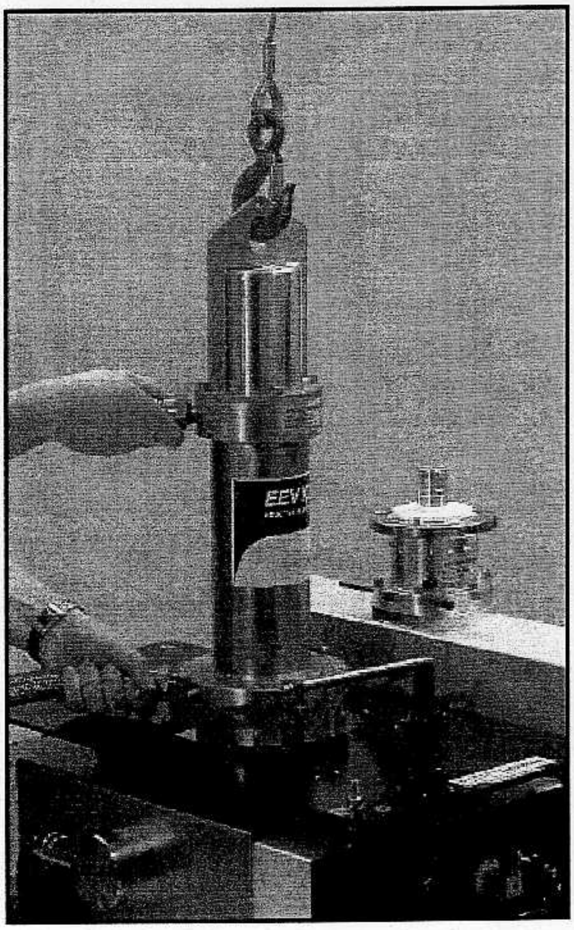

Fig. 29a

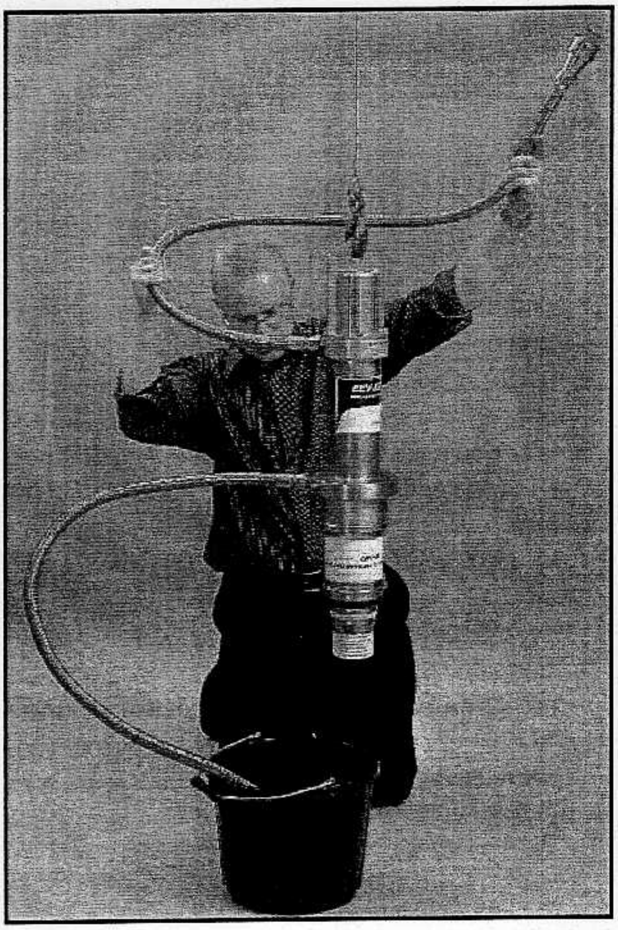

Fig. 29b

8. The tube can now be lowered into its original pack. If this is not available it should be lowered temporarily into the top cushion from the packing case supplied with the new IOT.
9. Remove the hoses from the tube using the spanner supplied with the circuit assembly (see Fig. 29c). It is prudent to lay absorbent paper or rags around the base of the tube collector to catch any coolant spillage while the hoses are being removed.
10. Refit the plastic caps to the tube water fittings (with O-rings in place) to help prevent coolant spillage (see Fig. 29d).
11. Ensure all information is filled in on the Product Service Report if the tube is to be sent back to the tube supplier.

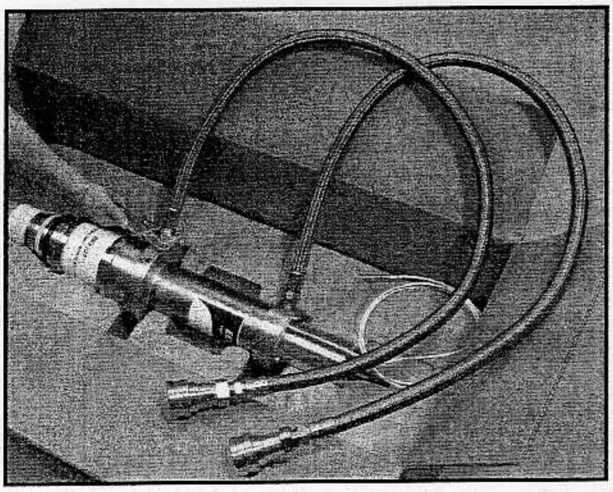

Fig. 29c

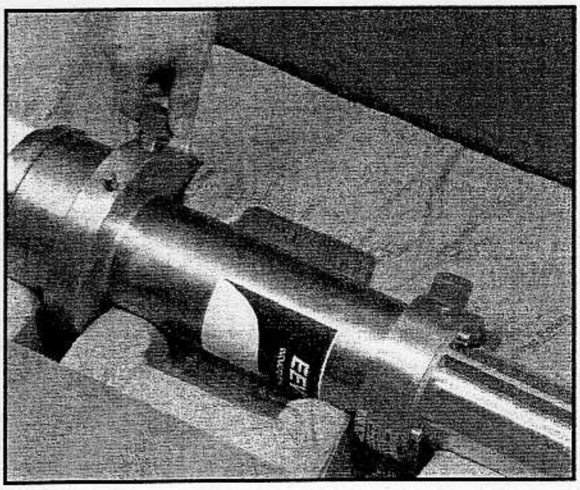

Fig. 29d

7.2 Preparing the Circuit Assembly for Tube Replacement

Safety:

Before carrying out any of the following operations, the cathode, grid and heater must be earthed using a suitable earthing wand. A momentary short must also be applied between the grid and cathode to discharge the bypass capacitors.

Both the operations described above may be carried out at the supply lead terminations or at the gun connection socket as shown in Fig. 30 in section 8.

Take care when looking into the circuit assembly to avoid injury on the guide pins.

1. Remove the carbon anode gasket and replace it with the new one supplied with the tube documentation (refer to section 8.3).
2. Check the condition of each contact finger set. If they are noticeably oxidised or showing any arc damage or defamation, carefully remove them and replace them as described in section 8. Contact the tube supplier for further replacements if necessary.
3. Check cavity doors and loops for evidence of arcing. Refer to the tube supplier if arc damage is evident.

7.3 Installing the New Tube

Refer to sections 5 and 6.

8. Contact Finger and Carbon Anode Gasket Replacement

(Tube removed from circuit as described in the previous section)

Safety:

Before carrying out any of the following operations, the cathode, grid and heater must be earthed using a suitable earthing wand. A momentary short must also be applied between the grid and cathode to discharge the internal bypass capacitors.

Both the operations described above may be carried out at the supply lead terminations or at the gun connection socket as shown in Fig. 30.

If close visual inspection is required, care must be taken to avoid injury on the tube guide pins.

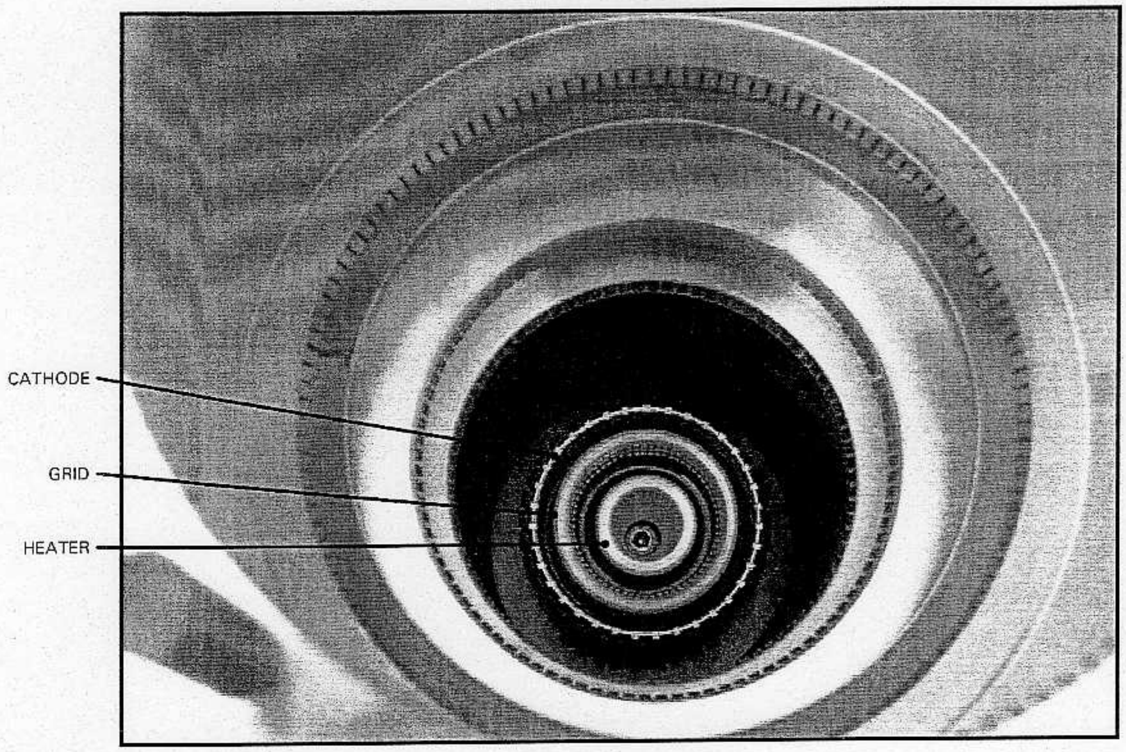

Fig. 30

8.1 Input and Output Cavities

Replacement of the contact fingers can be achieved by springing the faulty length from its groove and replacing it with a new strip from MA3562B (see Fig. 2d, section 3). The finger strip may require trimming to length to achieve best fit. Ensure that all contact finger remnants are removed from the tuning cavities prior to tube installation.

Note: To remove and replace the lower output cavity contact finger strip, the carbon anode gasket must be removed first as described in section 8.3.

8.2 Gun Connection Socket

To replace the outer strip of contact fingers on the gun socket, undo the captive screw in the centre of the socket (see Fig. 30) and carefully withdraw the complete socket from the circuit (see Fig. 31). Once withdrawn, the outer strip of contact fingers can be replaced with a new strip from MA3562B (see Fig. 2d, section 3). Care must be taken to ensure that the barbs on the back of the contact finger strip locate in the groove on the socket. A set of replacement contact fingers MA3562B is included in the accessory pack MA3561B.

Ensure that all contact finger remnants are removed from the tuning cavities and that all insulator surfaces are clean prior to re-insertion of the connector socket.

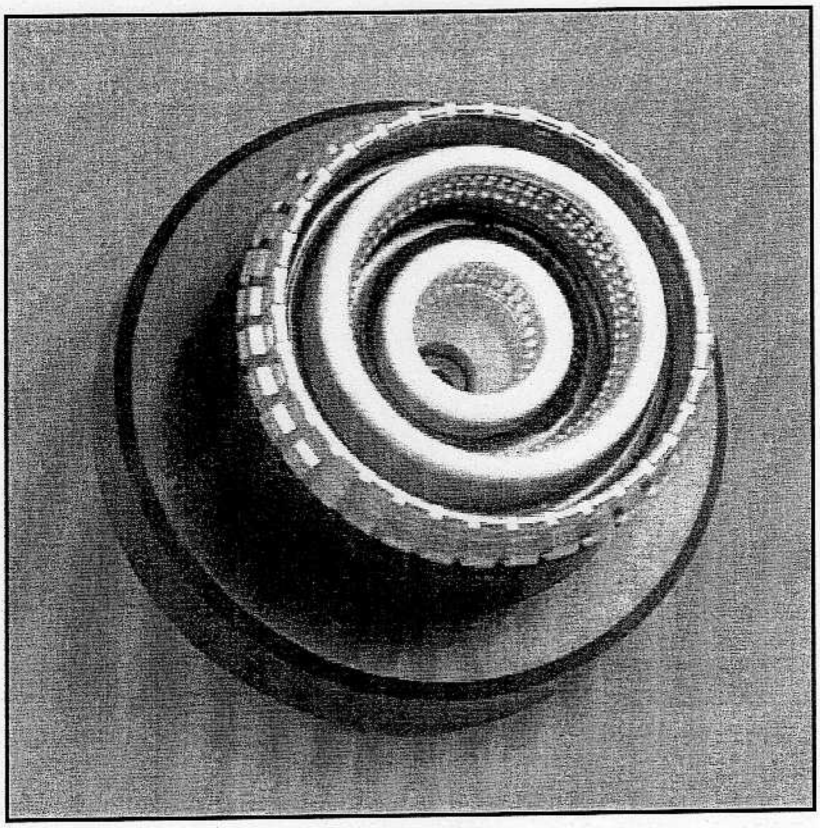

Fig. 31

8.3 Carbon Anode Gasket Replacement

If a new tube is being fitted, or if any damage is evident, the carbon anode gasket should be replaced.

1. Remove tube from circuit.
2. Remove any loose particles from the inside of the tuning cavity system paying particular attention to surface 'X' (see Fig. 32a).
3. Carefully place carbon gasket onto surface 'X', working around the circumference of the gasket allowing it to slip under the contact fingers so that the internal diameter of the gasket matches the internal of the flange. To ensure concentricity the gasket is a tight fit on its outside diameter. As a result, the last part of the gasket may kink up as shown in Fig. 32b. The gasket may be distorted to allow the remaining part to fit under the contact fingers. Once in position, the gasket must be flattened out to ensure that no lumps and kinks remain (see Fig. 32c).
4. Once the gasket is in place the tube may be re-inserted into the circuit.

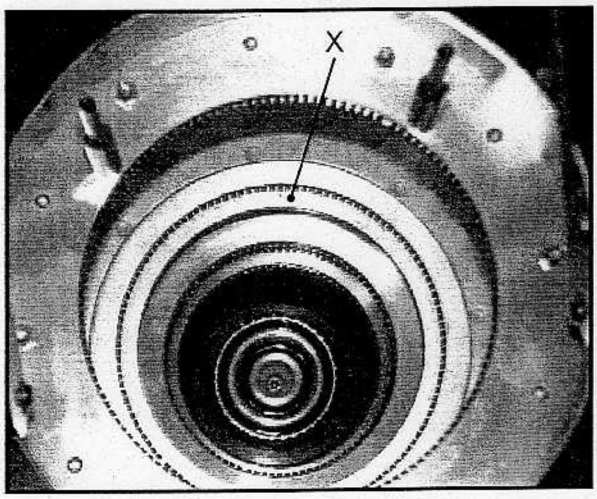

Fig. 32a

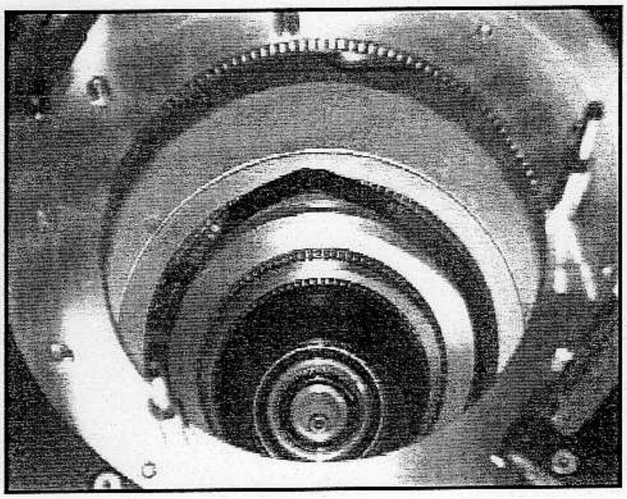

Fig. 32b

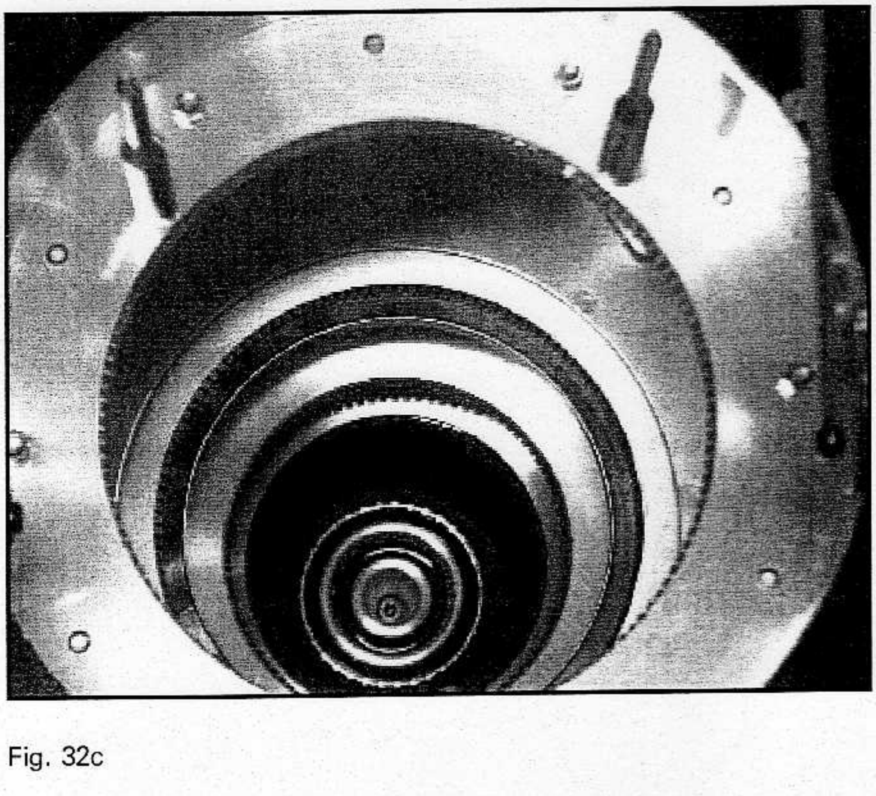

Fig. 32c

9. Bypass Capacitor Inspection

With the gun connection socket removed (see section 8.2), the internal bypass capacitor arrangement can be inspected (see Fig. 33). Contact the tube supplier if any damage is visible.

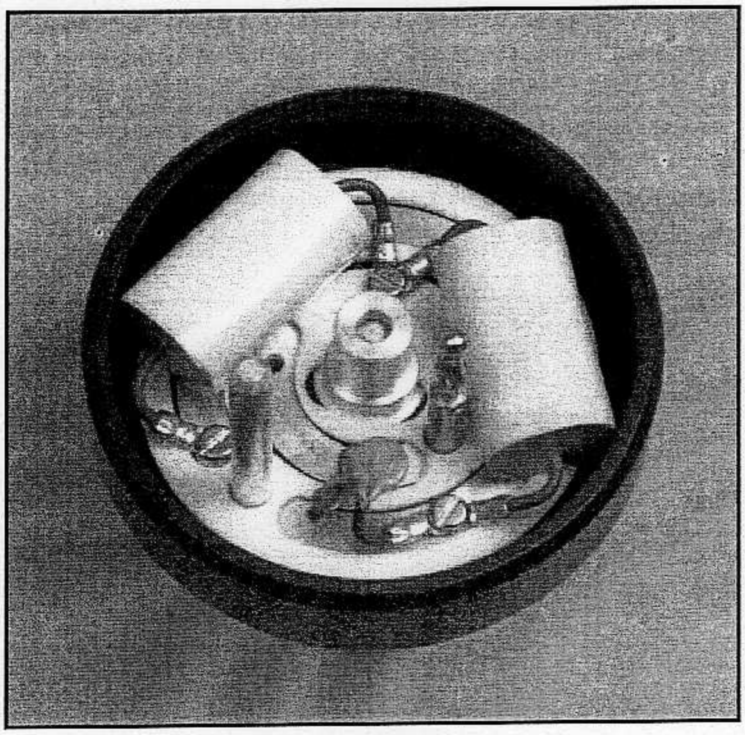

Fig. 33

Appendix A

Operation at Altitude

As altitude above sea level increases it is necessary to consider the fact that the air density reduces, thus the volume of air must be increased in the ratio of air density at sea level to air density at altitude in order to maintain the mass flow. See e2v technologies technical note TVB-TN01, which is available on e2v technologies website. For operation at altitudes above 2286 m (7500 ft), contact e2v technologies.

Appendix B

RFI Reduction Band for US Channels 21 to 32

Operators using the IOT between 512 MHz and 584 MHz (US channels 21 to 32) should be aware of a slightly higher risk of RF interference radiating from the slots on the sides of the input cavity. The fitting of radiation shield FM706998A (see Fig. 34a) can minimise this.

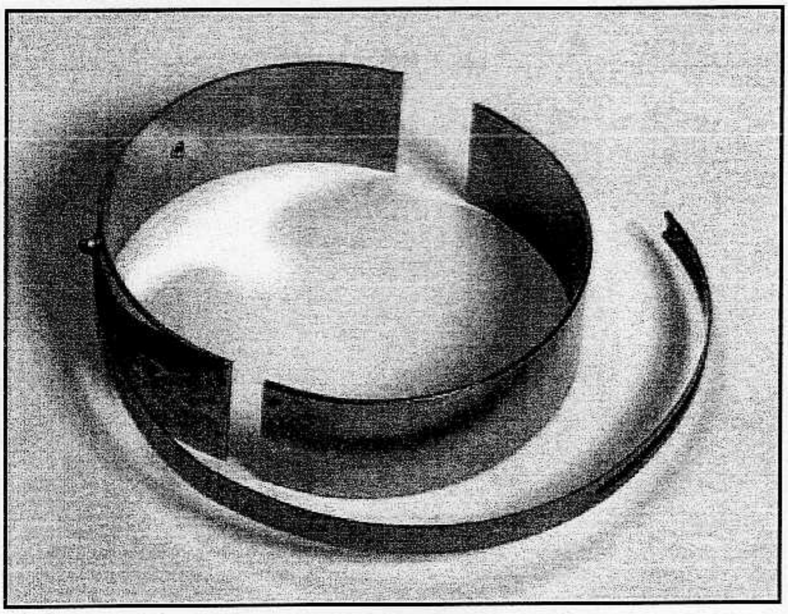

Fig. 34a

This will be supplied by the tube supplier as required and should be fitted as shown in Fig. 34b. All other set-up aspects of the tube remain unaffected.

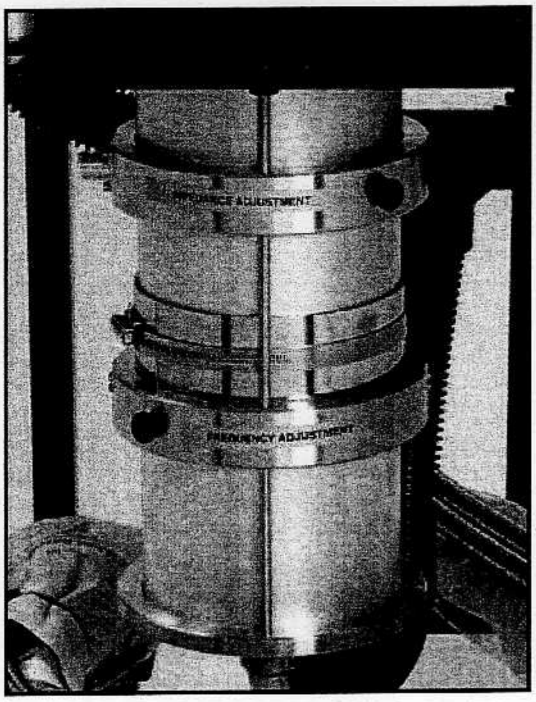

Fig. 34b

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