ZFG2
Oxygen Probes

**Operating Instructions**

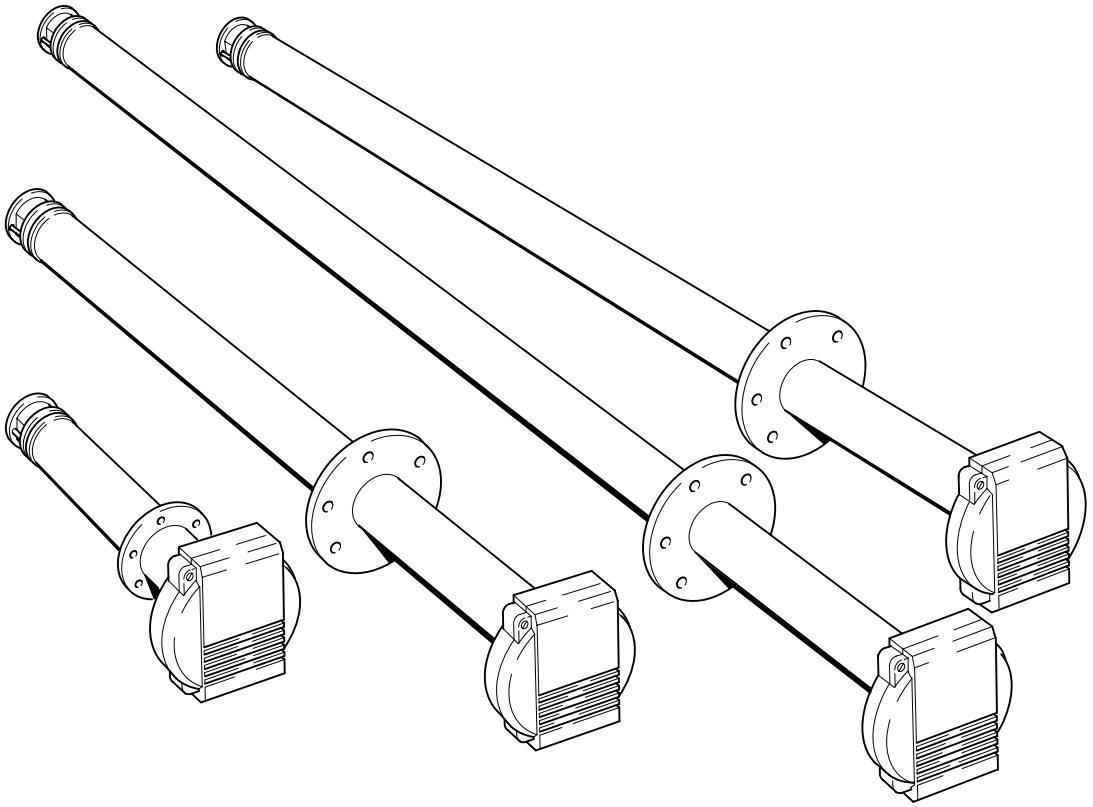


ABB Process Analytics

# ABB PROCESS ANALYTICS

## The Company

ABB Process Analytics specializes in the engineering, manufacture, sale and support of high quality, highly functional, analytical instrumentation for on-line analysis of process streams.

ABB Process Analytics is committed to quality leadership in the on-line analyser industry. The Company-wide, world-wide commitment is well expressed in the **quality statement** for ABB Process Analytics:

**'We will conform to requirements and deliver defect-free products on time, to satisfy the needs of our internal and external customers.'**

## Use of Instructions

**Warning.**
An instruction that draws attention to the risk of injury or death.

**Note.**
Clarification of an instruction or additional information.

**Caution.**
An instruction that draws attention to the risk of damage to the product, process or surroundings.

**Information.**
Further reference for more detailed information or technical details.

Although **Warning** hazards are related to personal injury, and **Caution** hazards are associated with equipment or property damage, it must be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death. Therefore, comply fully with all **Warning** and **Caution** notices.



**Health and Safety**
To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

# CONTENTS

# 1 INTRODUCTION

The ZFG2 zirconia oxygen probe is designed to measure oxygen concentration in flue gas by an in situ ('wet analysis') method which avoids the measurement error, typically 20% higher than the actual value, introduced by the sampling system used in a 'dry analysis' method.

The system comprises a flue-mounted ZFG2 oxygen probe containing a zirconia cell and a Z-MT electronics unit which provides the power and reference air supply necessary for probe operation.

The probe is safe under start-up conditions for all conventional boiler fuels and for refinery 'safe area' applications, provided the ignition temperature of the fuel is greater than 200°C, Apparatus Group IIB is appropriate and the optional flame arrester is fitted.

These instructions must be read in conjunction with the Z-MT Zirconia Oxygen Analyser Operating Instructions (IM/ZMT), Issue 5 onwards.

## 1.1 Principle of Operation – Figs 1.1 and 1.2

The probe contains a sensing element, comprising a thimble-shaped zirconia cell fitted with inner and outer electrodes at its closed end. The inner electrode is exposed to the flue gas entering the open end of the cell; the outer electrode is supplied with air from a pump or regulator and is therefore exposed to a constant partial pressure of oxygen. Since zirconia is an electrolyte which conducts only oxygen ions at temperatures in excess of 600°C, the voltage generated between the electrodes (i.e. the cell output) is a function of the ratio of the oxygen partial pressure on the inner electrode and its temperature. Therefore, any change in the oxygen partial pressure of the flue gas at the exposed electrode produces a change in the cell output voltage as dictated by the Nernst equation – see Appendix A3.

Cell output voltage decreases logarithmically with increasing oxygen, thus giving high sensitivity at low oxygen levels as shown in Fig. 1.2.

A heater element, powered by the ZMT electronics unit, maintains the cell temperature at 700°C.

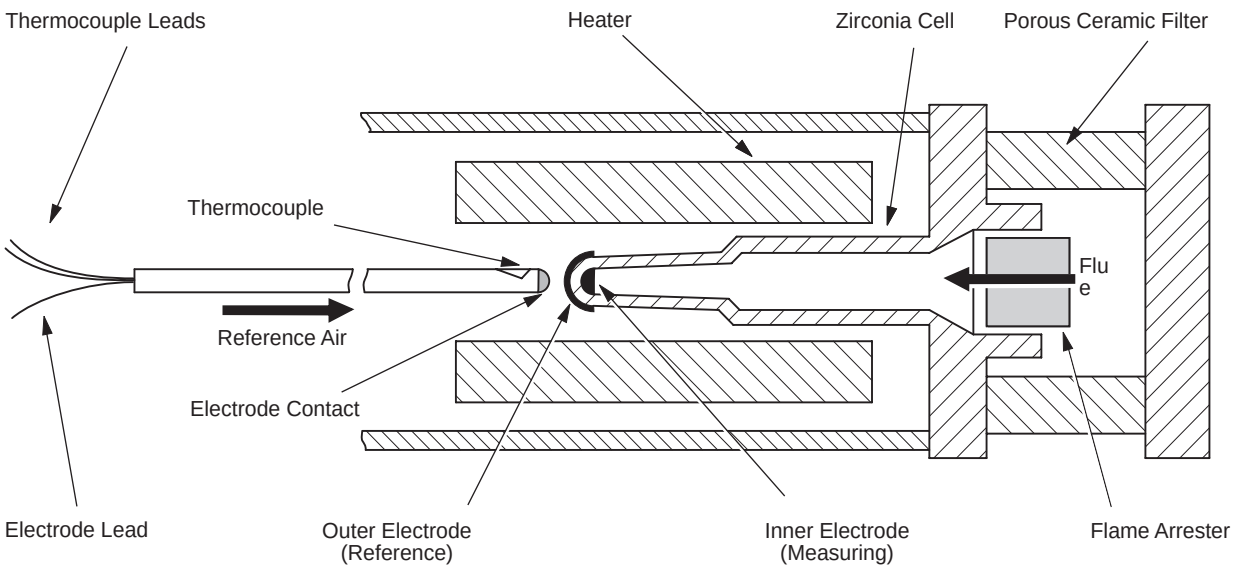



**Fig. 1.1 Probe Construction**

**Note.** The line shown is only applicable for a cell constant of zero mV at 700°C.

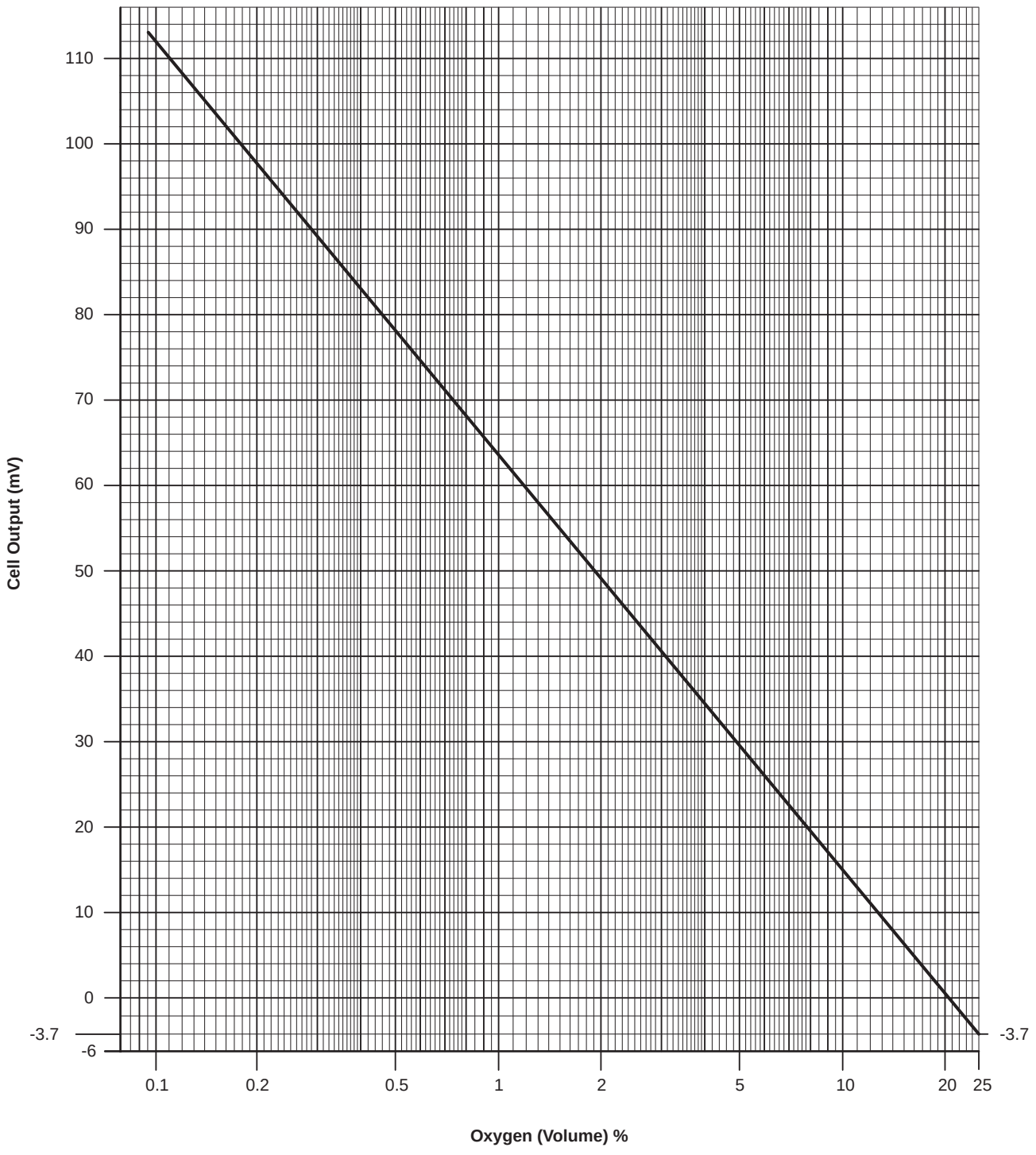



**Fig. 1.2 Cell Output v. Percentage Oxygen**

# 2 PREPARATION

## 2.1 Checking the Code Number – Fig. 2.1

Ensure that the correct probe is being installed by checking the code number against Table 2.1 below. The identification label is fitted on the probe head – see Fig. 2.1.

✶ **Note.** The table is for identification purposes only. Not all code combinations are available.

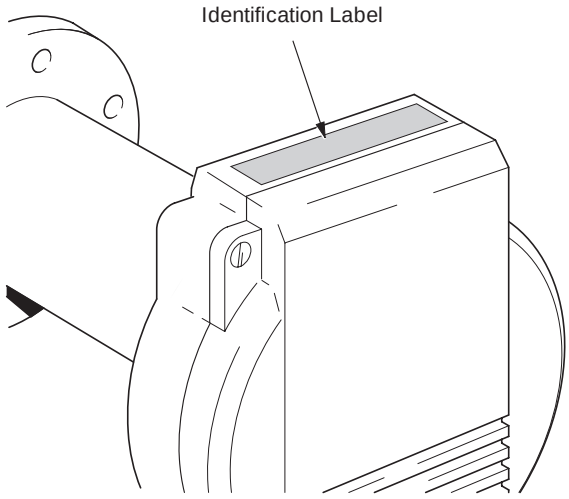



**Fig. 2.1 Checking the Code Number**

## 2.2 Accessories Check

### 2.2.1 Test Gas Connector Kit

Check that the following items are supplied:

connector pipe (1/4in o.d.) with nut and 1/4in olive,
6mm olives (3) (spare alternatives),
spare 1/4in olive,
M4/M5 open-ended spanner.

| Code Digits 1, 2, 3, 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|
| **Basic Type Number** | **Insertion Length** | **Flange Type** | **Conduit** | | | **Cell** | **Flame Arrester** | **Reference Air** | **Mounting Plate Assembly** |
| | | | **Entry Type** | **No. Off** | **Lenght** | | | | |
| ZFG2 Zirconia Oxygen Probe | 1 0.4m<br>2 1.0m<br>3 1.5m<br>4 2.0m | 1 STD<br>2 DIN<br>3 ANSI<br>4 JIS<br>5 Model132<br>9 Special | 1 20mm<br>2 1/2 in NPT | 0 None<br>1 One Std.<br>2 Two Std.<br>3 One IP65<br>4 Two IP65 | 0 None<br>1 6m<br>2 10m | 1 Standard Cell<br>2 Flow Through Cell | 0 None<br>1 Flame Arrester | 1 Internal<br>2 External | 0 None<br>1 Standard (0.4m probes)<br>2 Standard (long probes) |

**Table 2.1 Identification**

| ZFG2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 |
|---|---|---|---|---|---|---|---|---|---|
| ZFG2 Zirconia oxygen probe | | | | | | | | | |
| Insertion length – 1.0m | | | | | | | | | |
| Flange type – standard | | | | | | | | | |
| Conduit entry type – 20mm | | | | | | | | | |
| Number of conduits – two | | | | | | | | | |
| Conduit length – 6m | | | | | | | | | |
| Cell type – standard | | | | | | | | | |
| Flame arrester fitted | | | | | | | | | |
| Internal reference air tubing (within conduit) | | | | | | | | | |
| Standard mounting plate | | | | | | | | | |

**Table 2.2 Code Number Example**

### 2.2.2 Probe Flanges – Figs. 2.2 to 2.7

The probe is supplied with one of the following mounting flanges welded to the probe body:

Standard flange – 0.4m probes (Fig. 2.2), 1.0m, 1.5m and 2.0m probes (Fig. 2.3),
DIN flange – all probes (Fig. 2.4),
ANSI flange – all probes (Fig. 2.5),
JIS flange – all probes (Fig. 2.6),
Model 132 flange – 0.4m probes only (Fig. 2.7).

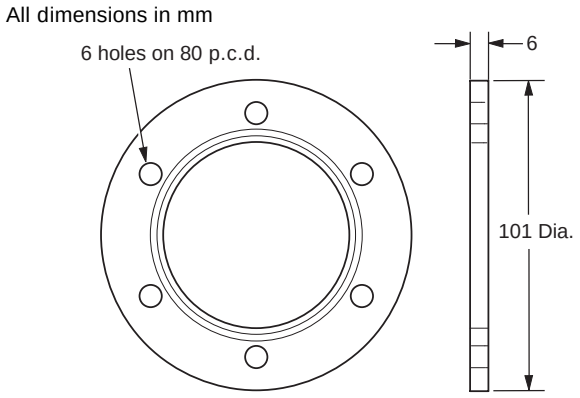



**Fig. 2.2 Standard Mounting Flange (0.4m Probes)**

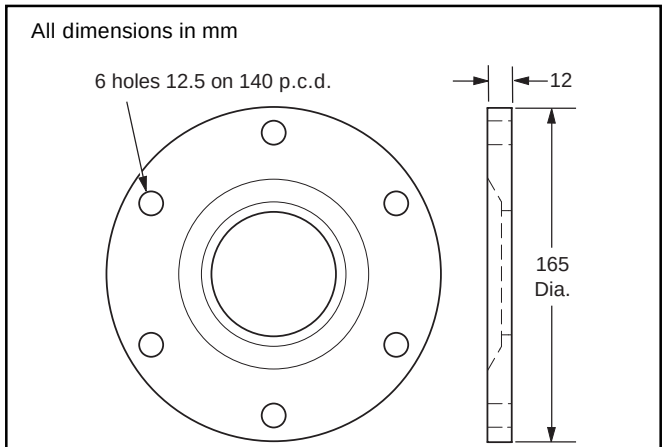



**Fig. 2.3 Standard Mounting Flange (1.0m, 1.5m and 2.0m Probes)**

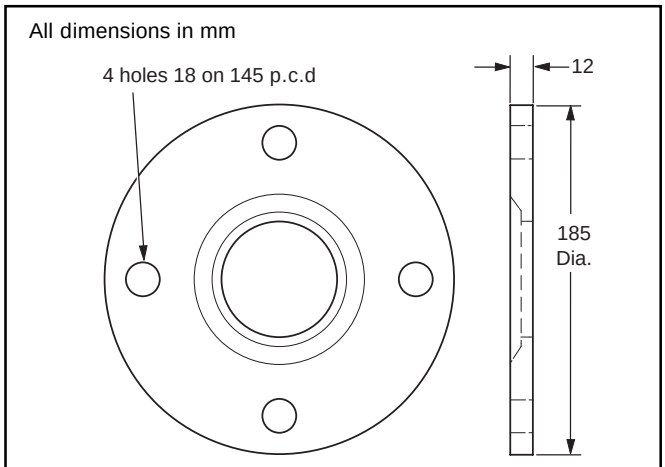



**Fig. 2.4 DIN Mounting Flange (all Probes)**

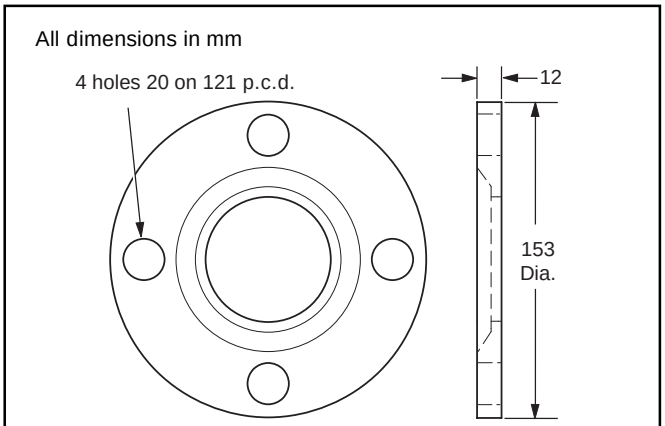



**Fig. 2.5 ANSI Mounting Flange (all Probes)**

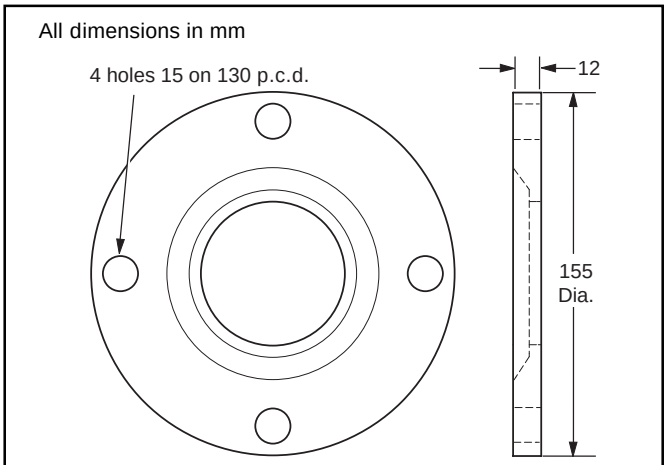



**Fig. 2.6 JIS Mounting Flange (all Probes)**

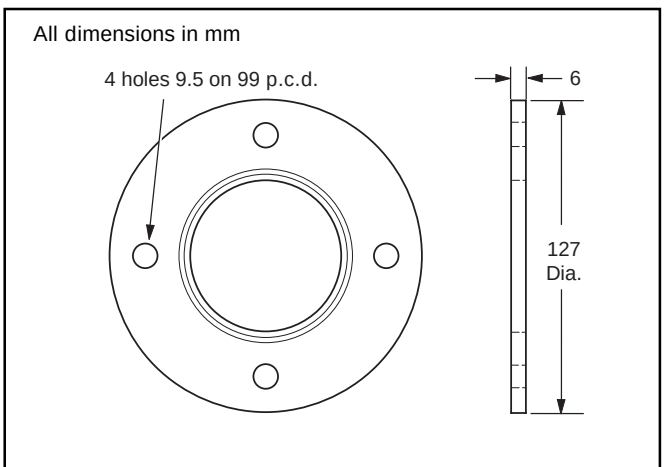



**Fig. 2.7 Model 132 Mounting Flange (0.4m Probes)**

### 2.2.3 Mounting Plates – Figs 2.8 and 2.9

In addition to the probe flange, the probe may also be supplied with a mounting plate assembly if specified – see Table 2.1. A mounting plate is required if there is no existing mounting on the flue or boiler.

**0.4m probes**, including items not shown in Fig. 2.8:
probe mounting gasket,
M6 shakeproof washers (6),
M6 plain washers (6),
M6 nuts (6).

**1.0m, 1.5m and 2.0m probes**, including items not shown in Fig. 2.9:
probe mounting gasket,
M10 nuts (6),
M10 washers (6).

### 2.2.4 Mounting Adapters (0.4m Probes only) – Figs. 2.10 and 2.11

Mounting adapters are available for special mounting configurations.

**2½in NPT male bush**, including items not shown in Fig. 2.10:
probe mounting gasket,
M6 x 16 hexagon-head steel screws (6),
M6 shakeproof washers (6),
M6 plain washers (6).

**Long probe to 0.4m probe adapter**, including items not shown in Fig. 2.11:
adapter gasket,
Probe mounting gasket,
M6 x 16 hexagon-head steel screws (6),
M6 shakeproof washers (6).

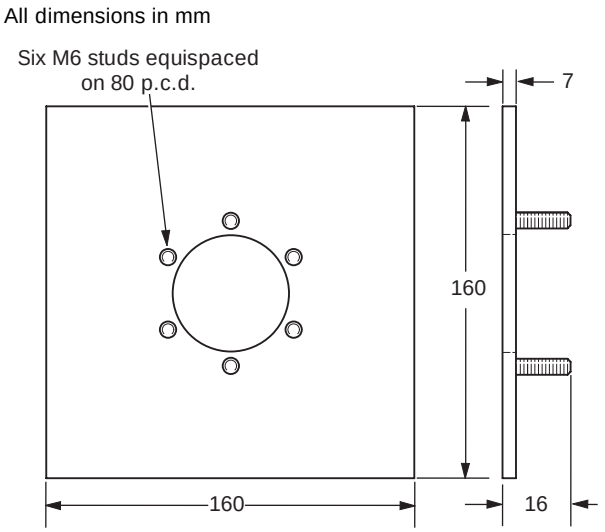



**Fig. 2.8 Standard Mounting Plate (0.4m Probes)**

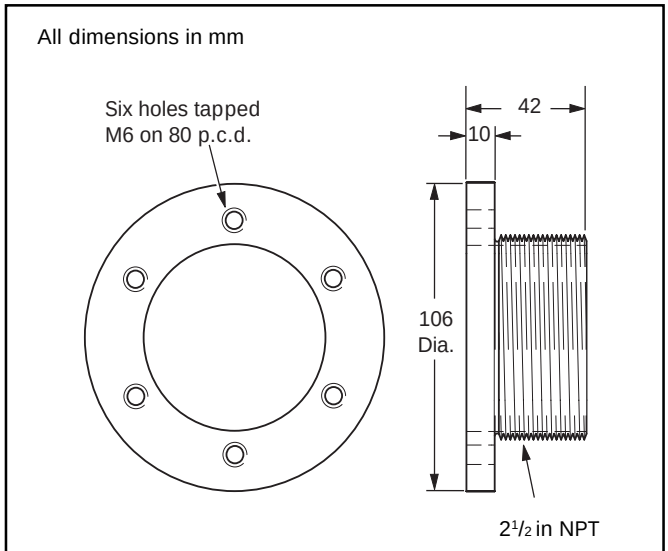



**Fig. 2.10 2½in NPT Male Bush Adapter 0.4m Probes**

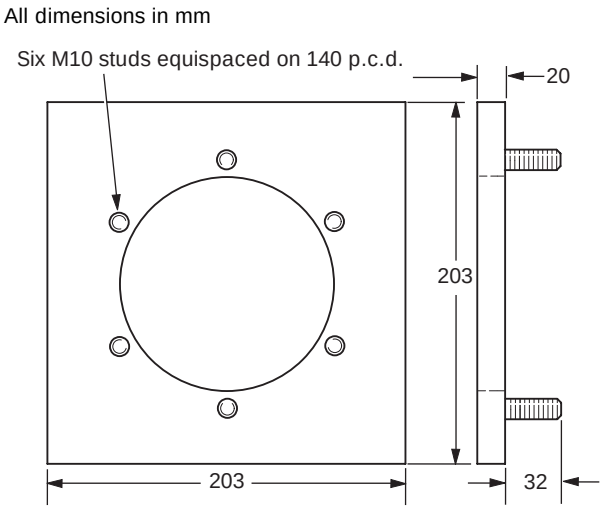



**Fig. 2.9 Standard Mounting Plate (1.0m, 1.5m and 2.0m Probes)**

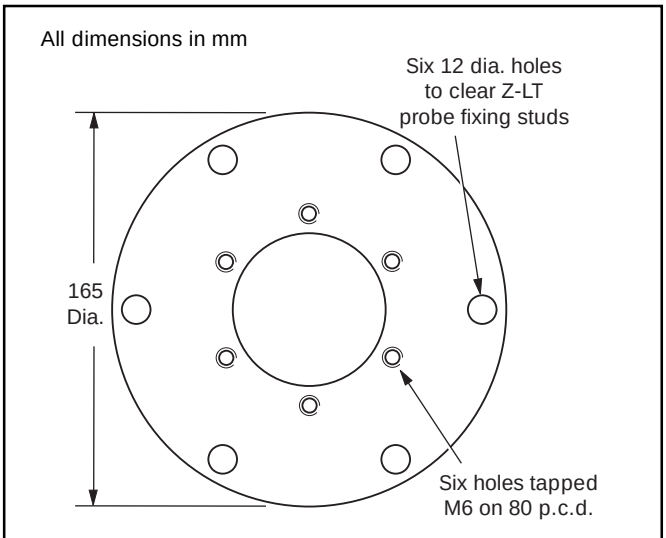



**Fig. 2.11 Long Probe to 0.4m Probe Adapter Plate**

**Caution.** Handle the probe with care. The probe inners have fragile ceramic components which are easily damaged.

### 3.1 Siting

Select a position where the intake is located in the main stream of flue gas. Gas temperature must be in the range 20°C to 600°C.

Avoid positions where obstructions or bends may create turbulence in the gas flow, prevent insertion, or subsequent removal, of the probe.

Avoid positions where vibration levels induced by other plant or vortex shedding of the probe may result in mechanical failure of the probe.

If excessive dust flows are likely, fit a deflector plate with its apex facing the direction of gas flow as shown in Fig 3.1.

If necessary the probe mounting flange and body should be thermally lagged to prevent acid dew point corrosion and maintain the probe head temperature within the range of –10° to +80°C.

**Note.** If a deflector plate is required for use with a 0.4m probe, contact the Company.

Probe dimensions are shown in Fig 3.2. A clearance of at least 25mm in excess of the overall probe length is necessary for installation or removal procedures.

The probe can be supplied with 6 or 10m of flexible conduit as standard (IP65 protection rating optional) which encloses cables for connection to the electronics unit. The probe head can accept two conduits for separate routing of signal and power cables if required. The reference air tubing can also be incorporated in the conduit or routed independently to an optional external connector on the probe head. If the location of the electronics unit is more than 10m from the probe, a junction box is available to extend the run within the limitations detailed in Table 3.1.

**Caution.** Thermal shock may break the zirconia cell if the flue is cleaned using a high pressure water hose. If this method of cleaning is employed, remove the probe from the flue prior to cleaning.

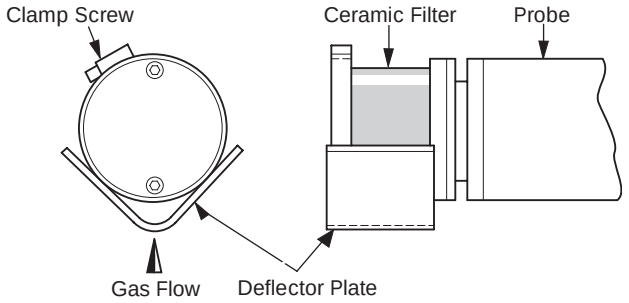



**Fig. 3.1 Deflector Plate**

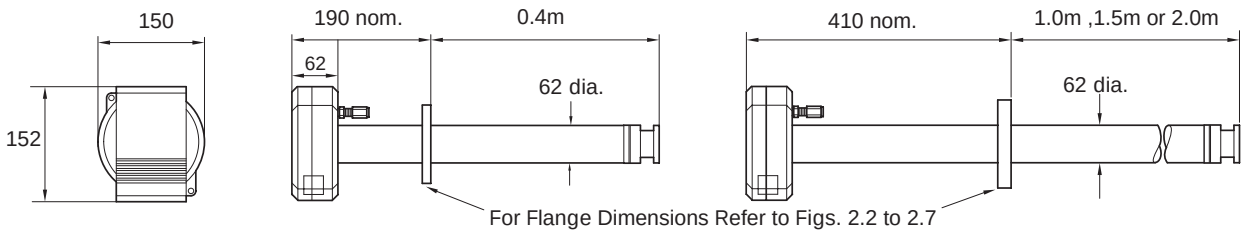



**Fig. 3.2 Probe Dimensions**

| Cable/Tubing Reference | Description |
|---|---|
| Cell output cable | 16/0.2 laid up red andblue twin copper braid with overall p.v.c sheath |
| Thermocouple cable | Ni Cr/Ni Al BS4937 type Kanmd IEC 584 (BS part no.4)<br>Pt/Pt Rh BS 4937 types R and S and DIN IEC 584 (BS part nos. 1 and 2) |
| Heater cable | Max run 100m. Max loop impedance 2Ω |
| Air tubing | 1/4 in o.d. x 1/8 in stainless steel, nylon or p.v.c. tube (100°C ambient max) |

**Table 3.1 Cable References and Tubing Specification**

## 3.2 Mounting

### 3.2.1 0.4m Probe (Flange 'Standard' Mounting) – Fig. 3.3

① Cut a 75mm minimum diameter hole in the flue wall.

② Weld the mounting plate into place, concentric with the hole in the flue. Alternatively drill and bolt the plate to the flue. When using the latter method, fit a suitable gasket between the plate and the flue casing.

③ Fit the probe gasket and insert the probe into the flue.

④ Secure the probe and gasket using six M6 nuts and washers.

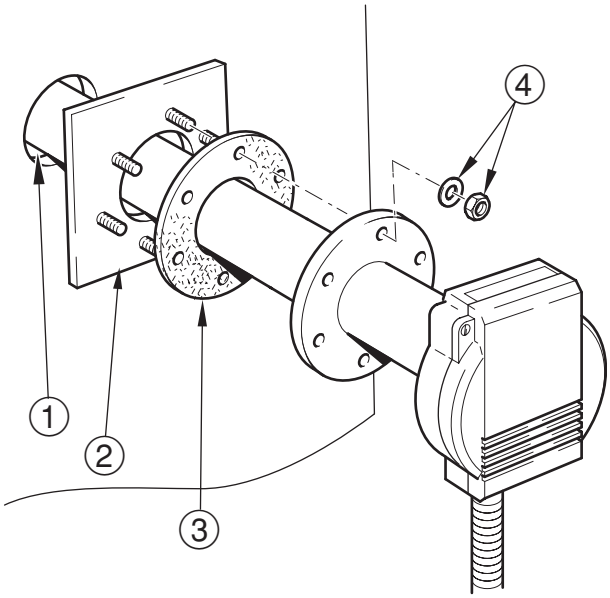



**Fig. 3.3 Mounting – 0.4m Probes**

### 3.2.2 1.0m, 1.5m and 2.0m Probes – Fig. 3.4

① Cut a 120mm minimum diameter hole in the flue wall.

② Weld the mounting plate into place, concentric with the hole in the flue. Alternatively drill and bolt the plate to the flue. When using the latter method fit a suitable gasket between the plate and the flue casing.

③ Fit the probe gasket and insert the probe into the flue.

④ Secure the probe and gasket using six M10 nuts and washers.

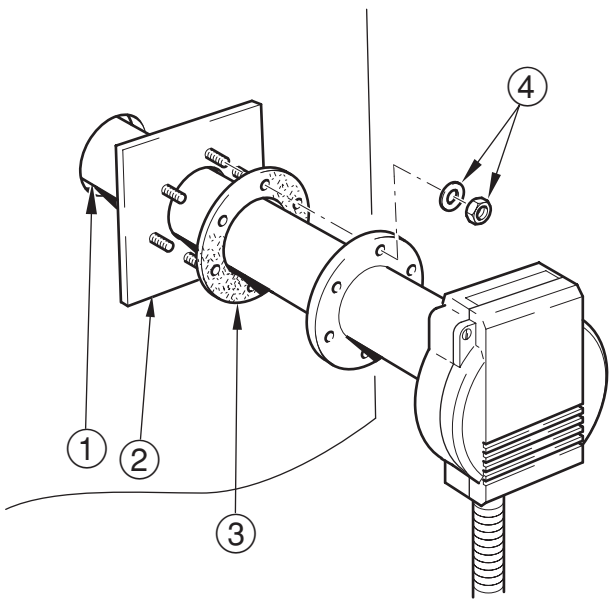



**Fig. 3.4 Flange Mounting,1.0m, 1.5m and 2.0m Probe**

### 3.2.3 0.4m Probe (2½in NPT Male Bush Mounting) – Fig. 3.5

✶ **Note**. The following procedure applies where a 2½in NPT female fitting is already installed in the flue.

① Apply anti-seize compound (e.g. Rocol J166 or similar) to the thread on the male bush mounting adapter. Screw the adapter into the existing flue fitting. Tighten by inserting two M6 screws into opposite holes in the adapter and using a bar as a lever.

⚠ **Caution.** Do not use the probe body as a lever to tighten the male bush.

② Fit the probe gasket over the probe and insert the probe through the adapter into the flue.

③ Secure the probe and gasket using six M6 screws and washers.

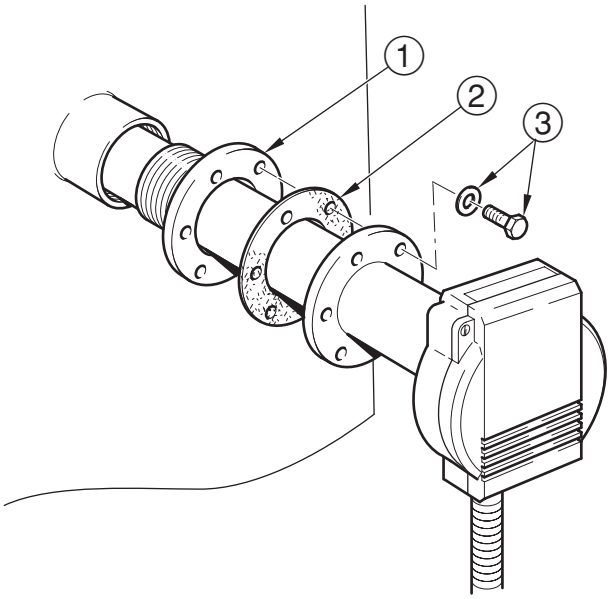



**Fig. 3.5 Male Bush Mounting, 0.4m Probe**

### 3.2.4 0.4m Probe (Z-LT Adapter Plate Mounting) – Fig. 3.6

✶ **Note**. This procedure applies where an existing Z-LT or long ZFG installation is to be replaced by a 0.4m ZFG2 probe.

① Locate the Z-LT adapter gasket on the existing Z-LT mounting plate.

② Locate the Z-LT adapter plate on the gasket.

③ Secure the gasket and plate with six M10 nuts and washers.

④ Fit the probe gasket over the probe end. Insert the probe into the flue.

⑤ Secure the probe and gasket using six M6 screws and washers.

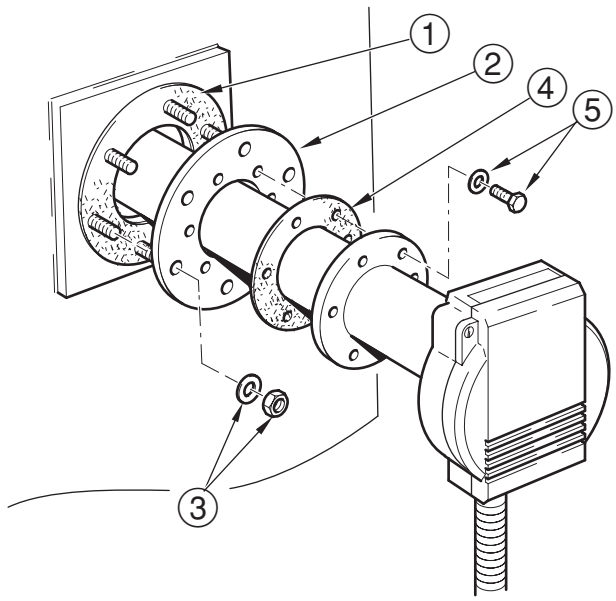



**Fig. 3.6 Z-LT Adapter Plate Mounting**

# 4 CONNECTIONS

### 4.1 Conduit Runs and Cable Details

A schematic diagram is given in Section 5 of the Z-MT Operating Instructions (IM/ZMT). For cable and reference air tubing details refer also to Table 3.1 on page 7.

### 4.2 Probe Connections, General

The probe is usually supplied ready-fitted with 1 or 2 flexible conduits which contain the connection leads and reference air tubing (if applicable). However, if the probe is supplied without conduit(s), carry out the procedures detailed in Sections 4.2.1 and 4.2.2 following. A 6mm external earth bonding point is provided on the back of the probe head – see Fig. 4.5.

For electronics unit connections refer to the ZMT Operating Instructions IM/ZMT.

#### 4.2.1 Access to Probe Terminals – Fig. 4.1

① Slacken the two captive M4 screws retaining the head cover and remove the cover.

② Pull off the test gas tube.

③ Pull off the reference air tube.

④ Slacken the 2 x M4 captive screws retaining the connections cover and remove the cover.

**Caution.** Once the cover has been removed, take care not to catch or damage the four-bore insulator protruding from the centre of the probe head.

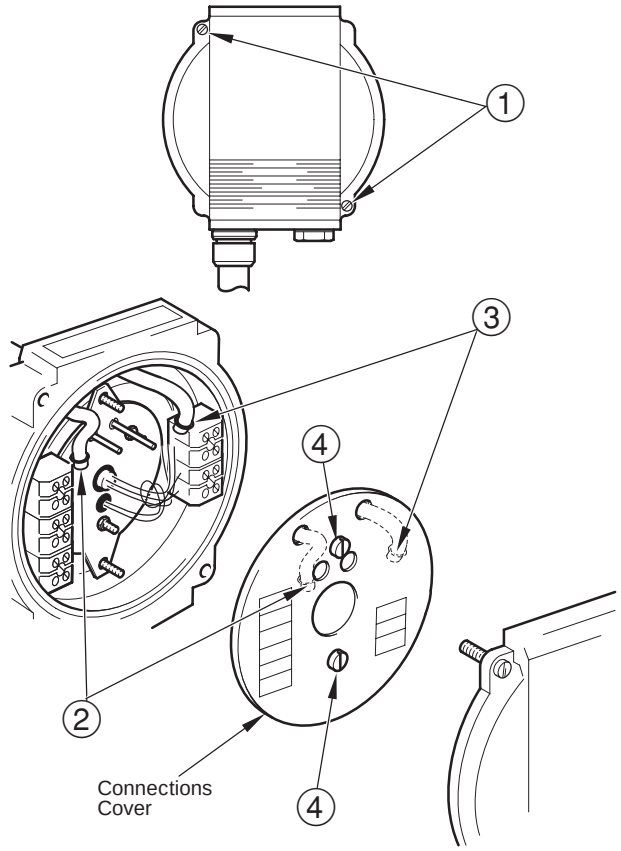



**Fig. 4.1 Access to Probe Terminals**

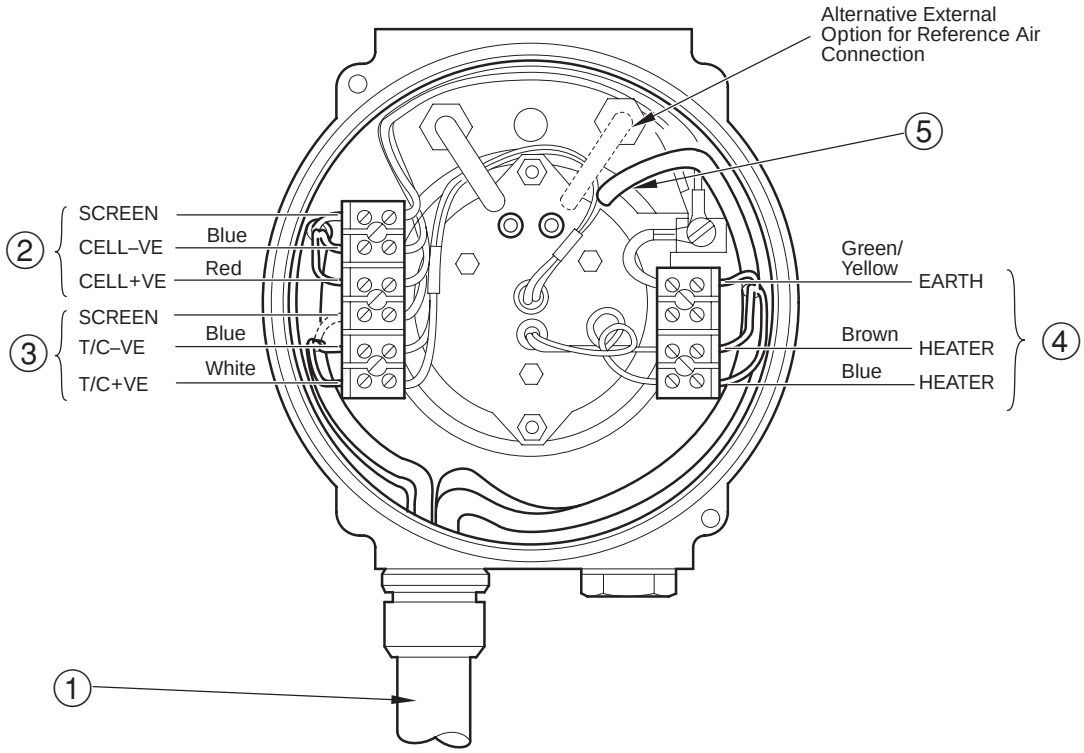



**Fig. 4.2 Probe Connections, Single Conduit (Power and Signal)**

### 4.2.2 Probe Connections – Fig. 4.2 or 4.3 and Fig. 4.4

If the probe is supplied ready-fitted with conduit(s) no further probe connections are required. When making connections, ensure that the cables and tubing are routed correctly as shown in Fig. 4.2 (single conduit) or Fig. 4.3 (double conduit).

① Fit suitable cable gland(s) or conduit fitting(s) into the head ($^1$/2in NPT or 20mm as applicable).

② Make cell connections:

| | | |
|---|---|---|
| Red | – | 'CELL +VE' |
| Blue | – | 'CELL –VE' |
| Screen | – | 'SCREEN'. |

③ Make thermocouple connections:

| | | |
|---|---|---|
| White | – | 'T/C +VE' |
| Blue | – | 'T/C –VE' |
| Screen* | – | 'SCREEN'. * If applicable. |

④ Make heater connections:

| | | |
|---|---|---|
| Brown* | – | 'HEATER' |
| Blue* | – | 'HEATER' *polarity unimportant. |
| Green/Yellow | – | 'EARTH'. |

⑤ **Internal reference air connection only** – route the reference air tubing as shown but do not connect yet.

✶ **Note.** For external reference air connection refer to Section 4.3.1 overleaf.

Referring to Fig. 4.4:

⑥ Replace the connections cover, ensuring that the test gas and reference air tubes are threaded through the correct holes in the cover.

⑦ Secure the cover with the two M4 captive screws.

⑧ Connect the 'TEST GAS' tubing.

⑨ Connect the 'REF. AIR' tubing.

Refit the head cover (reversing step ① in Section 4.2.1).

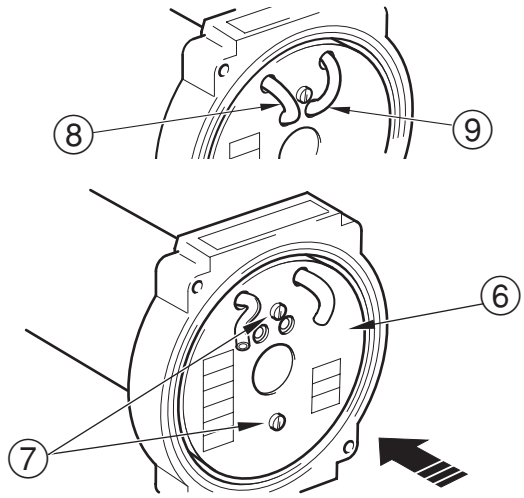



**Fig. 4.4 Refitting the Connections Cover and Air Tubes**

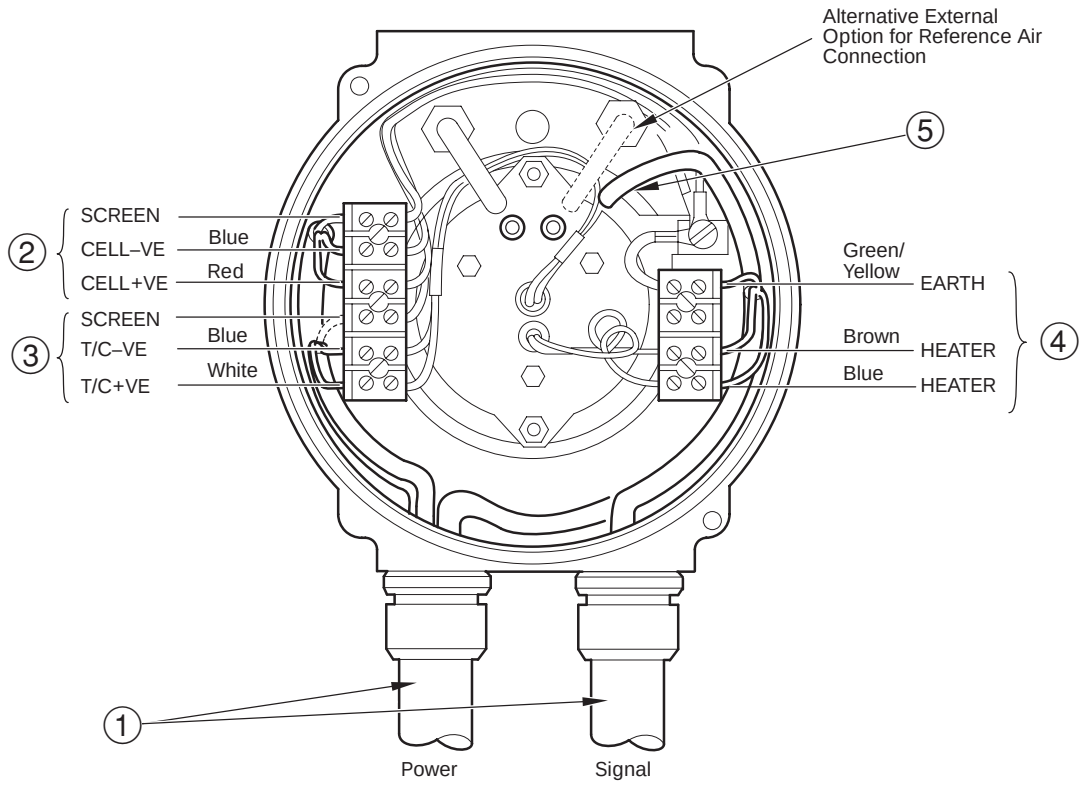



**Fig. 4.3 Probe Connections, Double Conduit**

## …4 CONNECTIONS

### 4.3 Pipe Connections – Fig. 4.5

The compression fittings on the back of the probe head have a $^1/_4$in olive as standard. 6mm olives are supplied in the accessory kit, if required – see Section 2.2.

### 4.3.1 External Reference Air Connection – Fig. 4.5

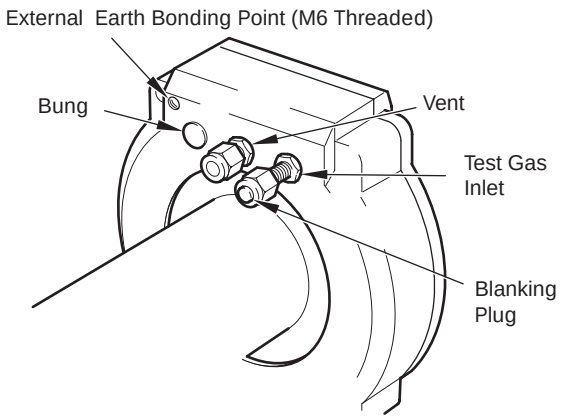
A clean, dry, oil-free air supply is required, e.g. from a pump or regulator unit (see page 30). Connect the reference air tubing as shown in Fig. 4.5. For internal reference air connection (enclosed in probe conduit) refer to Section 4.2.2, step 5 on the previous page.

### 4.3.2 Vent Connection – Fig. 4.5

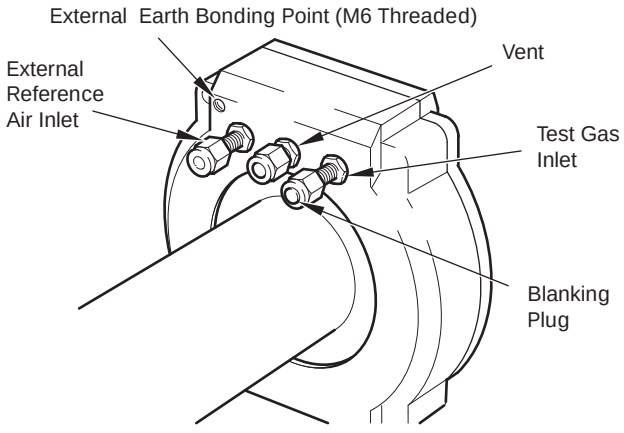
The vent outlet allows the reference air to escape to atmosphere. If the outlet is likely to be exposed to moisture, a suitable vent tube must be connected to the outlet and routed to a dry area – see Fig. 4.5. Ensure that the vent outlet, or the vent tube, does not become blocked during probe use.

### 4.3.3 Test Gas Connection – Fig. 4.5

A test gas inlet is provided for in situ probe testing using a test gas. A test gas connector kit is supplied in the accessory kit. Refer to Section 7.1 for test gas use.




**A – Internal Reference Air**




**B – External Reference Air**

**Fig. 4.5 Air Connections**

# 5 OPERATION

### 5.1 Preparation – Fig. 4.5

a) Check that a blanking plug is securely fitted to the test gas connector on the probe – see Fig. 4.5.

✶ **Note.** If the blanking plug is not fitted, air leaking into the probe via the connector may cause measurement errors. In a pressurised flue, gases venting to atmosphere through the connector could cause corrosion of the test gas tube. In a negative pressure flue, air leakage may cause high $O_2$ reading errors.

b) Check the connections on both the probe and the electronics unit (refer also to the ZMT Operating Instructions IM/ZMT).

c) Adjust the reference air flow to a stable flow rate between 100 and 1,000cc/min.

# 6 CALIBRATION

Full gas calibration procedures for the system are detailed in Section 13 of the ZMT Operating Instructions (IM/ZMT).

✶ **Note.** Important - test gas air flows for all ZFG2 probes must be set to 3,000cc/min. (±10%) or measurement errors may occur.

| Ambient Temp. (°C) | Millivolts | Ambient Temp. (°C) | Millivolts |
|---|---|---|---|
| 50 | 27.106 | 25 | 28.128 |
| 49 | 27.147 | 24 | 28.168 |
| 48 | 27.188 | 23 | 28.209 |
| 47 | 27.229 | 22 | 28.249 |
| 46 | 27.27 | 21 | 28.29 |
| 45 | 27.311 | 20 | 28.33 |
| 44 | 27.352 | 19 | 28.37 |
| 43 | 27.394 | 18 | 28.41 |
| 42 | 27.435 | 17 | 28.451 |
| 41 | 27.476 | 16 | 28.491 |
| 40 | 27.527 | 15 | 28.531 |
| 39 | 27.558 | 14 | 28.571 |
| 38 | 27.599 | 13 | 28.611 |
| 37 | 27.639 | 12 | 28.651 |
| 36 | 27.68 | 11 | 28.691 |
| 35 | 27.721 | 10 | 28.731 |
| 34 | 27.762 | 9 | 28.771 |
| 33 | 28.803 | 8 | 28.811 |
| 32 | 28.843 | 7 | 28.851 |
| 31 | 28.884 | 6 | 28.89 |
| 30 | 27.925 | 5 | 28.93 |
| 29 | 27.966 | 4 | 28.97 |
| 28 | 28.006 | 3 | 29.009 |
| 27 | 28.047 | 2 | 29.049 |
| 26 | 28.087 | 1 | 29.089 |
| | | 0 | 29.128 |

**Table 7.1 Thermocouple v. Ambient Temperature for a Probe Temperature of 700°C**

System fault finding procedures are detailed in the ZMT Operating Instructions (part no. IM/ZMT). Where a fault is traced to the probe, it may be possible to identify and rectify the fault. After any rectification, the system must be recalibrated as detailed in IM/ZMT to maintain the stated accuracies.

### 7.1 In Situ Probe Testing – Fig. 4.5

Equipment required:

Digital Multimeter (10MΩ input impedance on mV ranges),
Earth continuity tester,
Zero test gas (within the range 10 to 21% $O_2$ in $N_2$),
Span test gas (within the range 1 to 10% $O_2$ in $N_2$).

Ensure that the flue temperature is within the limits 20 to 600°C and allow a 30 minute warm-up period for the instrument.

a) Remove the blanking plug from the test gas inlet and fit the pipe, nut and olive from the connector kit to the inlet – see Fig. 4.5.

b) Connect the test gas using flexible tubing to suit the outside diameter of the pipe (6mm or 1/4in i.d.).

c) Apply the test gas at a rate of 3 litres per minute and allow 5 minutes for the instrument reading to settle.

If the analyser response is normal when measuring test gas but sluggish and insensitive when measuring flue gas, replace the ceramic filter as described in Section 8.2 overleaf.

✶ **Note**. Check that the air supply tube has not become disconnected inside the probe head – see Sections 4.2.1 and 4.2.2.

If correct test gas response cannot be obtained, measure the cell output voltage detailed in steps d) and e).

d) With the test gas connected remove the leads to the 'Input' terminals on the ZMT Unit and connect the digital multimeter (0 to 200mV range) directly across the leads.

e) The measured voltage should correspond generally to the oxygen volume percentage for the test gas used – see Fig. 1.2 on page 3. Slight differences result if the probe's cell constant is not zero mV.

If there is a difference of more than ±5mV between the measured cell output voltage and the graph, check the probe heater temperature by measuring the thermocouple voltage as described in steps f) and g).

f) Use either a mercury or digital type thermometer to measure the ambient temperature at the terminals marked 'Probe T/C' on the electronics unit – see Section 5.4.1 in the Z-MT operating instructions IM/ZMT.

g) Measure the voltage across the 'Probe T/C' terminals on the electronics unit.

Table 7.1 gives the voltages which should be present at the 'Probe T/C' terminals (step g), according to the temperature measured at step f), when the probe has stabilised at 700°C.

If the thermocouple voltage is correct, remove the probe from the flue and replace the cell and/or the electrode lead assembly – see Sections 8.3 and 8.6 (0.4m probes) or 8.10 (other probes).

If there is no thermocouple voltage proceed to step h).

If the thermocouple voltage is low proceed to step i).

If the thermocouple voltage is high, relocate the probe to a position where the flue temperature is 600°C or lower.

h) Disconnect the thermocouple leads from the 'TC' terminals and check the thermocouple for open- or short-circuit.

✶ **Note**. A short circuit usually indicates a wiring fault rather than a faulty thermocouple.

If the thermocouple appears to be faulty the thermocouple/electrode lead assembly must be replaced as described in Section 8.6 (0.4m probes) or 8.10 (other probes). If the thermocouple appears to be in order continue from step i).

i) Switch off the a.c. supply, disconnect the heater 'H' leads from their terminals on the Z-MT Unit, and measure the resistance across these leads at the probe terminal head and at the cable ends.

The correct heater resistance is 28 to 31Ω for 0.4m probes and 26 to 29Ω for 1.0m, 1.5m and 2.0m probes.

If the resistance is incorrect, check the heater wiring and, if necessary, replace the heater assembly as described in Section 8.8 (0.4m probes) or 8.13 (other probes).

### 7.2 Bench Testing

When the fault has been rectified, the probe should be bench tested before fitting into the flue.

a) Connect the probe heater and thermocouple cables to the electronics unit.

b) Connect the reference air supply tube

c) Connect a d.v.m. directly across the cell output leads after removing them from the 'PROBE CELL' terminals on the ZMT Unit.

Allow the probe to operate in air for about 20 minutes in order to achieve temperature stability.

Periodically check the reading on the d.v.m. after the initial temperature stabilising time has expired.

The reading should settle at the cell constant of typically 0V ±2mV for a new cell.

When the cell attains its constant (typically after 1 hour), apply a test gas and measure the cell output as described in Section 7.1, steps and a) to d). Otherwise, the tests detailed in Section 7.1 should be carried out whilst the probe is still on the bench.

✶ **Note**. The cell can take up to three hours to settle fully at its constant.

If the cell responds correctly to the test gas the probe can be refitted into the flue. For full probe calibration details refer to IM/ZMT.

# 8 DISMANTLING AND REASSEMBLY

Before dismantling the probe, thoroughly clean the outer surfaces with non-abrasive materials to prevent contamination of the inner assemblies.

### 8.1 Tools Required

M3 open ended spanner,
M4 open ended spanner (supplied),
0 to 5Nm torque driver fitted with a hexagon (Allen) M4, wrench, or alternatively, M4 Allen key,
Small, flat-bladed (terminal) screwdriver,
Medium, flat-bladed screwdriver.

### 8.2 Renewing the Ceramic Filter (all Probes) – Fig. 8.1

① Remove the two socket-head screws retaining the filter clamping plate and remove the plate and gaskets.

② Remove the filter, and the gasket(s) between the filter and the cell mount. Discard the old filter.

When reassembling, insert a sufficient number of gaskets to allow the securing screws to hold the filter firmly in position.

✶ **Note.** There must be at least two gaskets on the cell side of the filter and at least one on the end plate side. The central hole in the filter gaskets is enlarged to allow free flow of test gas past the gaskets. Ensure that the gaskets are positioned concentric with the filter to prevent any test gas flow restriction.

Tighten the screws evenly to a torque of 2Nm.

⚠ **Caution.** Over-tightening of the screws can cause the filter to break at the probe's working temperature.

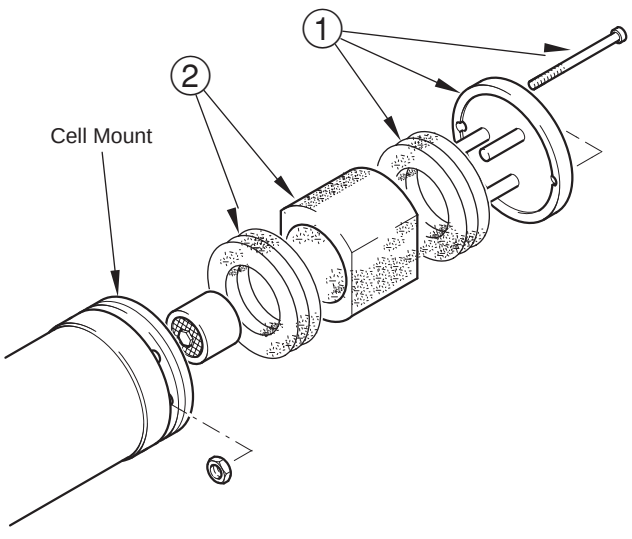



**Fig. 8.1 Replacing the Ceramic Filter**

### 8.3 Removing the Zirconia Cell (all Probes) – Fig. 8.2

Remove the filter as described in Section 8.2.

① Carefully withdraw the flame arrester, if fitted, from the cell mount.

② Remove the four socket-head screws from the flange on the cell mount.

✶ **Note.** The four screws are secured by nuts located in a groove at the end of the probe body. If the bolts have corroded and are difficult to release, the nuts must be removed carefully with a hacksaw.

③ **Gently** ease the cell and mount from the probe body without excessive twisting (2 to 3mm max.).

⚠ **Caution.** During prolonged service the cell tip may become welded to the helical contact on the end of the thermocouple/electrode lead assembly and thus prevent removal of the cell. If resistance is felt when removing the cell mount, once all of the spring movement is taken up, do not try to force removal or the inner electrode may be damaged. Re-insert the cell mount and refer to Appendix A1.

### 8.4 Fitting the Zirconia Cell (all Probes) – Fig. 8.3

① Examine the contact on the inner electrode insulator. The connection should appear as a flat helix, supported centrally on the insulator, when viewed through the hole at the end of the probe body.

② Thoroughly clean the end of the probe body, in particular the 'O' ring recess and the central hole, using dry lint-free cloth only. Unless the 'O' ring is scratched or damaged, do not attempt to remove it for cleaning.

✶ **Note.** If the probe is used in temperatures exceeding 400°C it is recommended that a new 'O' ring is fitted.

If the replacement cell/cell mount is scratched, unclean or damaged it must not be used or the flame arresting properties of the probe may be suspect.

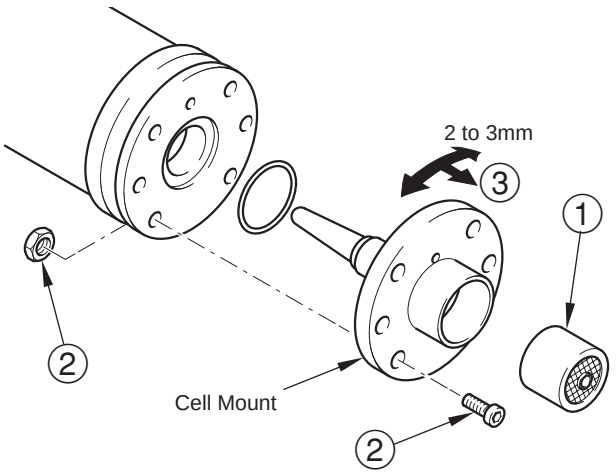



**Fig. 8.2 Removing the Zirconia Cell**

③ Align the blind hole in the cell mount with the small counterbored hole in the end of the probe body. If the holes are not correctly aligned, the in situ test gas facility cannot be used.

④ **Gently** lead the cell into the cell body until the spring resistance from the internal electrode is felt. If there is some difficulty in locating the cell, do not force it as it may be obstructed by the heater. Use self-adhesive tape to temporarily hold the cell mount in place.

If the heater is obstructing cell insertion, re-align the heater assembly as detailed in step ⑤ in Section 8.15.

Referring to Fig. 8.3:

⑤ Refit the four socket head bolts and tighten to a torque of 4Nm.

⑥ Replace the flame arrester (if applicable) with the female thread outermost.

Refit the ceramic filter as described in Section 8.2 opposite.

### 8.5 Removing the Inner Assembly (all Probes) – Fig. 8.4

a) Remove the ceramic filter as described in Section 8.2 opposite.

b) Remove the zirconia cell as detailed in Section 8.3 opposite.

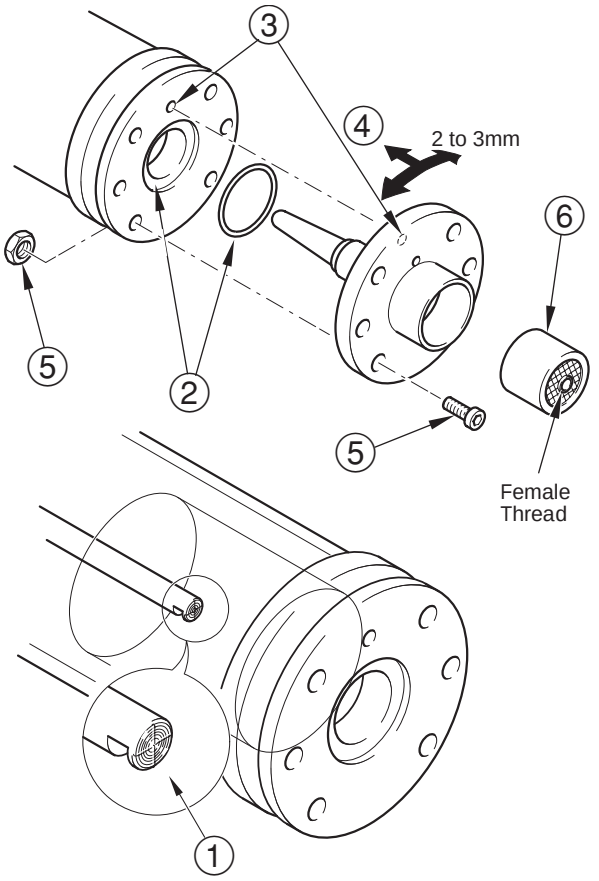



**Fig. 8.3 Fitting the Zirconia Cell**

c) Gain access to the probe terminals as detailed in Section 4.2.1 on page 10.

Referring to Fig. 8.4:

① Disconnect the heater leads (translucent insulation on 0.4m probes or brown and blue on 1.0m, 1.5m and 2.0m probes).

② Disconnect the thermocouple and electrode leads (red, blue and white insulation).

③ Remove the two M4 pillars and shakeproof washers securing the inner assembly and retain.

④ Carefully withdraw the inner assembly from the probe body.

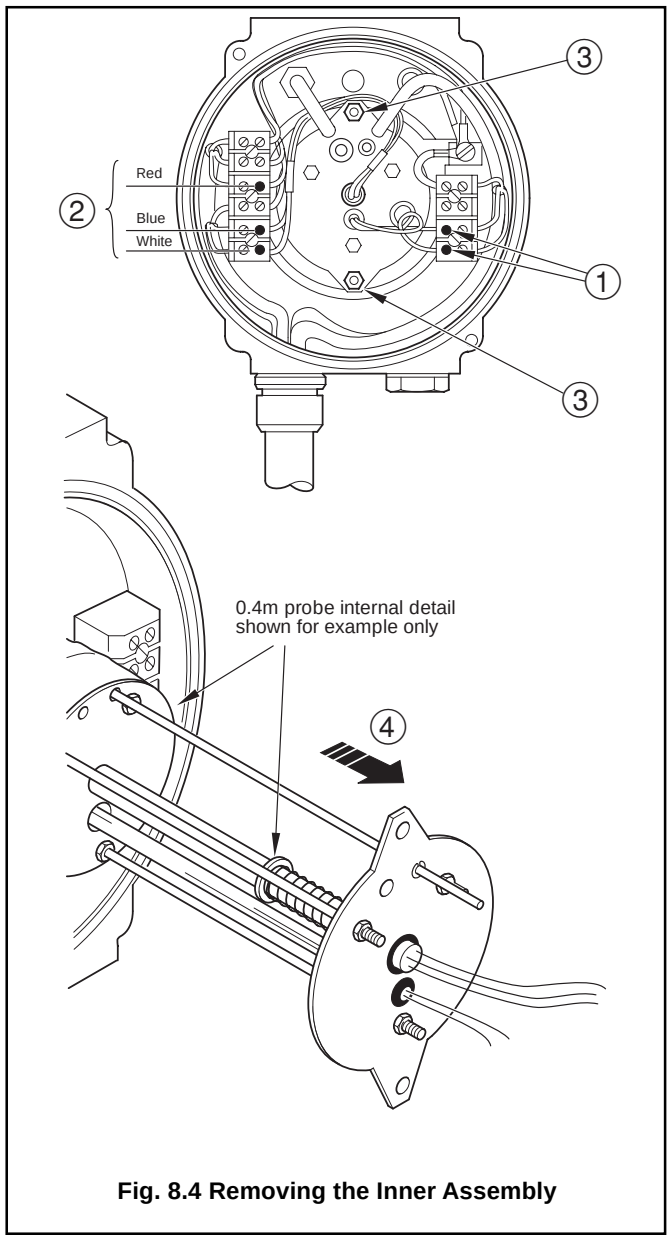
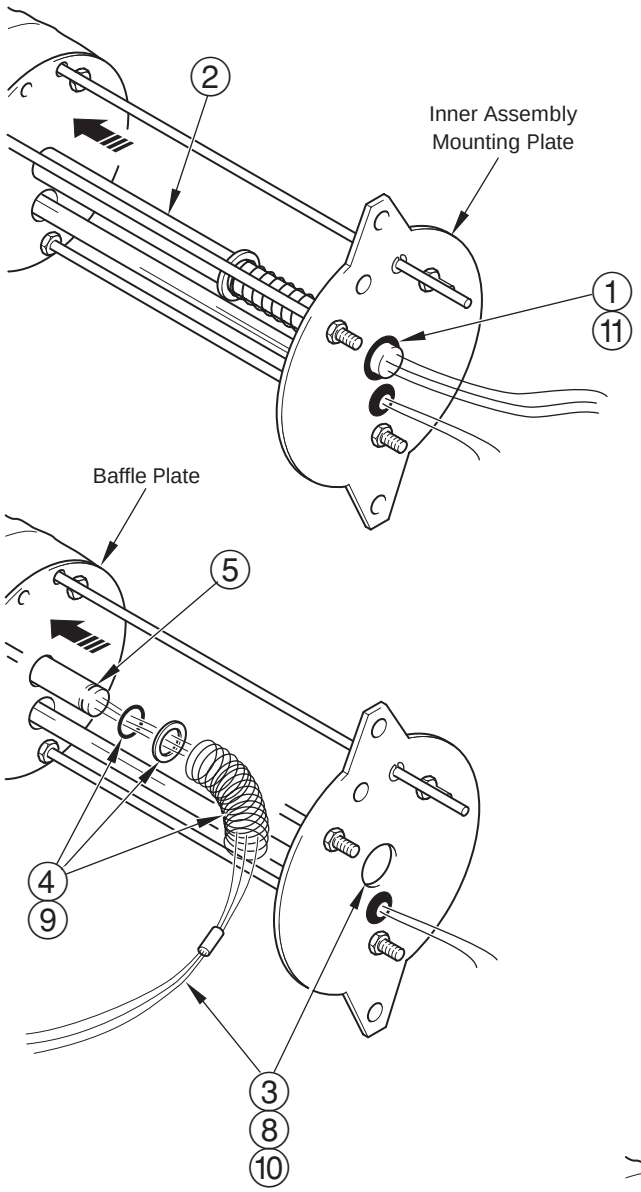
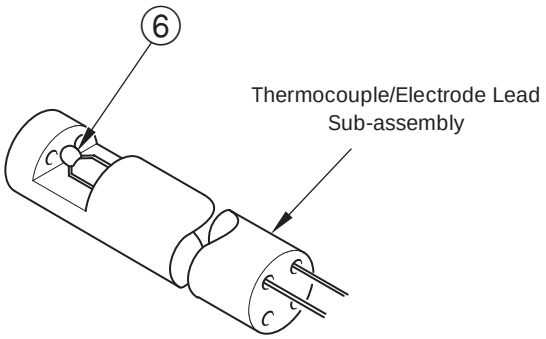



**Fig. 8.4 Removing the Inner Assembly**



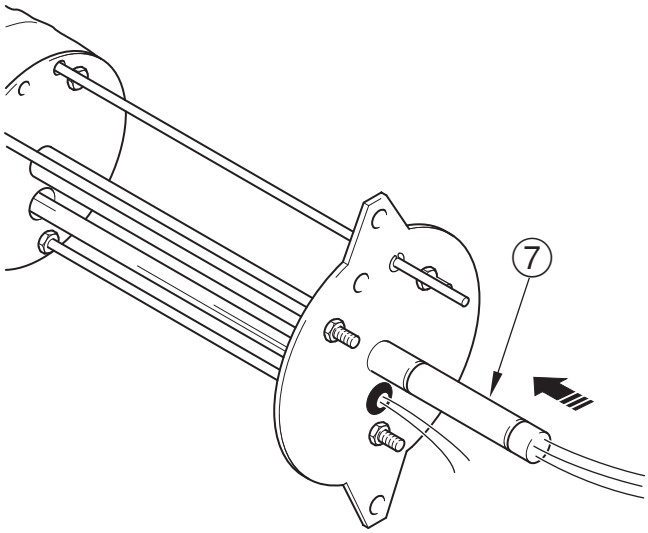




**Fig. 8.5 Replacing the Thermocouple/Electrode Lead Assembly**

### 8.6 Removing the Thermocouple/Electrode Lead Assembly (0.4m Probes) – Fig. 8.5

Remove the inner assembly as detailed in Section 8.5.

> ⚠ **Caution.** The thermocouple/electrode lead assembly is fragile. Take extreme care not to damage the assembly during dismantling and reassembly.

Referring to Fig. 8.5:

① Remove the rubber 'O' ring from the electrode insulator and allow the thermocouple/electrode assembly to slide through the inner assembly mounting plate under spring pressure.

② Slide the thermocouple/electrode lead assembly towards the heater.

③ Pull the electrode leads through the mounting plate (from the underside of the plate).

④ Remove the spring, washer and rubber 'O' ring from electrode assembly and retain.

⑤ Slide the thermocouple/electrode lead assembly through the baffle plates and withdraw from the heater end.

### 8.7 Fitting the Thermocouple/Electrode Lead Assembly (0.4m Probes) – Fig. 8.5

⑥ Check that the thermocouple bead is located at the **electrode end** of its cut-out, i.e. butted up against the end of the cut-out.

⑦ Slide the thermocouple/electrode lead assembly through the central holes in the mounting plate, baffle plates and heater.

⑧ Pull the electrode leads through the mounting plate (from the underside of the plate).

⑨ Thread the rubber 'O' ring, washer and spring over the lead ends and onto the thermocouple/electrode lead assembly (locate the 'O' ring in the second groove on the assembly).

**Caution.** Take care not to break the ceramic insulator (nearest the head) when fitting the rubber 'O' ring.

⑩ Thread the electrode leads back through the central hole in the mounting plate.

⑪ Slide the thermocouple/electrode lead assembly through the mounting plate, against the spring pressure, and secure with the rubber 'O' ring. Do not pull on the wires as this may disturb the location of the thermocouple bead (see step ⑥), resulting in low $O_2$ readings.

**Caution.** Take care not to break the ceramic insulator (nearest the head) when fitting the rubber 'O' ring.

## 8.8 Replacing the Heater Assembly (0.4m Probes) – Fig. 8.6

Remove the inner assembly as detailed in Section 8.5.

Referring to Fig. 8.6:

① Remove the three 6BA screws securing the heater assembly to its carrier assembly.

② Withdraw the heater assembly by pulling the ceramic insulators through the baffle plates.

③ Fit the new heater assembly, carefully guiding the heater leads and insulators through the baffle plates and ensuring that the clear hole in the heater aligns with the slot in the heater mounting plate.

④ Thread the heater leads through the grommet in the mounting plate.

⑤ Ensure that the three support rods are correctly located in the recesses on the heater mounting plate.

⑥ Secure the heater with the three 6BA screws.

The length of the inner assembly must be adjusted to suit the new heater assembly as detailed in Section 8.9 overleaf.

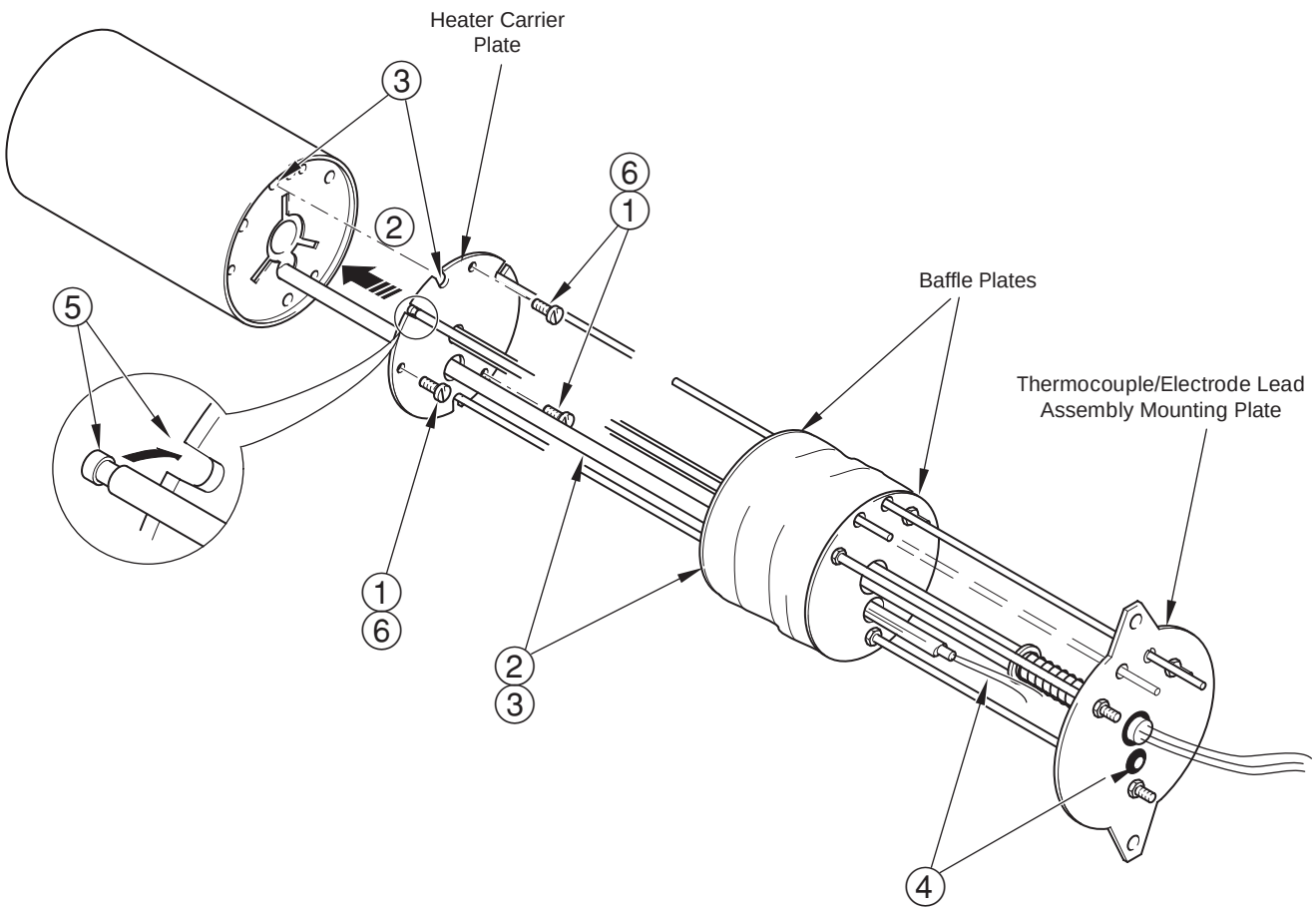



**Fig. 8.6 Replacing the Heater Assembly, 0.4m Probes**

### 8.9 Adjusting the Length of the Inner Assembly (all Probes) – Fig 8.7

If the heater assembly has been replaced it is necessary to adjust the length of the inner assembly to suit the new heater.

Referring to Fig. 8.7a:

① Slacken the three M3 nuts on the top of the mounting plate.

② Screw the three M3 nuts on the underside of the plate to the bottom of the thread on the extension rods.

③ Locate the test gas tube in the clear hole in the heater assembly and insert the inner assembly into the probe body, carefully guiding the test gas tube through the heater, baffle plates and mounting plate.

**Caution.** The inner assembly should slide freely into the probe; do not force it.

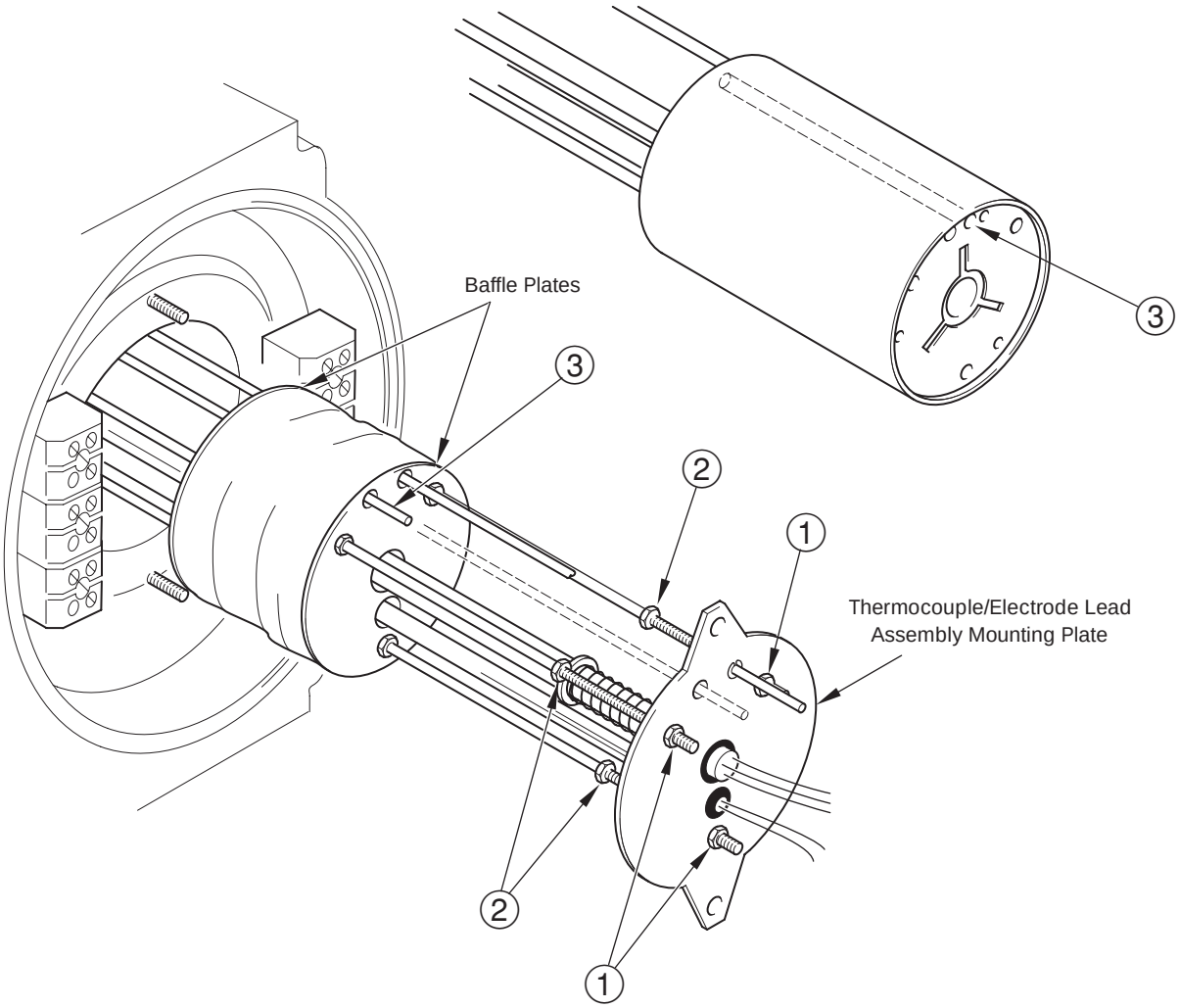



**Fig. 8.7a Adjusting the Length of the Inner Assembly**

Referring to Fig. 8.7b:

④ Locate the mounting plate over the studs inside the head.

> **Caution.** Ensure that the inner assembly is aligned correctly with the test gas tube, i.e. not twisted through 180°.

⑤ Firmly press the end of one support rod to push the inner assembly and heater against the end of the probe body.

⑥ Tighten the three M3 nuts on the top of the support rods until they **just** touch the mounting plate. Release the nuts by two turns.

⑦ Slide the complete inner assembly out of the probe body to gain access to the three M3 nuts on the underside of the mounting plate.

⑧ Tighten the underside nuts onto the mounting plate, ensuring that the nuts on the other side are not disturbed.

⑨ Re-insert the inner assembly into the probe body and secure with the two M4 pillars and shakeproof washers (finger tight only).

If the procedure has been carried out correctly, there should be between 1.0mm and 1.5mm clearance between the mounting plate and the head casting.

⑩ Ensure that the end of the test gas tube is clear of fibre.

Align the heater assembly as detailed in steps 5 and 6 in Section 8.15 on page 24.

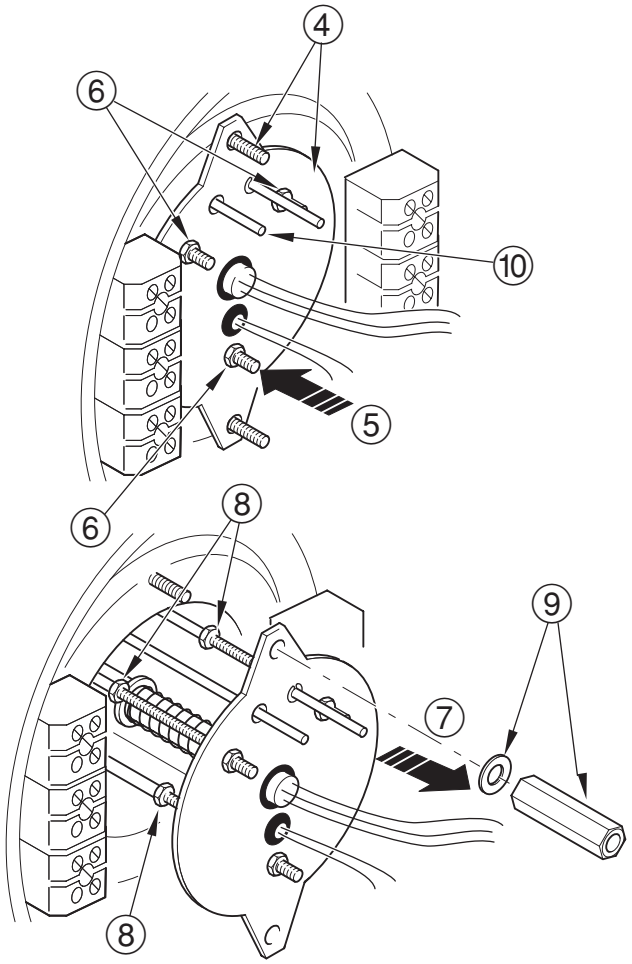



**Fig. 8.7b Aligning the Heater Assembly, 0.4m Probes**

### 8.10 Removing the Thermocouple/Electrode Lead Assembly (1.0m, 1.5m and 2.0m Probes)

The procedure is as for the 0.4m probe (Section 8.6, page 16), noting the following:

a) At step ④, remove **two** springs and M6 washers.

⚠ **Caution.** When carrying out step ⑤ the ceramic insulators joints may snag on the baffle plates; take care not to damage the insulators since they are not supplied with a replacement thermocouple/electrode lead sub-assembly – see Section 8.12 opposite.

### 8.11 Re-assembling the Thermocouple/Electrode Lead Components (1.0m, 1.5m and 2.0m Probes) – Figs. 8.8 to 8.10

A replacement assembly comprises the following:

1 thermocouple/electrode lead sub-assembly
3 lengths of PTFE sleeving (red, white and blue)
2 lengths of rubber sleeving (black)
2 springs
2 M6 washers
2 rubber 'O' rings.

Referring to Fig. 8.8:

① Cut through the electrode wires on the old thermocouple/electrode lead sub-assembly, close to the ceramic insulator nearest the head end of the probe.

② Remove and retain the plain ceramic insulators from the wires:

1.0m probes – two insulators
1.5m probes – three insulators
2.0m probes – four insulators.

Discard the old thermocouple/electrode lead sub-assembly. Lay the thermocouple/electrode lead sub-assembly at the end of a long work surface and carefully uncoil the extension wires, one at a time.

⚠ **Caution.** Take extreme care not to kink the wires as this may render the finished assembly unusable.

✶ **Note.** To temporarily retain the uncoiled lead ends when refitting the ceramic insulators it is recommended that a simple clamping block is constructed using bulldog clips – see Fig. 8.9.

Referring to Fig. 8.10:

③ Thread the ceramic insulators, one at a time, onto the extension wires ensuring that each wire is located in the correct bore.

Do not attempt to thread more than half the insulator length onto a wire at any one time.

④ Ensure that the leads do not cross between insulators and that the insulators butt together correctly at the joints.

Wind a single turn of thin self-adhesive tape around each joint to prevent it snagging when refitting the thermocouple/electrode lead assembly.

⑤ Slide 250mm of PTFE sleeving onto the wire ends and into the ceramic insulator until 200mm protrudes. Ensure that the correct colour sleeving is used.

⑥ Use a magnet to check that the insulators and PTFE sleeves have been threaded onto the correct wires; the thermocouple –ve lead should be attracted by the magnet.

Cut the wires to length leaving approximately 10mm bare and then thread on the two **rubber** sleeves.

⚠ **Caution.** Do not pull excessively on the wires or the thermocouple and/or the electrode contact may be dislodged.

⑦ Check that the thermocouple bead is located at the **electrode end** of its cut-out i.e. butted-up against the end of the cut-out.

✶ **Note.** If the bead is not correctly located, low Oxygen readings may result.

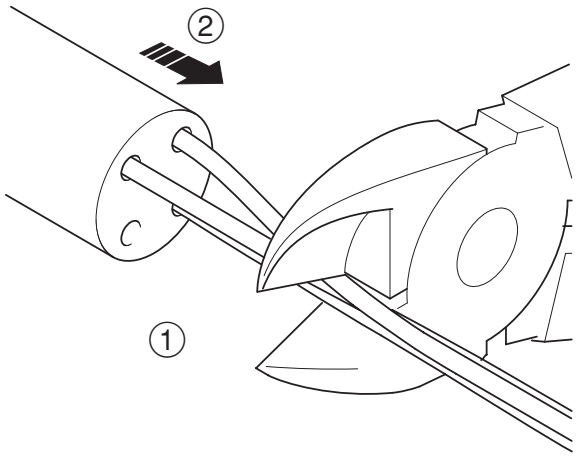



**Fig. 8.8 Removing the Ceramic Insulators (1.0m, 1.5m and 2.0m Probes)**

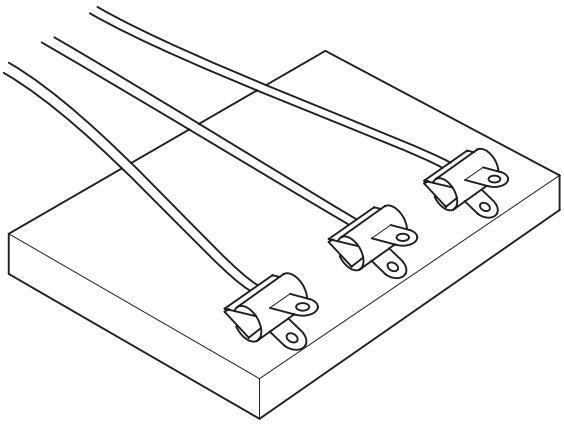


**Fig. 8.9 Clamping Block Recommendation for Retaining the Electrode Wires**

### 8.12 Fitting the Thermocouple/Electrode Lead Assembly (1.0m, 1.5m and 2.0m Probes) – Fig. 8.11

Lay the inner assembly and thermocouple/electrode lead assembly end to end on a clean flat surface, with the electrode contact facing the mounting plate.

Refit the thermocouple/electrode lead assembly as detailed in Section 8.7, page 16 but note also the following details:

a) remove the self-adhesive tape from the ceramic insulator joints after carrying out step ⑥

b) there are **two** springs and **two** washers to be fitted at step ⑧.

**Caution.** Take care not to break the head end four-bore ceramic insulator when refitting its retaining 'O' ring (step ⑩).

Refer to Fig. 8.11 to check the finished assembly.

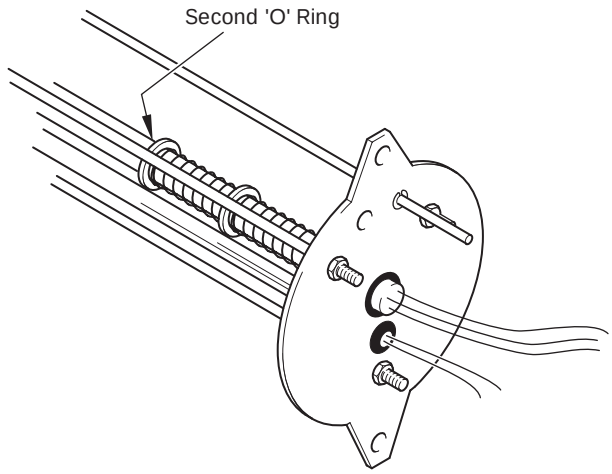



**Fig. 8.11 Thermocouple/Electrode Lead Final Assembly (1.0m, 1.5m and 2.0m Probes)**

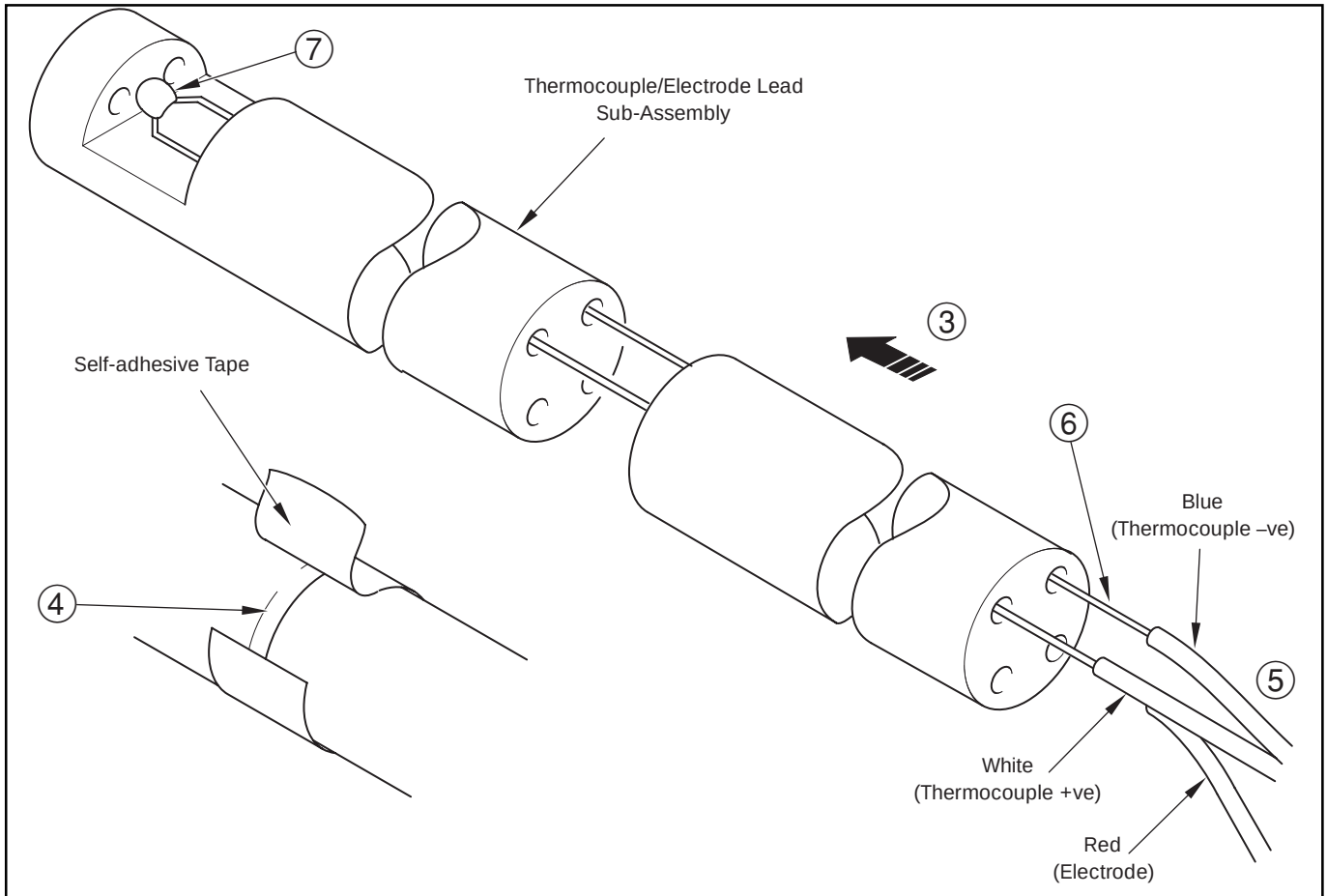



**Fig. 8.10 Re-assembling the Thermocouple/Electrode Lead Components (1.0m, 1.5m and 2.0m Probes)**

### 8.13 Replacing the Heater Assembly (1.0m, 1.5m and 2.0m Probes) – Fig. 8.12

Remove the inner assembly as detailed in Section 8.5.

① Identify the connection plate.

② Remove the two M4 nuts retaining the stranded heater leads and remove the leads and four M4 washers (one either side of the cable leads). Do not disturb any of the other nuts.

**Caution.** Take care not to stress the ceramic connection plate.

③ Remove the three 6BA screws retaining the heater to its carrier plate. (A replacement heater assembly is supplied with new screws).

④ Remove the heater assembly, carefully withdrawing the attached leads and ceramic insulator through the connection plate. Retain the ceramic insulator for refitting to the new heater assembly.

Check the connection plate for any cracks or fractures. If the plate is damaged it must be replaced as detailed in Section 8.14.

⑤ Thread the stranded leads on the new heater assembly through the ceramic insulator.

⑥ Ensure that the three support rods are correctly located in the recesses in the heater mounting plate and the offset (heater ceramic) hole aligns with the corresponding holes in the connection plate and baffle plates.

⑦ Carefully guide the heater leads/ceramic insulator through the offset hole in the heater mounting plate and the connections plate.

⑧ Secure the heater assembly to its mounting plate with the three new 6BA screws.

Ensure that the M4 nuts retaining the solid heater extension leads are tight.

⑨ Replace the two M4 washers over the termination bolts and refit the heater leads. Replace the remaining two M4 washers and secure with the two M4 nuts.

**Caution.** Ensure that the heater leads are routed as shown in Fig. 8.14 to prevent them shorting and/or interfering with the spring-loaded operation of the thermocouple/electrode lead assembly. Leave sufficient slack in the heater leads must to allow for expansion at the probe's operating temperature.

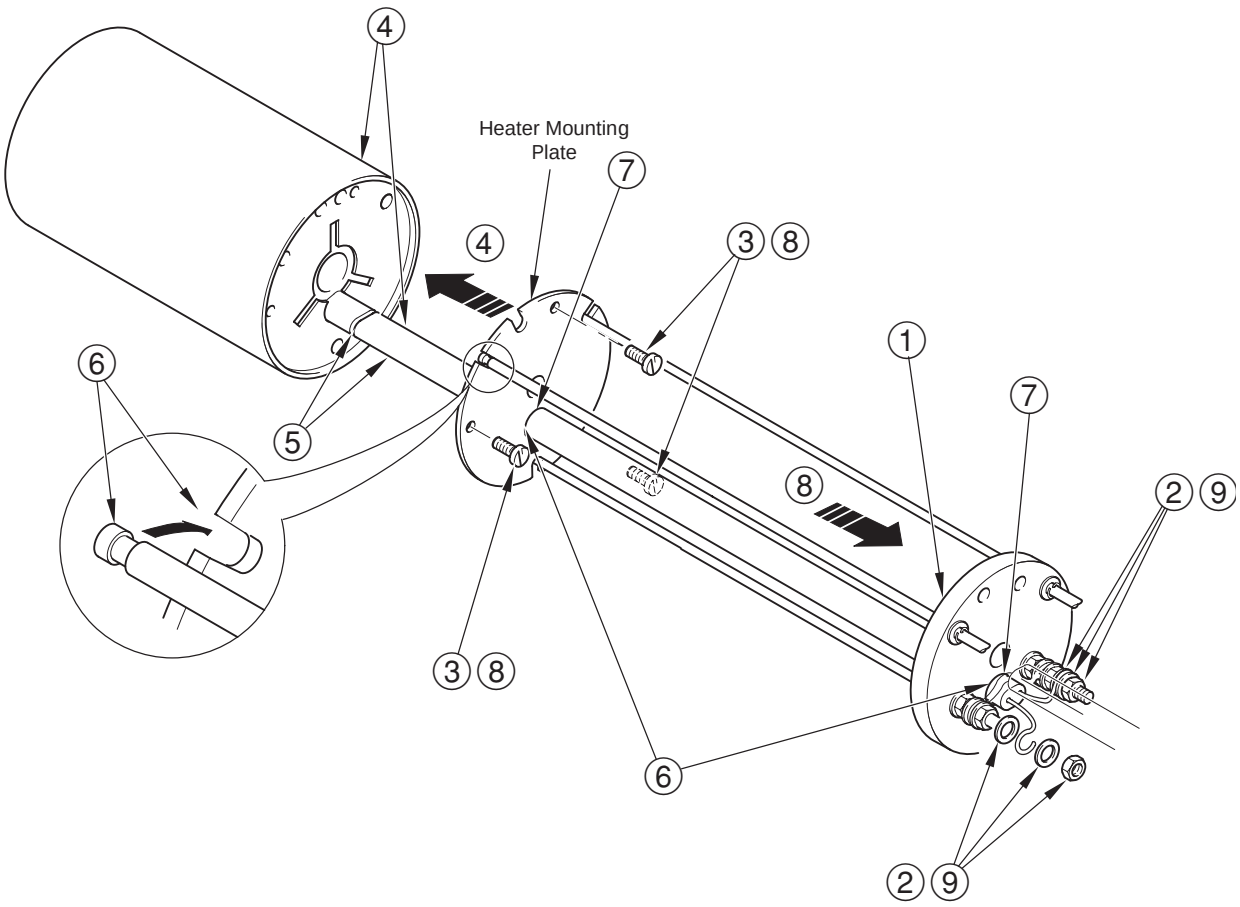



**Fig. 8.12 Replacing the Heater Assembly (1.0m, 1.5m and 2.0m Probes)**

### 8.14 Replacing the Connection Plate (1.0m, 1.5m and 2.0m Probes) – Fig. 8.13

Remove the heater assembly as detailed in Section 8.13, steps ① to ④.

① Remove the two M4 nuts retaining the solid heater extension wires and remove the wires and four M4 washers.

② Remove the three stainless steel wire twists from the extension rods (heater side of the connection plate) and retain.

③ Disengage the extension rods from the heater mounting plate.

④ Slide the connection plate off the extension rods taking care not to lose the six M3 washers on the rods.

⑤ Remove the two M4 nuts retaining the terminal bolts to the connection plate and remove the bolts, spacers and four M4 washers.

To fit a new connection plate, reverse the above procedure. Ensure that all connections are tight.

**Caution.** When refitting the bolts onto the new connection plate, (reversing step ⑤) they should move freely once tightened against the spacers. Do not attempt to over tighten the retaining nuts to grip the connection plate.

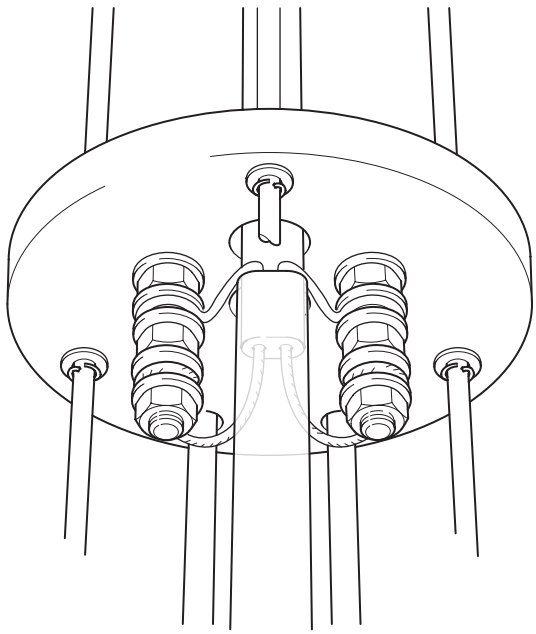


**Fig. 8.14 Connection Plate Final Assembly (1.0m, 1.5m and 2.0m Probes)**

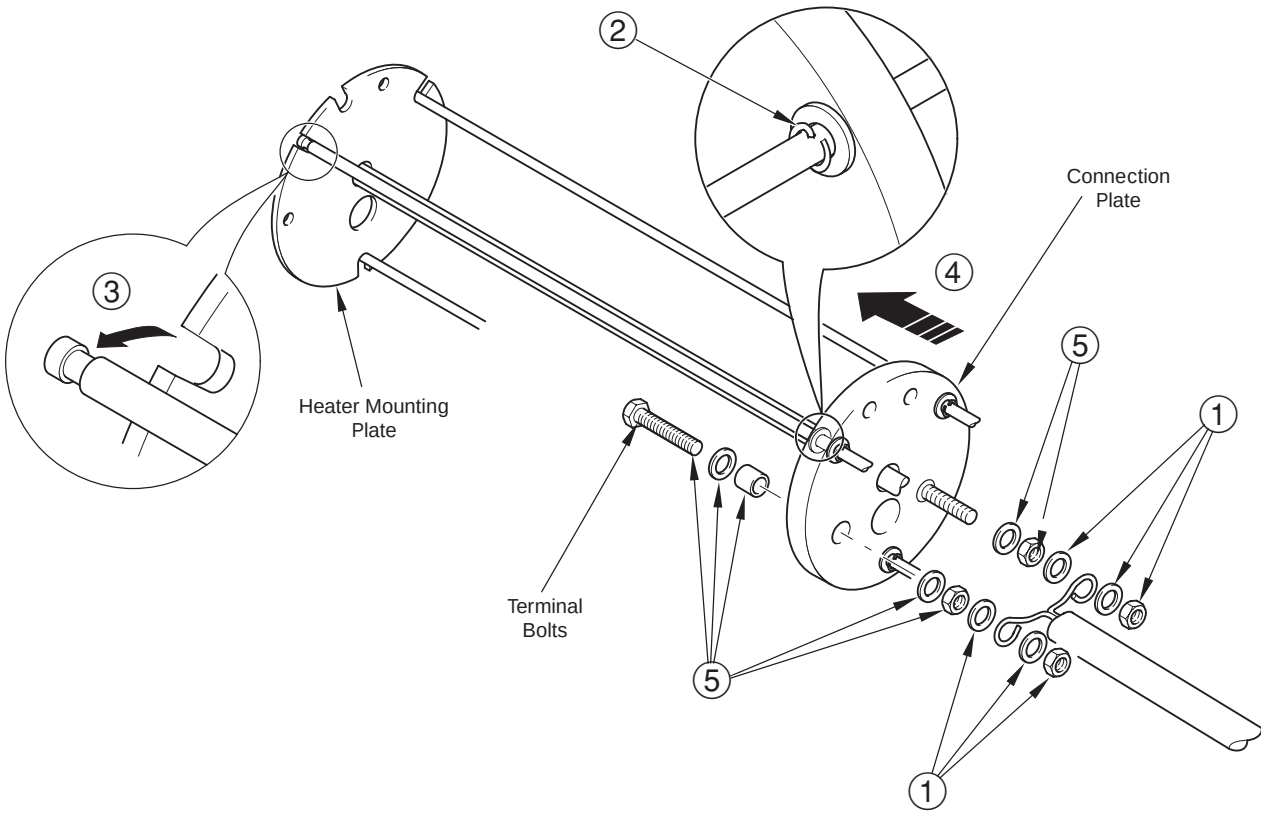



**Fig. 8.13 Replacing the Connection Plate (1.0m, 1.5m and 2.0m Probes)**

### 8.15 Refitting the Inner Assembly and Aligning the Heater (all Probes) – Figs. 8.15 and 8.16

**Caution.** Do not attempt to refit the inner assembly into the probe body with the cell in place.

With reference to Fig. 8.15:

① Locate the test gas tube in the clear hole in the heater assembly and insert the inner assembly into the probe body, carefully guiding the test gas tube through the heater, baffle plates and mounting plate.

**Caution.** Ensure that the inner assembly is aligned correctly with the test gas tube, i.e. not twisted through 180°.

② Locate the mounting plate over the studs inside the head.

③ Ensure that the end of the reference air tube is clear of fibre.

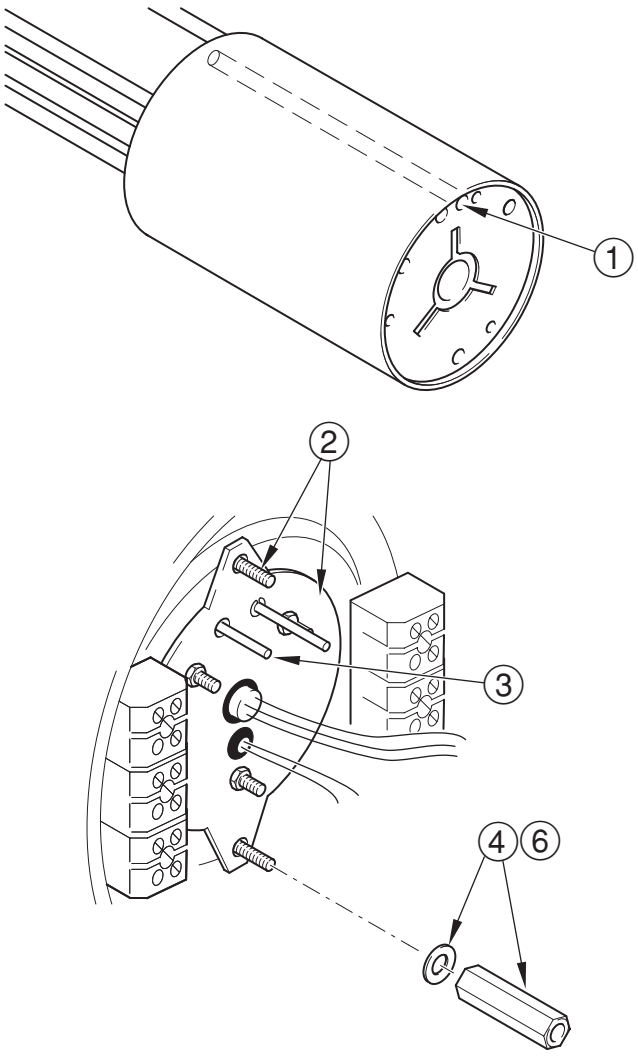



**Fig. 8.15 Refitting the Inner Assembly**

④ Secure the inner assembly with the two M4 pillars and shakeproof washers (finger tight only).

With reference to Fig. 8.16:

⑤ Align the heater bore concentric with the cell insertion bore in the end of the probe using a pencil or similar round tool.

**Caution.** Take extreme care not to damage the helical contact on the end of the thermocouple/electrode lead assembly.

Refit the cell as detailed in steps ① to ④ in Section 8.4.

With reference to Fig. 8.15:

⑥ Fully tighten the M4 pillars.

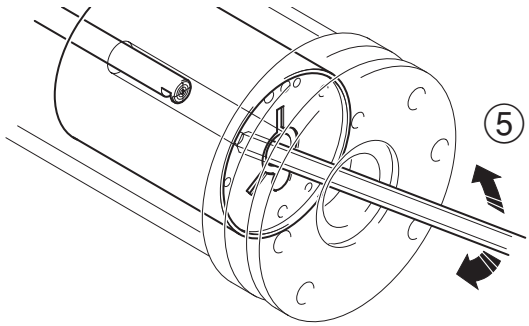



**Fig. 8.16 Aligning the Heater Assembly**

**General**

| | |
|---|---|
| Flue temperature | 20 to 600°C. |
| Heater temperature | 700°C ± 3°C (973°K). |
| Pressure | Suitable for all normal positive or negative flue pressures. |

**Electrical Data**

| | |
|---|---|
| Cell constant | 0V±2mV. |
| Cell output load | >10MΩ. |
| Heater rating: | |
| 0.4m probe | <100VA at 50 to 55V a.c. |
| 1.0m, 1.5m and 2.0m probes | <120VA at 50 to 55V a.c. |
| Heater resistance: | |
| 0.4m probe | 28 to 31Ω. |
| 1.0m, 1.5m and 2.0m probes | 26 to 29Ω. |
| Thermocouple | NiCr/NiAl (BS4937 Part 4 Type K). |
| External earth bonding | 6mm female thread – see Fig. 4.5 on page 12 |

**Mechanical Data**

| | |
|---|---|
| Mounting: | |
| 0.4m probe | Flange or 2½in N.P.T. screwed bush (see Figs. 3.3, 3.5 and 10.1). |
| 1.0m/2.0m probes | Flange (see Figs 3.4 and 10.2 ). |
| Overall length: | |
| 0.4m probe | 0.590m. |
| 1.0m probe | 1.410m. |
| 1.5m probe | 1.910m. |
| 2.0m probe | 2.410m. |
| Insertion length | |
| 0.4m probe | 0.4m. |
| 1.0m probe | 1.0m. |
| 1.5m probe | 1.5m. |
| 2.0m probe | 2.0m. |
| Head dimensions | 150 x 152mm. |
| Clearance for removal | Overall length plus 25mm. |
| Conduit length | 6m or 10m (standard). |
| Conduit type | Standard or optional IP65 rated. |
| Weight: | |
| 0.4m probe | 6.8kg |
| 1.0m probe | 10.3kg |
| 1.5m probe | 11.7kg |
| 2.0m probe | 13.1kg |

Including one 6m conduit.

**Test Gas Facility**

| | |
|---|---|
| Type | In situ (checks may be made with probe installed in operational flue duct). |
| Connections | ¼ in or 6mm o.d. compression fitting (both olive sizes supplied).<br>¼ in o.d. copper stub pipe also supplied. |
| Gas ratio (between test gas $O_2$ and the sample gas surrounding the probe) | ≤20:1. |
| Test gas flow requirement | 3,000cc/min. ±10%. |

**Reference Air**

| | |
|---|---|
| Reference air flow | Any stable flow in the range 100 to 1,000cc/min. |

**Environmental Data**

| | |
|---|---|
| Probe head | IP65 rated. |
| Standard conduit | Intermittent wetting permitted (providing the conduit(s) hang downwards). |
| IP65 conduit | Once installed in a dry flue duct, all exposed parts of the probe have full IP65 protection. |

# 10 SPARES LIST

## 10.1 0.4m Probe Spares

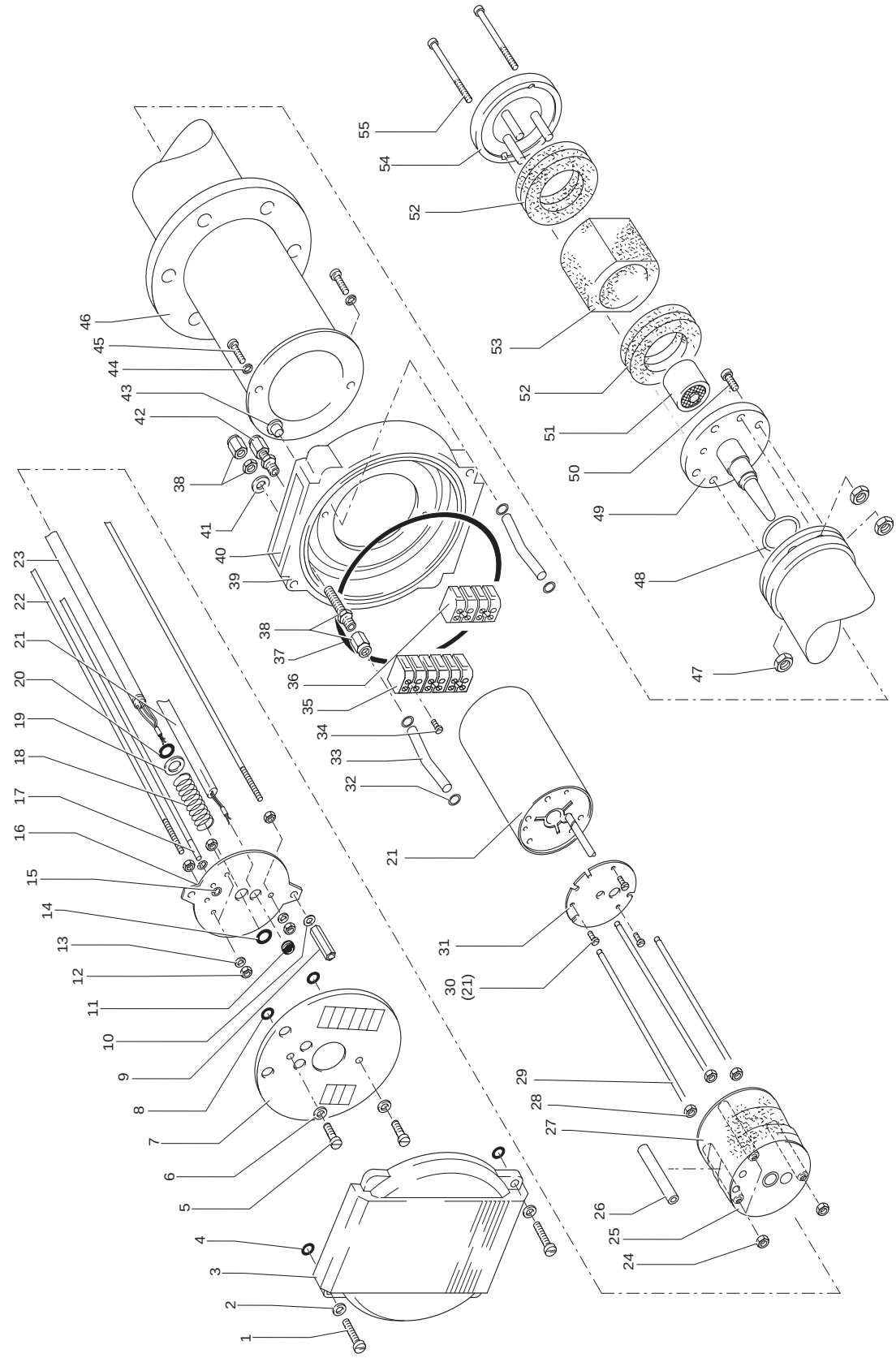



**Fig. 10.1 Identification of Parts – 0.4m Probes**

| Ref. | Item | Part. No. |
|---|---|---|
| 1 | M4 x 20 cheesehead screw | J/0227/681 |
| 2 | M4 plain washer | B7298 |
| 3 | Head cover | ZFG2/0120 |
| 4 | 'O' ring | J/0211/001 |
| 5 | M4 x 8 panhead screw | B5700 |
| 6 | M4 plain washer | B7298 |
| 7 | Connections cover | ZFG2/0131 |
| 8 | 'O' ring | J/0211/001 |
| 9 | M4 pillar | B10740 |
| 10 | M4 shakeproof washer | B7503 |
| 11 | Grommet | B10722 |
| 12 | M3 full nut | B7067 |
| 13 | M3 shakeproof washer | B6421 |
| 14 | 'O' ring | B10093 |
| 15 | 'E' clip | B10744 |
| 16 | Inner assembly mounting plate | ZFG2/0160 |
| 17 | Reference air pipe | ZFG2/0184 |
| 18 | Spring | B10723 |
| 19 | M6 plain washer | B9283 |
| 20 | 'O' ring | B10093 |
| 21 | Complete heater assembly comprising:<br>Heater<br>Heater ceramic insulator<br>Head end heater ceramic insulator<br>6BA x 1/4in cheesehead screws<br>Clear sleeving<br>Black rubber sleeving<br>Clear heatshrink sleeving | ZFG2/0035 |
| 22 | Extension rods (head) | ZFG2/0149 |
| 23 | Complete thermocouple/electrode lead assembly | ZFG2/0036 |
| 24 | M3 full nut | B7067 |
| 25 | Baffle plate | ZFG2/0156 |
| 26 | Pillars | ZFG2/0162 |
| 27 | Ceramic fibre baffle | ZFG2/0164 |
| 28 | M3 full nut | B7067 |
| 29 | Extension rods (heater) | ZFG2/0153 |

| Ref. | Item | Part. No. |
|---|---|---|
| 30 | 6BA x 1/4in screw | 002018219 |
| 31 | Heater mounting plate | ZFG2/0158 |
| 32 | 'O' ring | B10093 |
| 33 | Tubing | 2336BX201006 |
| 34 | M3 x 16 cheesehead screw | B6417 |
| 35 | 6-way terminal block | B9255 |
| 36 | 4-way terminal block | B9254 |
| 37 | Sealing ring | ZFG2/0147 |
| 38 | Union assembly (including coupling nut, olive & blanking plug) | B10721 |
| | Nipple | B10719 |
| 39 | Head base : 20mm conduit entries | ZFG2/0118 |
| | 1/2in NPT conduit entries | ZFG2/0119 |
| 40 | Serial number plate | 003000091 |
| | 1/8in self-tapping screw | B6220 |
| 41 | M10 plain washer | B10717 |
| 42 | Male adaptor union | B10720 |
| 43 | Blanking plug | B10734 |
| 44 | M4 locking washer | B7503 |
| 45 | M4 x 16 socket head screw | B7295 |
| 46 | Probe body: Standard flange | ZFG2/0195 |
| | ANSI flange | ZFG2/0196 |
| | JIS flange | ZFG2/0197 |
| | DIN | ZFG2/0198 |
| | Model 132 | ZFG2/0199 |
| 47 | M4 full nut | B8690 |
| 48 | Stainless steel 'O' ring | 002310036 |
| 49 | Cell assembly | 003000105 |
| 50 | M4 x 10 socket head screw | B9760 |
| 51 | Flame arrester | 003000087 |
| 52 | Filter gasket | 003000094 |
| 53 | Ceramic filter | 003000345 |
| 54 | Filter clamp assembly | 003000346 |
| 55 | M4 x 58 socket head screw | 002101115 |

**Spares List for 0.4m Probes – Fig. 10.1**

## 10.1 1.0m, 1.5m and 2.0m Probe Spares

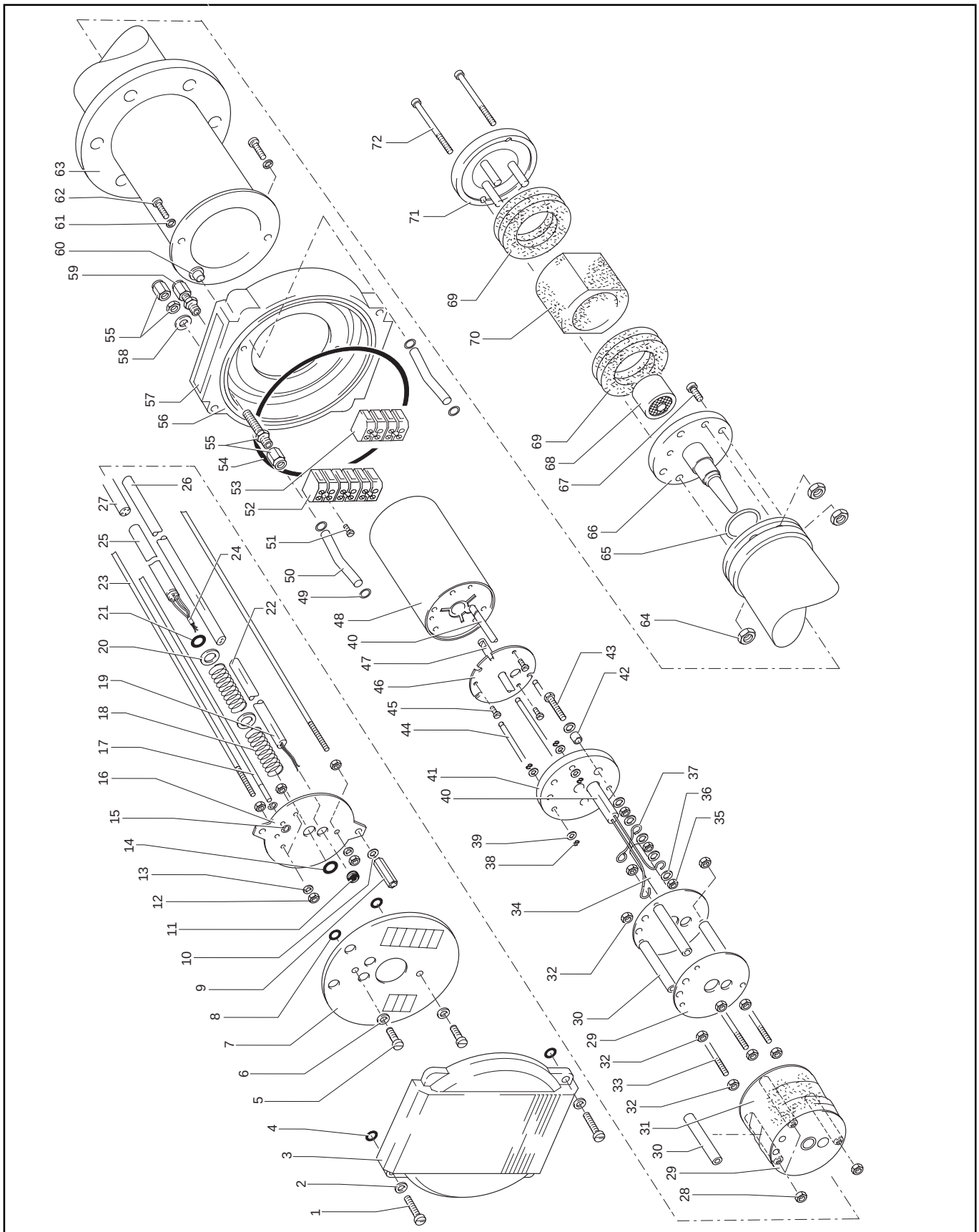



**Fig. 10.2 Identification of Parts – 1.0m, 1.5m and 2.0m Probes**

| Ref. | Item | Part. No. |
|---|---|---|
| 1 | M4 x 20 cheesehead screw | J/0227/681 |
| 2 | M4 plain washer | B7298 |
| 3 | Head cover | ZFG2/0120 |
| 4 | 'O' ring | J/0211/001 |
| 5 | M4 x 8 panhead screw | B5700 |
| 6 | M4 plain washer | B7298 |
| 7 | Connections cover | ZFG2/0131 |
| 8 | 'O' ring | J/0211/001 |
| 9 | Pillar | B10740 |
| 10 | M4 shakeproof washer | B7503 |
| 11 | Grommet | B10722 |
| 12 | M3 full nut | B7067 |
| 13 | M3 shakeproof washer | B6421 |
| 14 | 'O' ring B10093 | |
| 15 | 'E' clip B10744 | |
| 16 | Inner assembly mounting plate | ZFG2/0160 |
| 17 | Reference air pipe: | |
| | 1m probes | ZFG2/0185 |
| | 1.5m probes | ZFG2/0186 |
| | 2m probes | ZFG2/0187 |
| 18 | Spring | B10723 |
| 19 | Heater wires: | |
| | Brown | B2409 |
| | Blue | B2410 |
| | Heat shrink | J/0212/239 |
| 20 | M6 plain washer | B9283 |
| 21 | 'O' ring B10093 | |
| 22 | Head end heater insulator | ZFG2/0166 |
| 23 | Head extension rods | ZFG2/0150 |
| 24 | Insulation and sleeving: | |
| | Blue insulation | 002410034 |
| | White insulation | 002410033 |
| | Red insulation | 002410032 |
| | Rubber sleeving | B738 |
| 25 | Head end thermocouple insulator | ZFG2/0168 |
| 26 | Heater extension insulator | RMV331 |
| 27 | Thermocouple extension insulator | RMV332 |
| 28 | M3 full nut | B7067 |
| 29 | Baffle plate | ZFG2/0156 |
| 30 | Pillar | ZFG2/0162 |
| 31 | Ceramic fibre baffle | ZFG2/0164 |
| 32 | M3 full nut | B7067 |
| 33 | Extension support rods | ZFG2/0152 |
| 34 | Heater ceramic insulators | RMV333 |
| 35 | M4 full nut | B8690 |
| 36 | M4 plain washer | B7298 |
| 37 | 1.6mm dia. nickel wire (heater extension) | 001351006 |
| 38 | Nichrome wire | YBM0774 |
| 39 | M3 plain washer | STR7143 |
| 40 | 2-bore ceramic tube | 001730010 |
| 41 | Ceramic connections plate | ZFG2/0128 |
| 42 | Spacer ZFG2/0129 | |
| 43 | M4 x 20 hexagon head screw | B10727 |
| 44 | Heater end support rods | ZFG2/0151 |
| 45 | 6BA x 1/4in screw | 002018219 |
| 46 | Heater mounting plate | ZFG2/0158 |
| 47 | Thermocouple/electrode lead sub-assembly | ZFG2/0037 |
| 48 | Heater assembly | ZFG2/0038 |
| 49 | 'O' ring B10093 | |
| 50 | Tubing | 2336BX 201006 |
| 51 | M3 x 16 cheesehead screw | B6417 |
| 52 | 6-way terminal block | B9255 |
| 53 | 4-way terminal block | B9254 |
| 54 | Sealing ring | ZFG2/0147 |
| 55 | Union assembly | B10721 |
| | Nipple | B10719 |
| 56 | Head base: | |
| | 20mm conduit entries | ZFG2/0118 |
| | $^1/_2$in NPT conduit entries | ZFG2/0119 |
| 57 | Serial number plate | 003000091 |
| | $^1/_8$in self-tapping screw | B6220 |
| 58 | M10 plain washer | B10717 |
| 59 | Male adaptor union | B10720 |
| 60 | Blanking plug | B10734 |
| 61 | M4 locking washer | B7503 |
| 62 | M4 x 16 socket head screw | B7295 |
| 63 | 1m probe body: | |
| | Standard flange | ZFG2/0200 |
| | ANSI flange | ZFG2/0203 |
| | JIS flange | ZFG2/0201 |
| | DINZFG2/0202 | |
| | 1.5m probe body: | |
| | Standard flange | ZFG2/0205 |
| | ANSI flange | ZFG2/0208 |
| | JIS flange | ZFG2/0206 |
| | DINZFG2/0207 | |
| | 2m probe body: | |
| | Standard flange | ZFG2/0210 |
| | ANSI flange | ZFG2/0213 |
| | JIS flange | ZFG2/0211 |
| | DINZFG2/0212 | |
| 64 | M4 full nut | B8690 |
| 65 | Stainless steel 'O' ring | 002310036 |
| 66 | Cell assembly | 003000105 |
| 67 | M4 x 10 socket head screw | B9760 |
| 68 | Flame arrester | 003000087 |
| 69 | Filter gasket | 003000094 |
| 70 | Ceramic filter | 003000345 |
| 71 | Filter clamp assembly | 003000346 |
| 72 | M4 x 58 socket head screw | 002101115 |

**Spares List for 1.0m, 1.5m and 2.0m Probes – Fig. 10.2**

### 10.3 Conduit Assemblies

#### 10.3.1 Single Entry (Ref. Fig. 4.2 on page 10)

Standard 6m ..... 003000166
Standard 10m ..... ZFG2/0060

IP65 6m ..... ZFG2/0066
IP65 10m ..... ZFG2/0066

Coupling (including lock nut) ..... B10728
M20 plain washer ..... YZ2291
M20 threaded bung ..... STT1826

#### 10.3.2 Double Entry (Ref. Fig. 4.3 on page 11)

Standard 6m (Power) ..... ZFG2/0061
Standard 6m (Signal) ..... ZFG2/0062

Standard 10m (Power) ..... ZFG2/0063
Standard 10m (Signal) ..... ZFG2/0064

IP65 6m (Power) ..... ZFG2/0067
IP65 6m (Signal) ..... ZFG2/0068

IP65 10m (Power) ..... ZFG2/0069
IP65 10m (Signal) ..... ZFG2/0070

Coupling (including lock nut) ..... B10728
M20 plain washer ..... YZ2291
M20 threaded bung ..... STT1826

### 10.4 Pump and Regulator Units for External Reference Air Supply

Mains-powered pump unit ..... 003000240
Flow regulator unit ..... 003000241

### A1 Removing a Welded Cell – Fig. A1.1

During prolonged service the cell tip may become welded to the helical contact on the end of the thermocouple/electrode lead assembly and thus prevent removal of the cell.

To free the cell, the thermocouple/electrode lead assembly must be released as detailed in this section to allow it to slide out of the probe with the cell.

Carry out Section 4.2.1 on page 10 to gain access to the inside of the head.

With reference to Fig. A1.1:

① Slide the rubber 'O' ring off the electrode insulator and allow the electrode assembly to slide through its mounting plate under spring pressure.

> ✶ **Note.** Slide the 'O' ring a sufficient distance along the leads to prevent it passing through the mounting plate.

Temporarily replace the head cover to prevent damage to the released thermocouple/electrode lead assembly.

② Lay the probe on its side and gently ease the cell mount out of the probe end until approximately 10mm of the thermocouple/electrode lead assembly is visible.

> ⚠ **Caution.** If the thermocouple/electrode lead assembly cannot be easily withdrawn it is possible that one of the ceramic insulator joints has caught on a baffle plate – see Fig. 8.6. If necessary, gently tap the probe body to free the joint.

③ Use a scalpel or similar tool to **carefully** separate the cell tip from the helical contact on the end of the inner electrode.

> ⚠ **Caution.** Take great care not to damage the helical contact; the contact is an integral part of the thermocouple/electrode lead assembly which can only be replaced as a complete unit.

a) To relocate the thermocouple/electrode lead assembly remove the inner assembly (steps ① to ④ in Section 8.5) and then carry out step ⑧ in Section 8.7.

b) Refit the inner assembly as detailed in Section 8.15.

c) Fit a new cell as detailed in Section 8.4.

d) Fit the ceramic filter as detailed in Section 8.2.

e) Reconnect the cell, thermocouple and heater leads by reversing steps ① and ② in Section 8.5

f) Reassemble the head by reversing the steps detailed in Section 4.2.1.

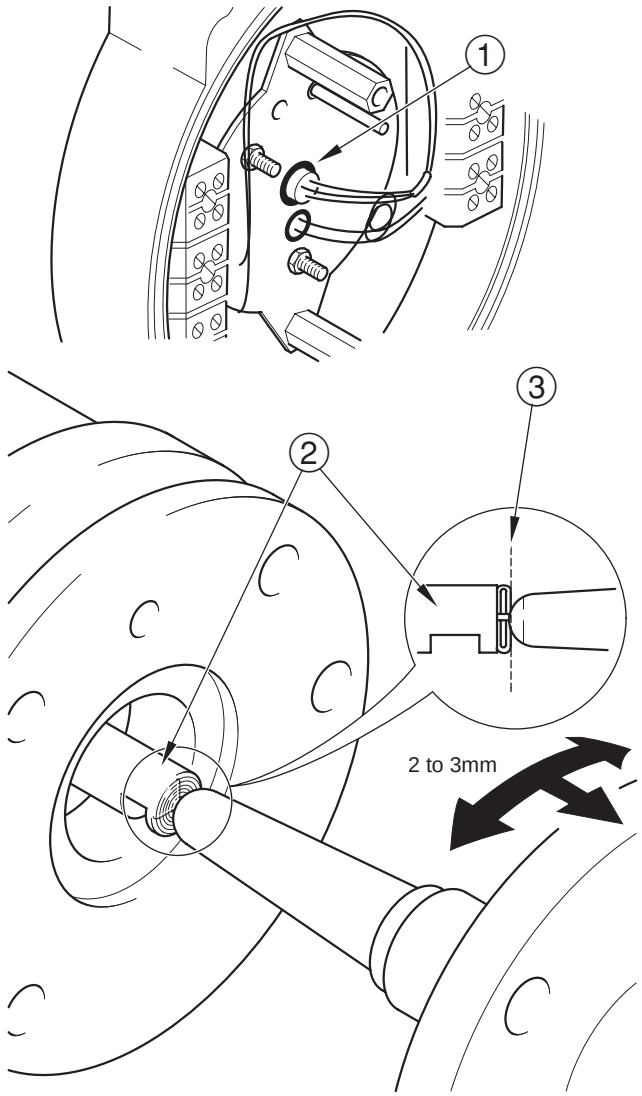



**Fig. A1.1 Releasing the Thermocouple/Electrode Lead Assembly**

## A2 Flow Through Sample Chamber (0.4m Probes)

A sample chamber may be fitted to the end of a 0.4m Z-FG probe for dry analysis of flue gases – see Fig. A2.1. The sample gas must be pre-conditioned (clean and dry) as for use with infrared analysers for emissions monitoring. The sample flow rate must not exceed 1 litre/minute.

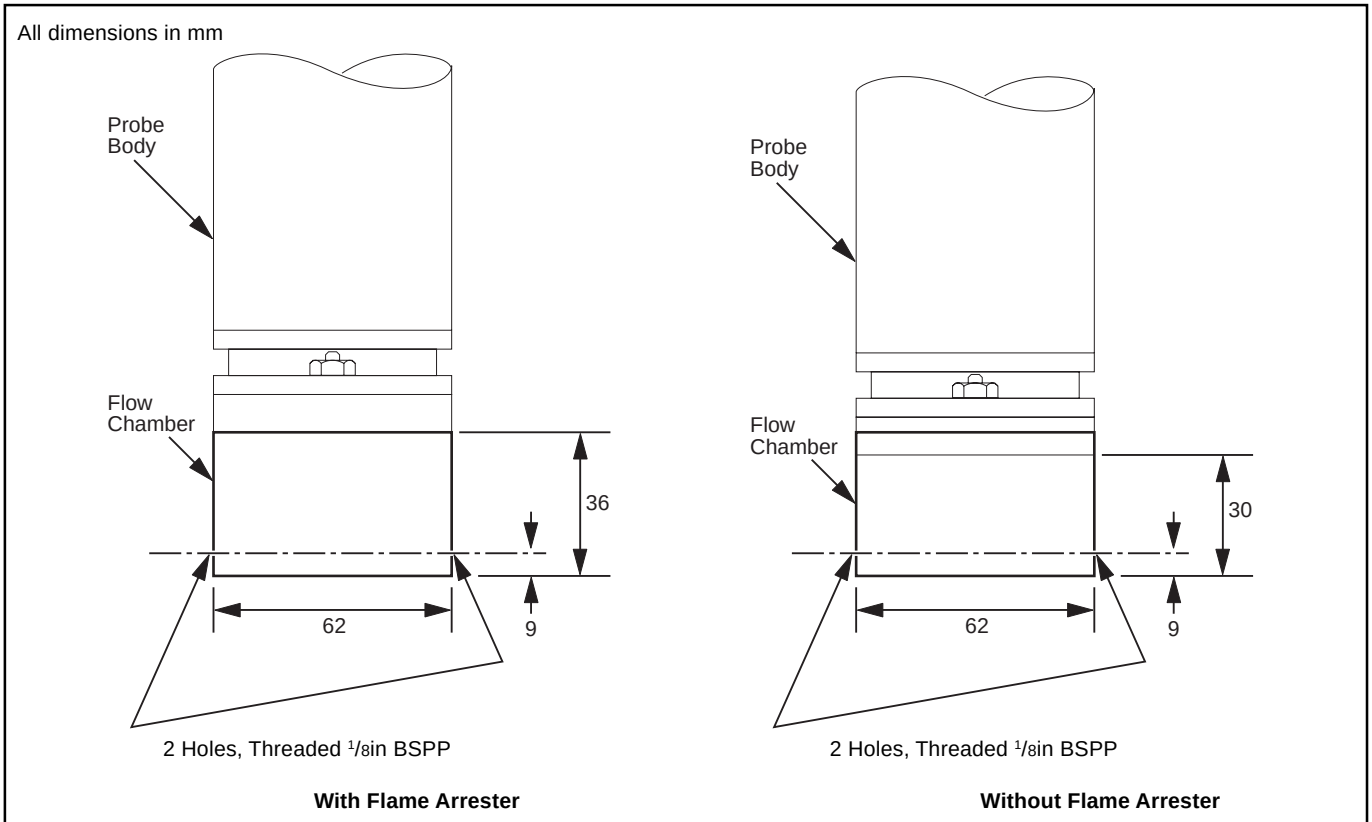



**Fig.A2.1 Sample Chamber Details for 0.4m Probes**

## A3 Probe Checking Using the Nernst Equation

The Nernst equation can be used for more accurate checking of the cell output than can be determined from the graph shown in Fig. 1.2 on page 3. The equation is used to calculate the theoretical cell output for a given certified test gas, as follows:

$$\mathbf{EmV = 0.0496\ T\ (\log_{10} \frac{P_0}{P_1}) \pm CmV}$$

Where:

| | | |
|---|---|---|
| 0.0496 | = | gas constant |
| T | = | absolute temperature (937°K) |
| $P_0$ | = | reference $O_2$ partial pressure (21%) |
| $P_1$ | = | measured $O_2$ partial pressure (% test gas) |
| C | = | cell constant (typically ±1mV for a new cell) |

**Example 1.**
For a certified test gas of 20.95%$O_2$ (air):

$$EmV = 0.0496 \times 973 (\log_{10} \frac{20.95}{20.95}) \pm CmV$$

$$EmV = 48.2608 (\log_{10} 1) \pm CmV$$

$$EmV = CmV \text{ (cell constant)}$$

This method for calculating the cell constant is used in the Diagnostics Page of the Z-MT electronics unit – see Section 12.3 in IM/ZMT.

**Example 2.**
For a certified test gas of 1%$O_2$:

$$EmV = 0.0496 \times 973 (\log_{10} \frac{20.95}{1.00}) \pm CmV$$

$$EmV = 48.2608 (\log_{10} 20.95) \pm CmV$$

$$EmV = 63.76mV \pm CmV$$

**Example 3.**
For a certified test gas of 10%$O_2$:

$$EmV = 0.0496 \times 973 (\log_{10} \frac{20.95}{10.00}) \pm CmV$$

$$EmV = 48.2608 (\log_{10} 2.095) \pm CmV$$

$$EmV = 15.50mV \pm CmV$$

✶ **Note.** Pure $N_2$, or any other inert gas, cannot be used to calibrate a zirconia system 'gas zero' since this equates to an infinite cell output voltage. A gas with a known value close to zero, e.g. 1% $O_2$ in $N_2$, must be used for this purpose.

# CUSTOMER SUPPORT

## Service, Support and Maintenance

ABB Process Analytics' commitment to quality doesn't end when we deliver our equipment.

We also provide, at the client's request: start-up services, maintenance services, training services, reconditioning, repair and replacement parts services.

Training services are available for virtually every aspect of operating and maintaining ABB Process Analytics analyzers and systems. Training may be arranged on-site or at any of our training centres.

Maintenance services are available on an unscheduled, as needed basis, or by way of long-term, scheduled maintenance agreements.

## Facilities

ABB Process Analytics' primary manufacturing and administrative facility is located in Lewisburg, West Virginia. We also operate sales and service centres in Houston, Texas; Baton Rouge, Louisiana; Sarnia, Ontario; UK; France; Italy; The Netherlands and Singapore. Training centres are located in Lewisburg, Houston and Europe.

For complete information and assistance with ABB Process Analytics analyzers, systems and services, contact any of our facilities for details of your nearest Service and Repair Centre.

**United States**
ABB Process Analytics
843 N. Jefferson Street
Lewisburg, WV 24901
USA
Office: (304)647-4358
FAX: (304)645-4236

**United Kingdom**
ABB Process Analytics Ltd
Howard Road
Eaton Socon, St. Neots
Cambs. UK PE19 3EU
Office: 44-1480-404440
FAX: 44-1480-405775

**Benelux**
ABB Process Analytics BV
Pampuslaan 89
1382 JM Weesp
Netherlands
Office: 31-2944-17291
FAX: 31-2944-13656

**Pacific Rim**
ABB Industry Pte. Ltd.
No. 2 Ayer Rajah Crescent
Singapore 0513
Office: 65-776-5711
FAX: 65-778-0222

**Canada**
ABB Process Analytics
1362 Lambton Mall Road
Unit#18
Sarnia, Ontario N7S 5R6
CANADA
Office: (519)541-0011
FAX: (519)541-0012

**Middle East**
ABB ARESCON
PO Box 2774
Manama, Bahrain
Office: 973-725377
FAX: 973-725332

**France**
ABB Instrumentation
Process Analytics Div
6/8 Rue Peupliers
BP 430-92004 Nanterre
Cedex, France
Office: 33-1-4769-7280
FAX: 33-1-4242-3995

**Italy**
ABB Kent-Taylor SpA
Process Analytics Division
Valle Edison, 50
20099 Sesto S. Giovanni - MI
Italy
Office: 39-2-262321
FAX: 39-2-26232902



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ABB Process Analytics
843 N. Jefferson Street
Lewisburg, WV 24901
USA
Office: (304)647-4358
FAX: (304)645-4236