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REVISION F

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# 1.0 INTRODUCTION

## 1.1 Application and Description

The Fisher & Paykel Dual Servo Controlled Heated Respiratory Humidifiers are used to warm and add humidity to gases delivered to patients requiring mechanical ventilation or positive pressure breathing assistance via an endotracheal tube or face mask.

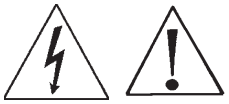
The warmth and moisture are supplied by passing the gas over heated water and the temperature of the gas flowing through the breathing circuit can be maintained by a heater wire.

Temperature is controlled accurately and measured via temperature probes located at the patient end of the delivery tube and at the humidification chamber outlet. The use of two heating systems also provides control over the level of humidity delivered to the patient. The temperature of the gas at the patient Y-piece is selected using the temperature control knob and the actual temperature of the delivered gas is displayed on the 3 digit LED display.

The MR700 must be operated with a heated wire breathing circuit, and is particularly suitable for all neonatal and critical applications. The MR730 and MR720 models provide the option of running the units with the heater wire function turned off. All units feature a standby mode which disables the low temperature alarms and reduces power to the heating systems for a specified period of time. This means that the humidifier may not have to be turned off or disconnected when treatments such as nebulisation are being carried out. While all units may be used with non-flammable anaesthetic agents, the MR720 has been optimised for operation with low flow conditions such as those used in anaesthesia.

## 1.2 Definitions

**Symbols:**

|  |  |  IPX1 | ~ |  UL |   |
|---|---|---|---|---|---|
| Type B<br>Class 1 | ATTENTION:<br>Consult<br>accompanying<br>documents | Drip Proof | Alternating<br>Current | CAUTION<br>Electrical Shock<br>Hazard<br>Refer to qualifed<br>service personnel | CAUTION<br>Hot surfaces<br>may exceed<br>85°C |

**Note, Caution, Warning:**

NOTE: A NOTE provides additional information intended to point out procedures or conditions which may otherwise be misinterpreted or overlooked.

**CAUTION:** A **CAUTION** statement designates the possibility of damage to equipment if a procedure is not followed exactly.

**WARNING:**
* *A WARNING statement refers to conditions with a possibility of personal injury if a procedure is not followed exactly.*

# 2.0 PRODUCT SPECIFICATIONS

**Dimensions:** 135mm x 170mm x 156mm (without chamber fitted)

**Weight:** 2.8 kg (without a chamber fitted)
3.1 kg (with a chamber fitted and filled with water)

**Electrical Rating:**

*Supply Frequency*: 50 - 60 Hz

| | | | |
|---|---|---|---|
| *Supply Voltage*: | 230V ± 25V | *Supply Current*: | 1.0A max at 230V |
| | 127V | | 1.9A max at 127V |
| | 115V | | 2.0A max at 115V |
| | 100V ± 10V | | 2.4A max at 100V |

| | | | |
|---|---|---|---|
| *Heater Plate Capacity*: | 150W | *Heater Wire Capacity*: | 60W |

**Maximum Operating Pressure:** 20kPa

**Temperature Control:**

*Range*: 31 - 40°C (marked)
29 - 40°C (actual)

*Display*: Three digit 14mm 7 segment LED
- Range: 5.0 to 80.0°C
- Accuracy: ±0.3°C (in 25.0 - 40.0°C temperature range)

| | | | |
|---|---|---|---|
| *Alarm Parameters*: | **Heater Wire On** | | |
| | - Airway Temp: | MR700, MR730 | Tracking ± 2°C from set temperature. |
| | | MR720 | Tracking + 2°C, -4°C from set temperature. |
| | | All models | Independent 41°C maximum |
| | - Chamber Temp: | Alarms if chamber temperature varies ±4°C from the set chamber temperature for 20 minutes, or alarms immediately if set chamber temperature is exceeded by 10°C. | |
| | **Heater Wire Off** | | |
| | - Airway Temp: | Fixed alarms at 41°C high, 29.5°C low. | |
| | - Chamber Temp: | Limited to 66°C maximum (visible indicator only). | |
| *Maximum Heater Plate Temperature:* | MR700, MR730 | 110°C | |
| | MR720 | 80°C | |

**Standards Compliance:**

Designed to conform to requirements of IEC601-1, UL544, CSA C22.2 No. 125, BS5724 Part 1, AS3200.1, DIN VDE 0750 Teil 1

Classified as:
Class 1
Type B
Drip Proof
Continuous Operation
Not to be used in the presence of flammable anaesthetics.

**General Information:**

Fuses in this equipment should only be replaced with fuses of the correct type rated as indicated on the appropriate labels or in the Technical Manual.

A full technical description including circuit diagrams, parts list and service data is contained in the Technical Manual which is available from your supplier or Fisher & Paykel Healthcare.

The safety, reliability and performance of this equipment is dependent upon:

1. The equipment being operated, maintained and repaired according to the manuals and instructions supplied.

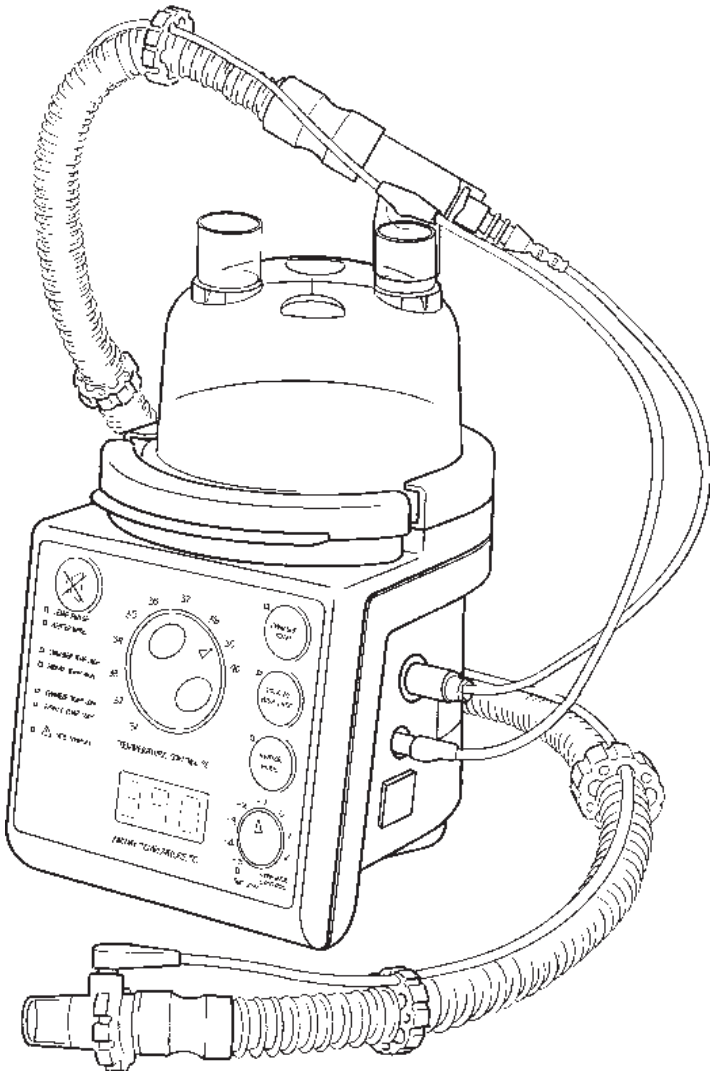
2. All servicing, calibration and repairs being carried out by a qualified service technician. Use only parts supplied or approved by Fisher & Paykel.

3. Compliance with the local electrical installation regulations.

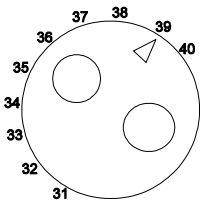
4. Maintenance of grounding integrity by connection to a "hospital grade" receptacle. Always disconnect supply before servicing.

This product is intended for use by a qualified medical practitioner. Users should ensure that they are totally familiar with the use of the humidifier before connecting the device to a patient.

# 3.0 EXPLANATION OF CONTROLS AND INDICATORS



**Front Panel**




TEMPERATURE CONTROL °C

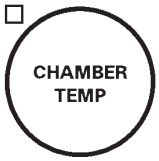
## 1. TEMPERATURE CONTROL:

Used to set the temperature of the gas to be delivered to the patient. The actual value being set is displayed as the control is rotated. The recommended set temperature is highlighted.


AIRWAY TEMPERATURE °C

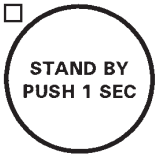
## 2. AIRWAY TEMPERATURE DISPLAY:

Displays the actual temperature of the gas being delivered to the patient OR if the chamber temperature button is being held, the display will show the temperature of the gas at the humidification chamber outlet.




## 3. CHAMBER TEMPERATURE:

While this button is being held, the display indicates the temperature of the gas at the humidification chamber outlet. The green indicator light next to the button will be illuminated while the button is held. This button is also used in conjunction with the mute button to access the diagnostic mode.

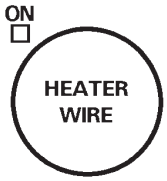



## 4. STANDBY:

Holding this button for one second enters standby mode whereupon the amber indicator light will begin to flash. The heater plate will be controlled to approximately 40°C and the heater wire output to 15% of maximum. The low temperature alarms will be disabled. After 30 minutes the humidifier will automatically return to warm-up and normal operation. The user can exit standby mode at any time by again holding the button for one second. The indicator light will stop flashing and an audible beep will sound when standby mode has been exited.

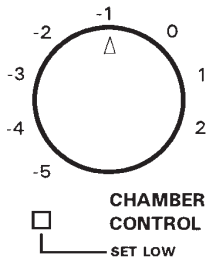
**5. HEATER-WIRE (MR720, MR730 ONLY):**

When this button is pressed power to the heater wire is turned on and the green indicator light will be illuminated. For non-heated wire circuits, the indicator light must be off. An alarm will occur if the heater wire function is turned off while a heated wire circuit is connected.




**6. CHAMBER CONTROL:**

When a heated wire circuit is used, this control sets the difference between the temperature at the humidification chamber outlet and the gas temperature delivered to the patient. In this way the user can control the relative humidity. The actual value being set is displayed as the control is rotated.

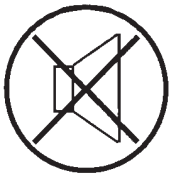



**7. SET LOW:**

The purpose of this light is to warn the user that the humidity being delivered to the patient is seriously low. This indicator is inactive if the heater wire function is turned off.

**8. MUTE BUTTON:**

Mutes all audible alarms. Normal mute time is 3 minutes. The alarm condition indicator lights will continue to flash until the condition is rectified.



**9. TEMPERATURE PROBE:**

☐ TEMP PROBE

The red indicator light will flash and an alarm will sound if the airway temperature probe connection is loose, not fitted or faulty.

**10. HEATER WIRE:**

☐ HEATER WIRE

The red indicator light will flash and an alarm will sound if the heater wire connection is loose, not fitted or faulty OR if the heater wire function is turned off while a heater wire is still connected.

**11. CHAMBER TEMPERATURE HIGH:**

☐ CHAMBER TEMP HIGH

The amber indicator light will flash and an alarm will sound if the temperature of the gas at the chamber outlet is 4°C higher than the set chamber temperature for longer than 20 minutes.

This alarm is activated immediately if the chamber outlet temperature is ever 10°C higher than the set chamber temperature.
NOTE: This alarm is disabled if the heater wire function is turned off. The temperature at the chamber outlet is monitored and limited to a maximum of 66°C.

**12. AIRWAY TEMPERATURE HIGH:**

☐ AIRWAY TEMP HIGH

The red indicator light will flash and an alarm will sound if the gas temperature being delivered to the patient is:

Heater wire on: 2°C higher than the set temperature.
Heater wire off: 41°C or higher.

## 13. CHAMBER TEMPERATURE LOW:

☐ CHAMBER TEMP LOW

The amber indicator light will flash and an alarm will sound if the temperature of the gas leaving the chamber is 4°C lower than the set chamber temperature for longer than 20 minutes.
NOTE: This alarm is disabled if the heater wire function is turned off.

## 14. AIRWAY TEMPERATURE LOW:

☐ AIRWAY TEMP LOW

The red indicator light will flash and an alarm will sound if the gas temperature being delivered to the patient is:

Heater wire on : 2°C lower than the set temperature (MR700, MR730)
: 4°C lower than the set temperature (MR720).

Heater wire off : 29.5°C or less.

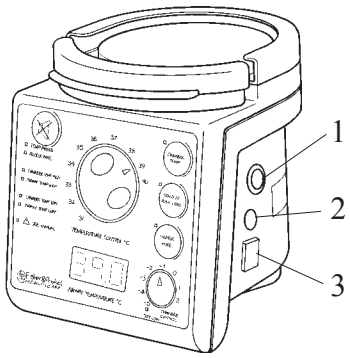
NOTE: This alarm is disabled during warm-up. See Section 7.1 for details.

## 15. SEE MANUAL :

☐ ⚠ SEE MANUAL

When this red indicator light is illuminated, a microprocessor fault has occurred and the humidifier cannot function. The unit should be immediately disconnected from the patient and sent for servicing.

**Right Side**

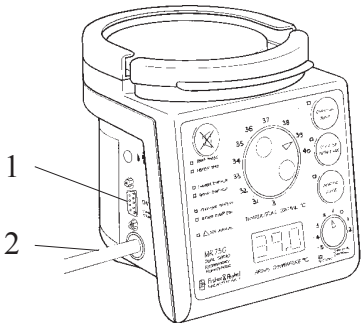



**1. HEATER WIRE POWER SOCKET**
The heater wire power connection plugs into this socket.

**2. TEMPERATURE PROBE SOCKET**
The temperature probe plugs into this socket.

**3. MAINS SWITCH**
Turns power to the humidifier on and off.

**Left Side**




**1. SERIAL DATA PORT**
An RS232 compatible 9-pin interface socket allows the humidifier to be connected to a computer to monitor humidifier data. Refer to the Technical Manual before use.

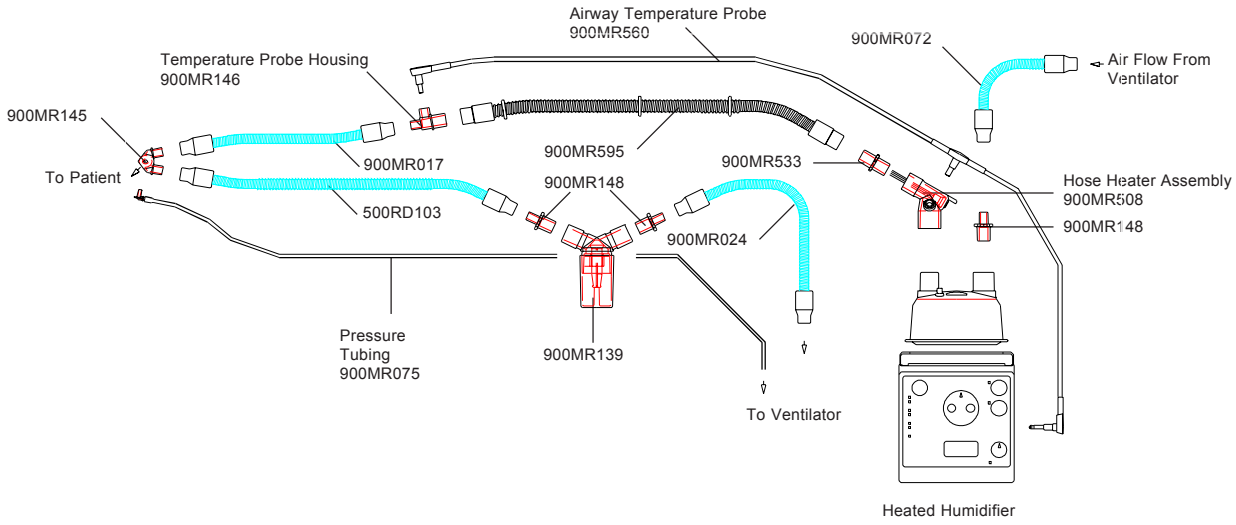
**2. POWER CORD**
Connects the humidifier to an AC power source as indicated on the side label.

# 4.0 ASSEMBLING REUSABLE BREATHING CIRCUITS

## 4.1 Reusable Circuits With a Heater Wire

Heated wire breathing circuits allow for greater control over the delivered gas temperature and ensure that optimum humidity levels are delivered to the patient. Since the gas temperature is maintained as it flows along the circuit, condensation is minimised, eliminating the need for a watertrap in the heated limb. Heated wire circuits are the most appropriate circuits for the majority of ventilated patients. Circuits with a heater wire in both the inspiratory and expiratory limb of the circuit are also available.

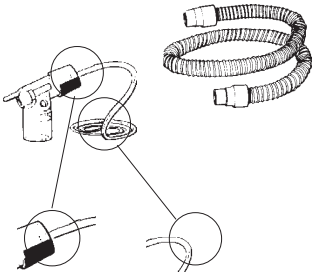
Parts required for a typical neonatal circuit are:




NOTE: The circuit illustrated is for use in an incubator or under a radiant warmer and the circuit is configured so that the temperature probe is positioned away from the heat source. This is to prevent the heat supplied by the incubator or radiant warmer from influencing the humidifier temperature control system.

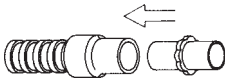
**To assemble:**

1. Select a clean tube of suitable diameter and length for the intended application and a heater wire assembly that is 25 - 100 mm (1" - 4") shorter in length than the tube. Ensure that there are no splits or holes in the tubing.

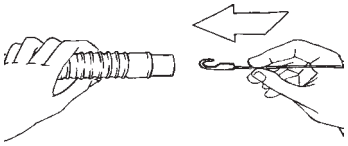


2. Before assembling, check the heater wire to ensure there is no damage to the insulation, particularly in the area of the loop and the connector. If there is any sign of damage, do not use.

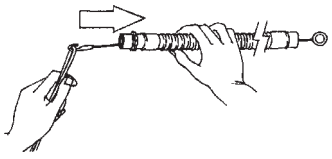
3. If the cuff of the tube is not 22mm in diameter, place an appropriate adaptor in one end of the delivery tube.



4. Examine the draw wire to ensure it is free of burrs and sharp edges. Thread it through the tube, hook first (from the non-adaptor end if an adaptor is being used).

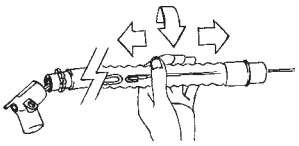


5. Place the loop of the heater wire over the hook of the draw wire and gently pull the heater wire through the tubing until the wire housing and tube are just touching.

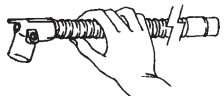


**CAUTION:** DO NOT join the tube and wire housing together with the draw wire.

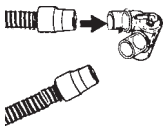
6. Push the draw wire forward and turn slightly to disengage the hook.



7. Carefully join the heater wire housing and circuit tubing by hand.



8. Place a connector or Y-piece with a temperature probe port at the patient end of the circuit.



9. Repeat steps 1-7 if a heated expiratory limb is to be used. If a heater wire is not used in the expiratory limb, a water trap should be installed.

10. Sterilise the assembled circuit by a suitable method before use (see Section 8.0).

11. If only the inspiratory limb is heated, a 900MR558 power connection will be required. If the expiratory limb is also heated, a 900MR556 power connection will be required.

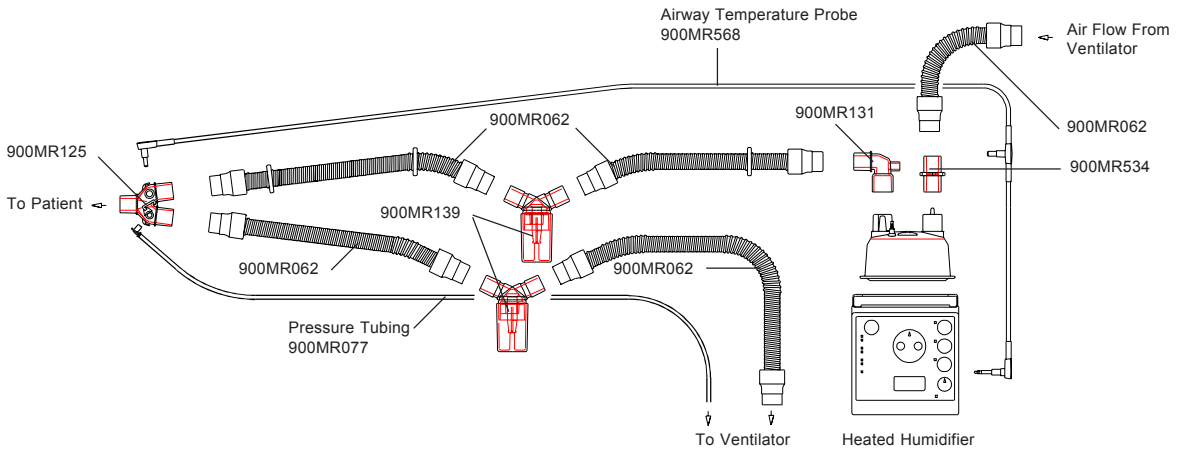
NOTE: Ensure that the correct length heater wire is used and that it is straight, not bunched inside the delivery tube. The delivery tube length may shrink slightly after use or autoclaving. If necessary, gently stretch the tube with the heater wire in place. Once assembled in the tube, the heater wire assembly should only be removed when absolutely necessary.

**WARNING:**

* ***DO NOT*** *assemble reusable heater wires into single use tubing.*
* *Before connecting to the patient, ensure that flow and pressure testing applicable to the ventilator has been completed to determine that there are no blockages or leaks.*
* ***DO NOT*** *cover heated breathing circuits with sheets, towels or other materials as this may cause the tubing to overheat.*
* *To prevent the possibility of patient burns, the breathing circuit should not be in contact with the patient's skin.*
* *Use only Fisher & Paykel approved chambers, circuits and accessories. Performance and safety cannot be guaranteed if other types of accessories are used.*
* *Condensation and consequent low delivered humidity can result if the temperature probe is located inside an incubator or warmed area.*

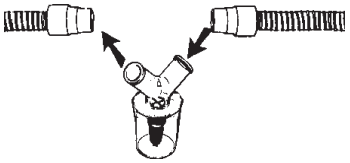
## 4.2 Reusable Circuits Without a Heater Wire

The humidifier is designed to provide gas temperatures of 31-40°C at the patient. To achieve this with a non-heated wire circuit, the gas leaves the chamber at approximately 50-65°C. As the gas travels along the circuit to the patient, it cools down and condensation forms in the circuit. Water traps are required in both limbs to collect the condensation. A flow rate of at least 1.5 L/min is recommended to ensure accurate control of the patient temperature. See Section 7.2.2 for further details.



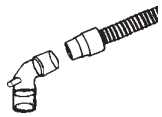

Parts required for a typical adult circuit configuration are:

**To assemble:**

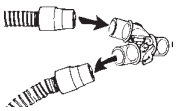


1. Select two clean 22mm tubes of suitable length and ensure there are no splits or holes in the tubing. Join with a 900MR139 watertrap.

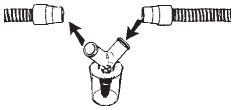
2. Place a 900MR131 elbow at one end. This connects to the outlet port of the humidification chamber.



3. Place a connector or Y-piece with a temperature probe housing at the patient end of the circuit, so that the temperature port is at the end of the inspiratory limb.



4. Select a further two tubes and join with a 900MR139 water-trap for the expiratory limb, if required.



5. Sterilise the assembled circuit by a suitable method before use (see Section 8.0).

**WARNING:**

* *Before connecting the humidifier to the patient, ensure that flow and pressure testing applicable to the ventilator has been completed.*
* *Do not cover heated breathing circuits with sheets, towels or other materials as this may cause the tubing to overheat.*
* *To prevent the possibility of patient burns, the breathing circuit should not be in contact with the patient's skin.*
* *Use only Fisher & Paykel approved chambers, circuits and accessories. Performance and safety cannot be guaranteed if other types of accessories are used.*
* *Many operating conditions will result in condensation in the circuit. Arrange the breathing circuit so that the water traps are at the lowest point and any condensate drains either into the water trap or back into the chamber. The humidifier should always be positioned lower than the patient.*

# 5.0 SINGLE USE BREATHING CIRCUITS

A range of pre-assembled, clean and ready-for-use circuits is available in adult, paediatric and neonatal sizing. See your supplier or the Fisher & Paykel product catalogue for full details. Refer to the instruction sheet provided with the single-use breathing circuit.

To use single heated disposable circuits (ie. heated inspiratory limb only) a 900MR557 power connection will be required. To use dual heated disposable circuits (ie. heated inspiratory and expiratory), a 900MR555 power connection will be required.

**WARNING:**

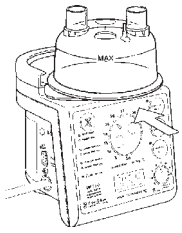
* *Before connecting the humidifier to the patient, ensure that flow and pressure testing applicable to the ventilator has been completed.*
* ***DO NOT*** *reuse single-use circuits. They are manufactured for* ***single patient one time use.***
* ***DO NOT*** *assemble heated wire circuits using reusable wires inside single use tubing.*
* ***DO NOT*** *cover heated breathing circuits with sheets, towels or other materials as this may cause the tubing to overheat.*
* *To prevent the possibility of patient burns, the breathing circuit should not be in contact with the patient's skin.*
* *Use only Fisher & Paykel approved chambers, circuits and accessories. Performance and safety cannot be guaranteed if other types of accessories are used.*

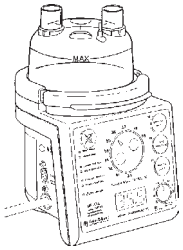
# 6.0 SETTING UP THE HUMIDIFIER

1. A range of brackets is available to attach the humidifier to a pole or directly to the ventilator. Please see your supplier or the Fisher & Paykel product catalogue for full details.

2. Select a suitable Fisher & Paykel humidification chamber. Refer to the chamber instruction sheet for chamber details. Ensure that the chamber base and heater plate are undamaged, clean and dry.

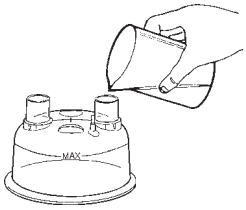
3. Slide the humidification chamber onto the heater plate. Push the chamber as far onto the plate as possible. The finger guard will automatically lock the chamber in place.




4. If using an auto waterfeed chamber, suspend a sterile water bag above the humidifier and connect the chamber according to the instructions for use provided in the chamber carton. Water will automatically be supplied to the chamber as required.

5. If using any other Fisher & Paykel chamber, fill with sterile, deionised water to the maximum water level line.



6. Connect a tube from the gas supply to the inlet port of the chamber.

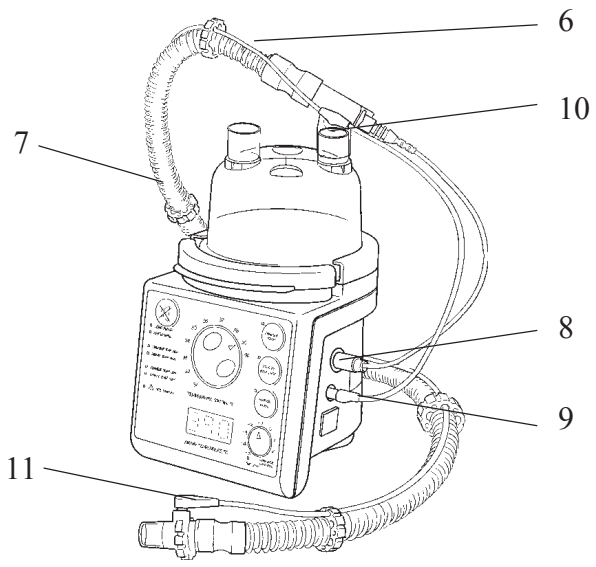
7. Connect the inspiratory side of the circuit to the outlet port of the chamber.

8. If using a heated wire circuit, connect the heater wire power connection to the heater base and to the heater wire assembly.

9. Select a Fisher & Paykel dual temperature probe of similar length to the chosen breathing circuit. Push the temperature probe plug into the socket on the side of the heater base.

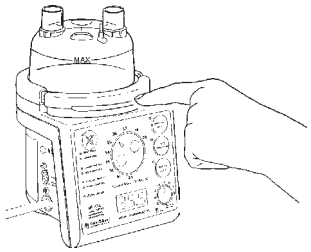
10. Place the "T-shaped" or first temperature probe sensor into the port on the side of the heater wire assembly. Push in firmly to ensure the tip of the sensor is in the middle of the airflow.

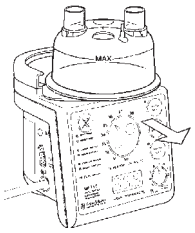
11. Place the second temperature probe sensor into the port at the end of the inspiratory limb. This is normally in the Y-piece. For reusable circuits ensure that the end of the heater wire is between 25 - 100mm (1" - 4") from the temp sensor. For disposable circuits ensure that



the end of the heater wire is no more than 25mm (1") away from the temperature sensor. The heater wire must not touch the sensor. The humidifier is now ready to be turned on.

12. To remove the chamber, push down on the finger guard. Pull the chamber forward until the rim is just touching the finger guard. Remove fingers from the guard and pull the chamber the rest of the way off the heater plate. Use this technique to avoid touching the hot heater plate or chamber base.





NOTE: Breathing circuits and humidification chambers should be replaced regularly in accordance with hospital infection control procedures.

**WARNING:**

* *When mounting a humidifier adjacent to a patient, ensure that the humidifier is always positioned lower than the patient.*
* *DO NOT fill the chamber above the maximum fill level line. Liquid could enter the breathing circuit if the chamber is overfilled.*
* *DO NOT fill the chamber with water in excess of 37°C.*
* *Ensure that both temperature probe sensors are correctly and securely fitted. Failure to do so may result in temperatures in excess of 41°C being delivered to the patient.*

# 7.0 OPERATING THE HUMIDIFIER

## 7.1 Basic Steps

1. Plug the humidifier power cable into an AC supply of the voltage and maximum power rating specified on the side label of the unit.

2. Ensure that the humidification chamber and breathing circuit are installed and connected correctly, as described in Section 6.0.

3. Switch on the ventilator or gas supply. Carry out flow and pressure testing applicable to the ventilator in use.

4. Switch on the humidifier using the switch at the side. The display will show "888" and all the indicator lights will be lit for one second. The following information will then be displayed for a period of 1 second each:

| | |
|---|---|
| model number | eg. 730 |
| software version | eg. 3.0 |
| set temperature (in °C) | eg. 39.0 |
| chamber control setting (not displayed if heater wire turned off) | eg. -2 |
| heater plate maximum temperature (in °C) | eg. 110 |

   The audio alarm will sound briefly. Ensure that the displayed set temperature and chamber control setting agree with the dial position before proceeding.

5. If the display shows anything other than a temperature after the start-up sequence is completed, the unit should be removed from the patient circuit and sent to a qualified service technician.

6. If a heated wire circuit is being used, check that the green indicator light next to the button labelled “heater wire” is illuminated. If not, press the button firmly. Ensure that the green light remains illuminated when the button is released.

7. Set the desired patient temperature by rotating the Temperature Control knob. As the setting is changed the display will flash. The new setting will continue to be displayed in flashing mode for 5 seconds after the last adjustment.

8. With gas flowing through the patient circuit, the digital display will show the rise in gas temperature as the humidifier warms up.
   NOTE: The low temperature alarms will not be activated during the warm-up period. They will be enabled as soon as any one of the following conditions is met:

   Heater Wire On:
   i. Delivered gas temperature is within 0.8°C of the set temperature.
   ii. Delivered gas temperature has not increased by 2°C within 2 minutes (or 4 minutes for Version 1.0 or 2.0 software).
   iii. Delivered gas temperature is not within 2°C of the set temperature within 10 minutes.

   Heater Wire Off:
   i. The temperature rises above 30°C.
   ii. Delivered gas temperature has not increased by 2°C within 15 minutes.
   iii. The delivered gas temperature has not reached 30°C a further 15 minutes from the initial 2°C rise.

9. When the temperature has stabilised (approximately 10 minutes, depending on operating conditions), connect the delivery tube to the patient.

10. Periodically check that the airway temperature displayed is close to the set temperature.

11. If an alarm is activated, refer to Section 7.4.

12. If the gas flow is stopped or interrupted, the Standby Mode should be selected or the humidifier turned off.

**WARNING:**

* *Unless the cause and effects of any alarm are understood and assessed to be of no hazard to the patient, the humidifier should be immediately switched off and disconnected from the patient.*
* *The temperature delivered to the patient may exceed 41°C if the airway temperature probe is not inserted correctly at the patient end of the inspiratory circuit .*
* *Do not touch the heater plate as the surface temperature may exceed 85°C. Other accessible metal surfaces may exceed 55°C*
* *Always ensure the gas supply is flowing through the humidifier before connecting to the patient.*
* *DO NOT use a heated wire breathing circuit in the presence of flammable anaesthetics, (this does not include pure oxygen). Verify with gas manufacturer that degradation of anaesthetic agents will not occur.*
* *Select STANDBY mode or switch the humidifier off if the gas flow is stopped or interrupted. If STANDBY mode is used ensure that gas flow is resumed before the mode is exited.*
* *Do not fill the chamber past the maximum water level mark. Monitor the water level in the chamber (or water bag for continuous feed chambers) and refill as necessary.*
* *The liquid output of the humidifier may exceed 44 mg/L if operating temperatures greater than 37°C are selected.*
* *Electric shock hazard - do not remove cover. In case of a fault, refer to a qualified service technician.*
* *The power rating of the outlet socket on some ventilators may be less than the maximum required by the humidifier. See Section 2.0 for details.*
* *The function of this humidifier may be adversely affected by the operation of high frequency surgical apparatus, shortwave or microwave equipment in the vicinity.*
* *Some pressure regulated neonatal ventilators may cause the generation of high temperatures to reach the patient upon disconnection and reconnection of the inspiratory limb,or disconnection only of the expiratory limb. To prevent this occurring, it is recommended that the humidifier is either placed in Standby Mode or switched off 5 minutes before disconnection.*

## 7.2 Setting the Patient Temperature and the Chamber Control

### 7.2.1 Circuits with a Heater Wire

With MR720 and MR730 attach a circuit with a heater wire and ensure that the heater wire button has been pressed until the green light is illuminated. The MR700 does not have this option and must be used with a heated wire circuit.

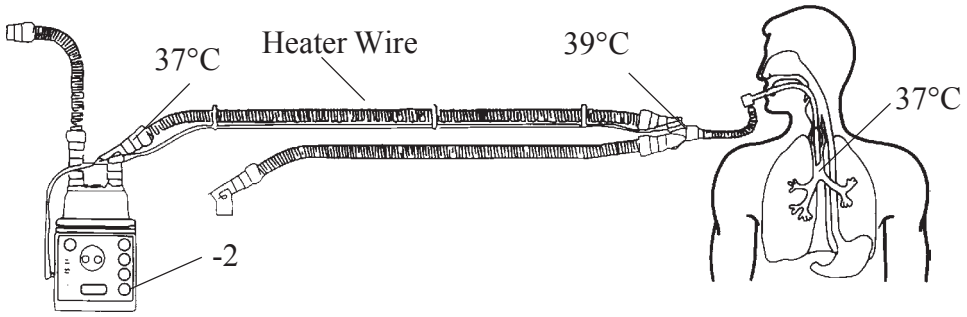
Use of a heated wire circuit means the humidifier now has two independent heating systems - the heater plate which heats the water (and therefore the gas in the chamber) and the heater wire. The heater wire maintains the temperature of the gas as it travels along the circuit, eliminating condensation and the need for a water trap. It also means that high temperatures at the chamber outlet are no longer necessary to ensure suitable patient gas temperature.

The temperature of the gas leaving the chamber is regulated by the Chamber Control. This control is calibrated from -5 to +2 and sets the temperature difference beween the chamber outlet and the patient temperature. The temperature at the chamber outlet is monitored by the first temperature probe and may be displayed by pressing the Chamber Temp button.

Patients whose airways are bypassed by an ET or tracheostomy tube should receive inspiratory gases at core temperature (37°), and saturated (44 mg $H_2O$/L) in order to optimise mucociliary transport. To achieve this, the set airway temperature should be set to 39°C and the chamber control to -2. These settings can be altered slightly (eg 40°C, -3 or 38, -1) depending on the actual temperature drop between the Y-piece and the patient. However, it is very important that the gas leaving the chamber is close to 37°C if it is to carry 44mg $H_2O$/L. Utilise a setting which ensures that the chamber exit temp is at least 37°C and which prevents condensation in either the circuit, its extensions or in the exposed section of the patient's endotracheal tube.

As the gas enters the Y-piece, it is no longer being heated, and the temperature will drop slightly. Therefore by setting the patient temperature to 39°C, the temperature of the gas when it reaches the patient is approximately 37°C.

eg. Set Temperature: 39° Chamber Control: -2




Gas leaves the humidification chamber at 37°C, almost fully saturated. It is heated in the circuit by 2°C to reach 39°C at the patient Y piece. It cools down in the unheated segment between the Y piece and the patient to approximately 37°C and is fully saturated.

### The Chamber Set Low Light:

If the gas temperature at the chamber is less than 34°C, the humidity delivered to the patient will be less than 38mg $H_2O$/L This is well below the 44mg $H_2O$/L required for optimal mucociliary transport and may result in damage to the mucociliary transport system over time. The Set Low light acts as a reminder of this to the clinician and is activated if the chamber outlet temperature is set to less than 34°C.

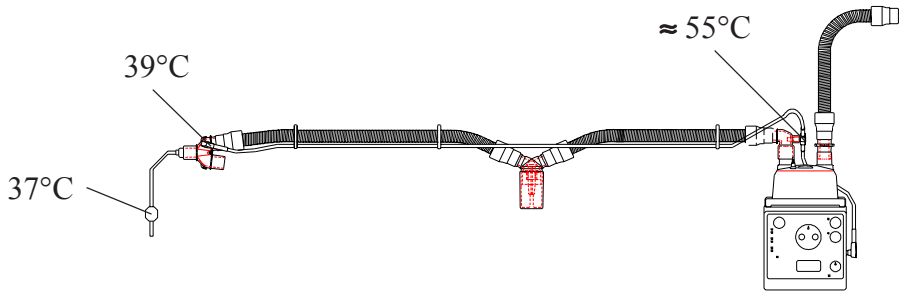
NOTE: This is not an alarm and has no effect on the normal operation of the humidifier.

### 7.2.2 Circuits without a Heater Wire

The HEATER WIRE button must be pressed until the green light is no longer illuminated and then released. In this mode, the temperature of the gas delivered to the patient is maintained by the heater plate only and this is controlled by the patient temperature probe. The temperature probe at the chamber outlet monitors and limits the temperature of the gas at this point to a maximum of 66°C.

It is recommended that the humidifier is set to deliver inspiratory gases at no less than 37°C, 100% RH at the tracheal tube, in order to optimise mucociliary transport. To achieve this, set the airway temperature to approximately 39°C, depending on the length of unheated tubing between the Y-piece and the patient.

In some applications these temperature and humidity levels may not be required, so the patient temperature may be set lower.




eg. Set Temperature = 39°C
Gas leaves the humidification chamber at approximately 50°-65°. It cools as it moves along the breathing circuit towards the patient, and condensation forms. A water trap must be used to collect condensation.

## 7.3 Using the Standby Function

The Standby mode is designed for use at any time that the gas flow through the humidification chamber is stopped or interrupted, eg. when refilling the chamber, changing the patient circuit, suctioning or nebulising.

To enter this mode, push the Standby button and hold for 1 second. The amber indicator light next to the button will flash.

In the Standby mode, all low temperature alarms are inhibited, the heater plate is controlled to 40°C maximum and the heater wire (if connected) to 15% maximum power. In this way, the temperature of the gas delivered to the patient when normal flow is resumed is limited, but some warmth is maintained to accelerate the warm-up period.

After 30 minutes the humidifier will automatically return to normal operation. Alternatively, the user can exit standby mode at any time by holding the button for one second. The indicator light will stop flashing and an audible beep will sound when Standby has been exited. On exiting Standby, the low temperature alarms will be enabled as soon as the warm-up conditions have been met (See Section 7.1 for details).

**WARNING:**

* *Gas flow **MUST** be resumed before standby mode is exited.*
* ***DO NOT** enter standby mode if gas flow is to be turned off for an extended period of time - turn the humidifier off completely.*

## 7.4 Guide To Alarm Systems

Unless the cause and immediate effects of an alarm condition are understood and assessed to be of no hazard to the patient, the humidifier should be immediately switched off and removed from the patient circuit.

All alarm conditions are expressed by audio and visual indicators. Each alarm condition has its own visual indicator and these can be displayed simultaneously. The audio alarm can be silenced for 3 minutes (or 10 minutes for a low temperature alarm when an unheated circuit is used) by pushing the mute button marked  . The visual alarm indicator will remain illuminated until the alarm condition is cleared. Any new alarm condition occurring within the silence period will reactivate the audio alarm.

NOTE: Any adjustments to the set temperature should be made SLOWLY. Adjusting the set temperature by more than the alarm limits may cause high or low temperature alarms to occur until the temperature control system adjusts to the new setting.

### 7.4.1 Heater Wire On

| Indicator | Condition Detected | Possible Cause | Action to Take |
|---|---|---|---|
| TEMP PROBE<br>Display shows:<br>"- - -" | Probe disconnect - power to both of the heaters is discontinued. | 1. The temperature probe is not connected.<br>2. There is a fault in the temperature probe cable.<br>3. The wrong type of probe is being used. | 1. Connect the temperature probe correctly.<br>2. Replace the temperature probe. Have the suspect temperature probe checked by a technician.<br>3. Ensure a dual temperature probe is being used. |
| HEATER WIRE<br>Display shows actual airway temperature<br>eg "25.0" | Heater wire disconnect - power to both of the heaters is discontinued. | 1. The heater wire is not connected.<br>2. There is a fault in the heater wire. | 1. Connect the heater wire correctly.<br>2. Replace the heated wire circuit. |
| HEATER WIRE<br>Display shows:<br>"F-2" | Fuse is open circuit - power to both of the heaters is discontinued. | 1. The 4 amp heater wire fuse is open circuit. | 1. Call a technician to replace the fuse. If fault persists, replace the heated wire circuit. |
| CHAMBER TEMP HIGH<br>Display shows actual airway temperature<br>eg. "36.9" | Temperature at the chamber outlet is:<br>10°C higher than set; or<br>4°C or more above the set chamber temperature for 20 minutes.<br>Power to the heater plate is discontinued. | 1. No water in the chamber.<br>2. Change in gas flow.<br>3. Heater plate control fault. | 1. Refill the humidification chamber.<br>2. Push the mute button and check that the chamber temperature falls. If fault persists, remove the humidifier from the patient circuit and have a technician check it. |

| Indicator | Condition Detected | Possible Cause | Action to Take |
|---|---|---|---|
| AIRWAY TEMP HIGH<br>Display shows actual airway temperature<br>eg. "39.2" | Temperature at the patient is at least 2°C above the set temperature - power to both of the heaters is discontinued immediately. | 1. Sudden increase in gas flow.<br>2. Temperature probe is located inside an incubator or under a radiant warmer.<br>3. The heater wire is too close to the temperature probe.<br>4. Set temperature knob has been adjusted by more than 2°C or too quickly. | 1. Push the mute button and wait for the temperature to fall. If the alarm condition persists, switch the humidifier off and remove from the patient circuit.<br>2. Use the correct circuit configuration.<br>3. Ensure the distance between the heater wire and temperature probe is more than 25 mm.<br>4. Push mute and wait for the temperature to fall. |
| CHAMBER TEMP LOW<br>Actual airway temperature is displayed<br>eg. "34.5" | Temperature at the chamber outlet is at least 4°C less than the set chamber temperature for 20 minutes. | 1. Poor thermal contact between the base of the chamber and the heater plate.<br>2. Temperature probe is not inserted at the chamber outlet.<br>3. Gas flow rate exceeds the recommended maximum.<br>4. Heater element fault. | 1. Check the chamber base and heater plate are clean, smooth and flat. Replace if necessary.<br>2. Fit the temperature probe at the chamber outlet correctly.<br>3. Check that the flow is not exceeding 80 L/min.<br>4. Call a technician. |

| Indicator | Condition Detected | Possible Cause | Action to Take |
|---|---|---|---|
| AIRWAY TEMP LOW Display shows actual airway temperature eg "32.4". | MR700, MR730:<br>Temperature at patient is at least 2°C less than the set temperature.<br>MR720:<br>Temperature at the patient is at least 4°C less than set temperature.<br>- Power to the heaters continues for 100 seconds. Pushing the mute button will resume heat for a further 100 seconds. | 1. The gas flow has been stopped or interrupted.<br>2. Gas flow rate is below the recommended minimum.<br>3. Temperature probe is not in the probe housing.<br>4. Set temperature has been adjusted by more than the alarm limit.<br>5. Distance between the heater wire and the temperature probe is too great. | 1. Select the Standby mode on the MR730/MR720. Turn the MR700 off.<br>2. Check that the flow rate is not below 1.5 L/min.<br>3. Fit the temperature probe correctly.<br>4. Push the mute button and wait for the temperature to rise.<br>5. Ensure the distance between the heater wire and probe is less than 100mm. |
| ERROR CODE Display shows eg "bi ; "Ec" | Fault with a mechanical or electrical part of the humidifier. | Failure of a mechanical or electrical part. | Send the humidifier for repair. Note the error code displayed and report to technician. Details of error codes can be found in the technical manual. |
| SEE MANUAL Continuously on - does not flash. There is no display. | Microprocessor fault.<br>There is no power to anything other than this single indicator light. Neither heater is turned on and there is no audible alarm. | Microprocessor failure. | Send the humidifier for repair. |

### 7.4.2 Heater Wire Off

| Indicator | Condition Detected | Possible Cause | Action to Take |
|---|---|---|---|
| TEMP PROBE<br>Display shows<br>"- - -" | Probe disconnect - power to the heater plate is discontinued. | 1. The temperature probe is not connected.<br>2. There is a fault in the temperature probe cable.<br>3. The wrong type of temperature probe is being used. | 1. Connect the temperature probe correctly.<br>2. Replace the temperature probe. Have the suspect probe checked by a technician.<br>3. Ensure a dual temperature probe is being used. |
| AIRWAY<br>TEMP HIGH<br>Display shows<br>actual airway<br>temperature<br>eg "41.0" | Temperature at the patient is 41°C (or higher) - power to the heater plate is discontinued. | 1. There is a sudden increase in gas flow.<br>2. The temperature probe is located inside an incubator or under a radiant warmer. | 1. Push the mute button and wait for the temperature to fall. If the alarm condition persists, switch the humidifier off and remove from the patient circuit.<br>2. Use the correct circuit configuration. |
| AIRWAY<br>TEMP LOW<br>Display shows<br>actual airway<br>temperature<br>eg "29.0" | The temperature at the patient is less than 29.5°C.<br>Power to the heater plate is discontinued. Pushing the mute button will resume heating for 10 minutes. | 1. The gas flow has been stopped or interrupted.<br>2. The gas flow rate is below the recommended mini-mum.<br>3. The temperature probe is not in the probe housing.<br>4. Heater element fault. | 1. Select stand-by mode on MR720, MR730.<br>2 Check that the flow rate is not below 5 L/min.<br>3. Fit the temperature probe correctly.<br>4. Call a technician. |

| Indicator | Condition Detected | Possible Cause | Action to Take |
|---|---|---|---|
| ERROR CODE Display shows eg "bi" ; "Ec" | Fault with a mechanical or electrical part of the humidifier. | Failure of a mechanical or electrical part. | Send the humidifier for repair. Note the error code displayed and report to the technician. Details of error codes can be found in the technical manual. |
| SEE MANUAL Continuously on - does not flash. There is no display | Microprocessor fault. There is no power to anything other than this single indicator light. The heater plate is not turned on and there is no audible alarm. | Microprocessor failure. | Send the humidifier for repair. |

## 7.5 Additional Features

**Anaesthesia Warm-up (MR720 Only)**

The MR720 has an extended warm-up which allows it to be switched on and warmed up throughout lengthy equipment checks without giving unnecessary alarms.

If the initial warm-up conditions are not met (See Section 7.1 for details) the unit automatically enters Standby mode for a period of 30 minutes.

While in Standby mode:

a) If a 2°C increase in temperature is sensed at the patient temperature probe at any time within the 30 minute period, initial warm-up resumes. The unit rechecks warm-up conditions and if these are not met, the unit re-enters Standby mode.

b) If the temperature has not increased by 2°C OR come within 2°C of the set temperature by completion of the 30 minute standby period, initial warm-up resumes. The unit rechecks warm-up conditions and if these are not met, the unit will alarm.

**Over Temperature Protection**

The patient temperature probe is continuously monitored by an electrical circuit independent of the microprocessor control. This circuit is preset to disconnect power to both of the heaters if the airway temperature reaches 41.0°C.

In addition, if the heater plate temperature exceeds 118 ± 6°C, power to the humidifier is discontinued by the activation of a thermostat. There will be no display or indicators lit. On cooling, this overheat protector must be manually reset by opening the unit and depressing the red button found under the surface of the heater plate. This should only be carried out by a qualified service technician.

**Diagnostic Mode**

The diagnostic mode contains information useful to the technician in servicing the product. It should not be necessary to access this mode for normal operation.

While in the diagnostic mode normal control is maintained; however the airway temperature is no longer continuously displayed. The mode can be accessed by pressing the mute button  marked together with the Chamber Temp button, and holding both for at least 1 second. The display will read "SET" when the mode has been accessed.

Release the Chamber Temp button to display the set temperature value. Release the mute button and then press it again at the relevant code to display the following information:-

Heater Wire On

| | |
|---|---|
| SET | Set temperature |
| OFF | Chamber control setting |
| Edc | Heater wire duty cycle |
| Cdc | Heater plate duty cycle |
| hP | Heater plate temperature |
| L | Programming link status |
| CP | Alternates between the two probe temperatures |
| Ei | Patient probe integral (for technical use only) |
| Ti | Chamber outlet probe integral (for technical use only) |

Heater Wire Off

| | |
|---|---|
| SET | Set temperature |
| dc | Heater plate duty cycle |
| L | Programming link status |
| CP | Alternates between the two probe temperatures |
| i | Integral (for technical use only) |

If the mute button is released and not pushed again, after a period of 6 seconds the display will show “END”, the diagnostic mode will be exited and the humidifier will again display the temperature of the gas being delivered to the patient.

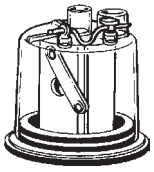
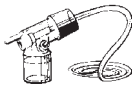
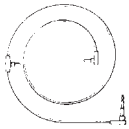
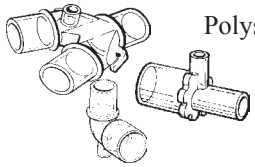
For further information on how to use the diagnostic mode please consult the Technical Manual.

**Computer Interface**

An RS232 compatible 9-pin interface socket is provided on the side panel of the humidifier. This allows the user to connect the humidifier to a computer and monitor the function of the humidifier, giving a permanent record of temperatures delivered to the patient.

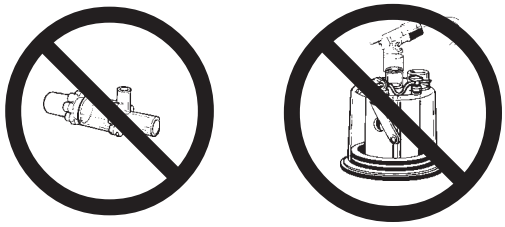
Consult the Technical Manual before using this socket, as the pins are also used for other signals.

# 8.0 STERILISATION OF FISHER & PAYKEL REUSABLE HUMIDIFICATION ACCESSORIES

| | Material | Autoclavable | | EtO |
|---|---|---|---|---|
| | | 136°C (276.8°F)<br>220 kPa (32 psi)<br>4 minutes | 120°C (248°F)<br>96 kPa(14 psi)<br>15 minutes | 55°C (131°F) |
|  | Top: Polysulphone<br>Scroll: Aluminium<br>Base: Aluminium | Yes | Yes | Yes |
|  | Housing: Polysulphone<br>Insulation: Silicone | Yes | Yes | Yes |
|  | Polypropylene<br>Polycarbonate | No | No | Gold Plated only |
|  | Tube: Hytrel<br>Cuffs: Silicone | Yes | Yes | Yes |
|  | Polysulphone | Yes | Yes | Yes |

## Special Instructions

Do NOT sterilise adaptors fitted together, or on chambers.



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Do NOT use the following solutions:

| | |
|---|---|
| Phenol (>5%) | Chlorinated Hydrocarbons |
| Ketones | Aromatic Hydrocarbons |
| Formaldehyde | Inorganic Acids |
| Hypochlorite | Quaternary Ammonium Compounds |

These solutions may cause stress cracking of the polysulphone components or disintegration of the Hytrel tubing. Do not use these solutions in any cleaning process, including autoclaving, soaking and pasteurisation.

Do not autoclave if medications containing Quaternary Ammonium, Chlorinated or Aromatic Hydrocarbons have been used.

# 9.0 ROUTINE MAINTENANCE

**Calibration Check of Temperature Probes**
Temperature probes should be checked every twelve months to ensure they are operating within design specifications.

The following recommended procedure should be carried out by a technician:
1. Obtain a good quality mercury thermometer.
2. Place the thermometer and the patient end of the probe into a container of warm water which is between 32°C and 40°C.
3. Turn the humidifier on and set the control knob to maximum. Allow the temperature of the probe and thermometer to stabilise. Once stable, compare the temperature displayed on the display to the reading on the thermometer.
4. The display should be within ± 0.5°C of the thermometer reading. If not, then it is recommended that the probe is replaced.

**Monthly Checks**
Check the temperature probe for damage to sensor tips, abrasion of the cable or tarnishing of electrical contacts. Replace if necessary. Probes with gold plated electrical contacts may be ethylene oxide sterilised; others should be cleaned with alcohol on a swab. The heater base may be cleaned by using a damp cloth.

Check the humidifier cables for damage and replace as necessary.

Plug a probe and heater wire assembly into the heater base, switch on and observe that the humidifier conducts the self test. Observe correct operation of self test. Check for correct display of ambient temperature and that no alarms are immediately actived. Ensure the heater plate surface is clean and free from pitting, gouging etc. These can be removed by sanding lightly.

For further maintenance information, please consult the Technical Manual.

# 10.0 PERFORMANCE DATA

## 10.1 Heater Wire On (MR730, MR720, MR700)

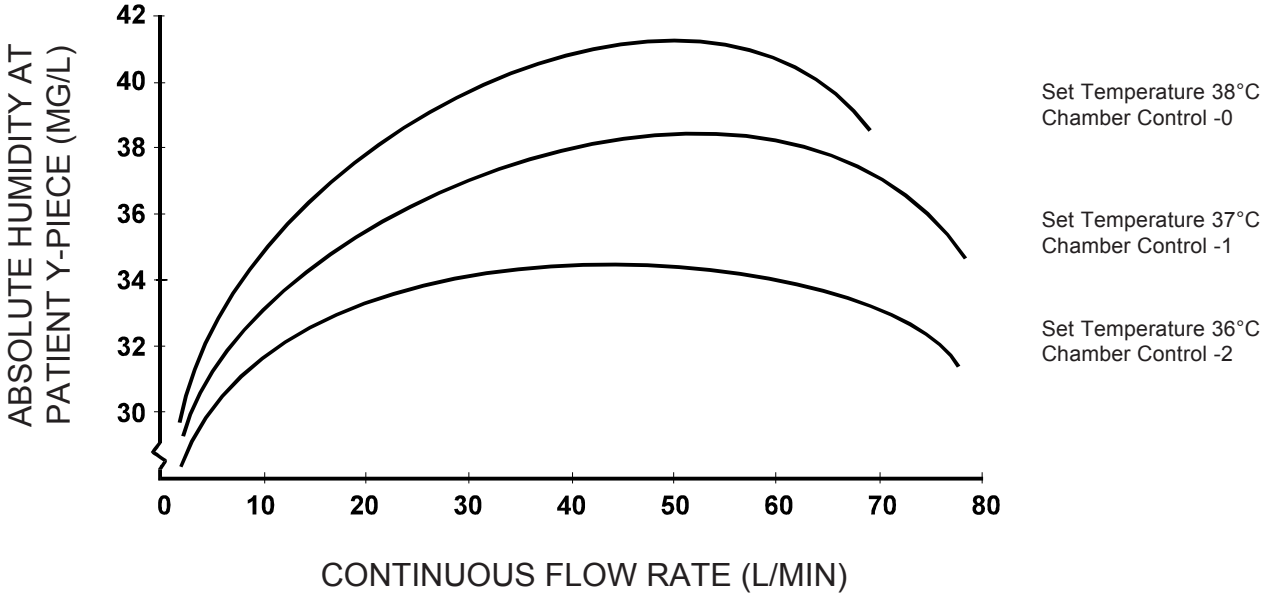
The graphs on the following pages give an indication of the approximate humidity delivered to the patient for varying set temperatures and flow rates.

They are based on laboratory tests and are offered **as a guide only**, as performance is dependent upon the equipment used, set up and other varying conditions.

Testing was conducted using the following equipment:

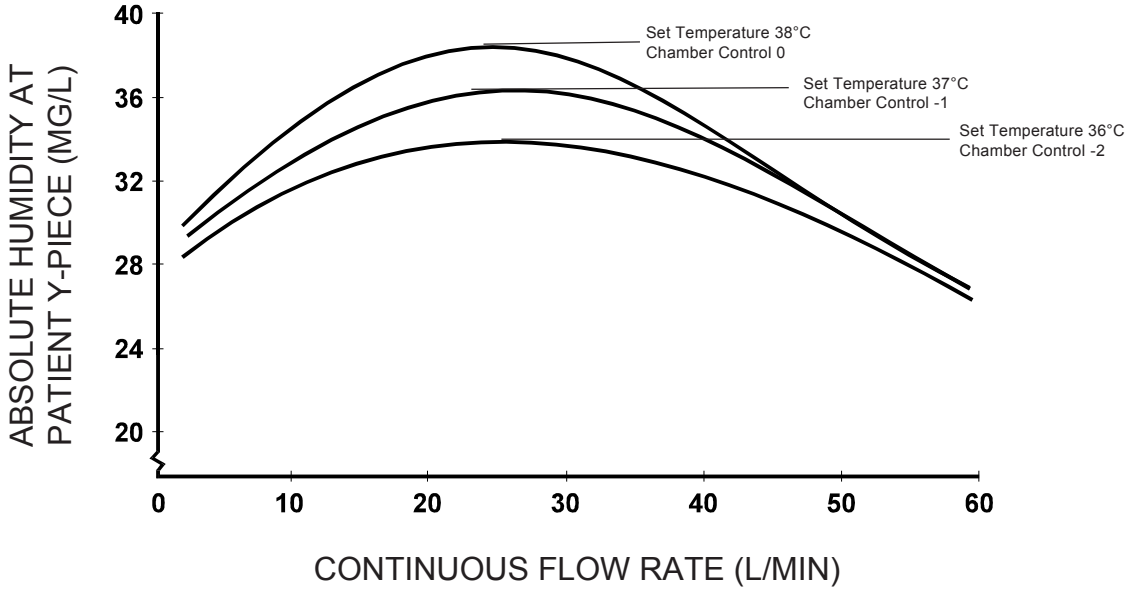
| | |
|---|---|
| Single use adult chamber: | MR250 |
| Single use adult circuit: | 1.5m (60") |
| Ambient air temperature: | 22-24°C |

## ABSOLUTE HUMIDITY AT THE PATIENT VS FLOW RATE (FOR VARIOUS SET TEMPERATURES)




REF: TEST REPORT TR9088

## ABSOLUTE HUMIDITY AT THE PATIENT VS FLOW RATE (FOR VARIOUS SET TEMPERATURES)




REF: TEST REPORT TR9088

## 10.2 Heater Wire Off (MR730)

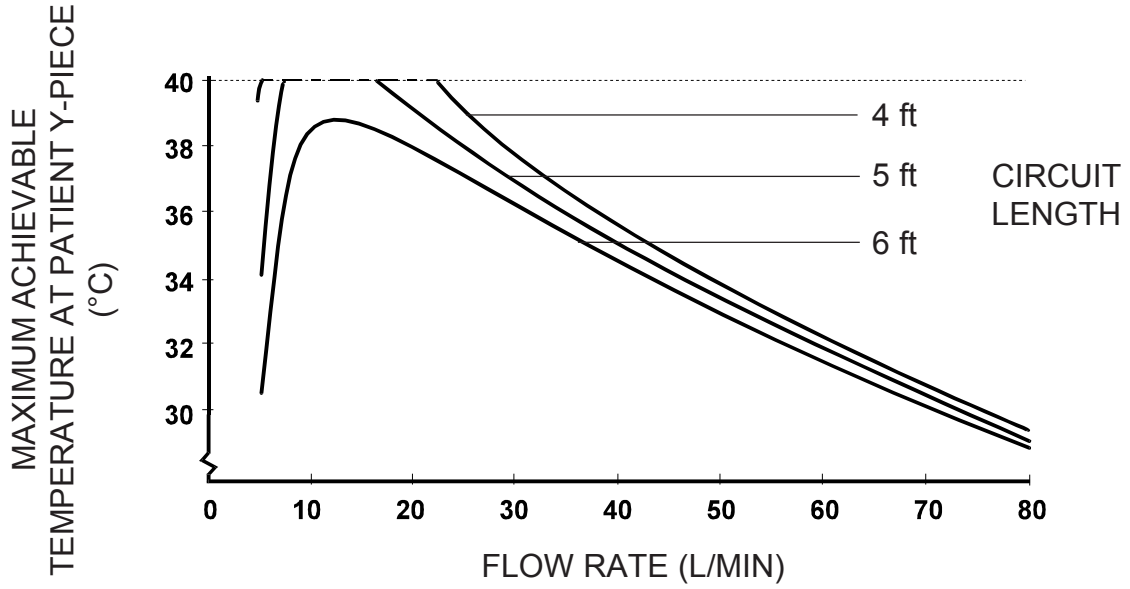
The graph below gives an indication of the maximum set temperature achievable for various continuous flow rates.

It is based on laboratory test results and is offered as a guide only, as performance is dependent upon equipment used, set up and other varying conditions.

Testing was conducted using the following equipment:

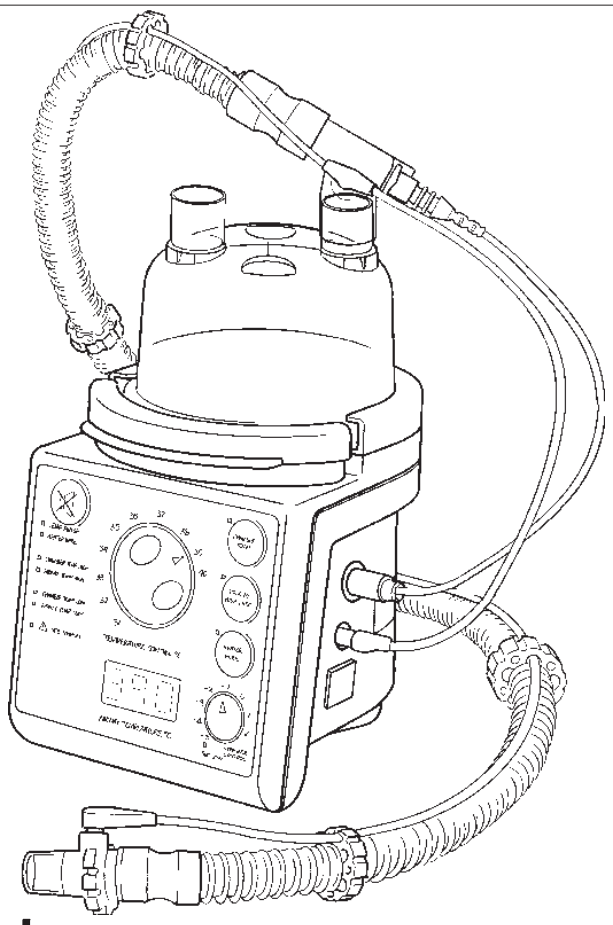
| | |
|---|---|
| Single use chamber: | MR250 |
| Single use circuit: | 1.2m (4ft), 1.5m (5ft), 1.8m (6ft) unheated circuit with a water trap. |
| Ambient air temperature: | 22-24°C |

## MAXIMUM ACHIEVABLE TEMPERATURE AT VARIOUS FLOWRATES FOR 1.2mm (4FT), 1.5mm (5FT) AND 1.8mm (6FT) CIRCUIT




REF: TEST REPORT TR9089

# MR700, MR720, MR730
# RESPIRATORY HUMIDIFIERS



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