Danfoss PM 1 and PM 3 Main Valves + Pilot Valves

Contents

List of Figures

List of Tables

1. About this Publication

These instructions have been prepared according to the following standards:

- BS EN ISO 11442: Technical product documentation. Document management;
- BS EN ISO 12100: Safety of machinery - General principles for design - Risk assessment and risk reduction;
- BS EN 62023: Structuring of technical information and documentation;
- BS EN 82079-1: Preparation of instructions for use. Structuring, content and presentation. General principles and detailed requirements.

1.1. Safety Warnings and Symbols

The system of safety warnings and symbols is based on:

- BS EN ISO 7010: Graphical symbols. Safety colours and safety signs. Registered safety signs;
- BS EN 82079-1: Preparation of instructions for use. Structuring, content and presentation. General principles and detailed requirements.

DANGER

This indicates a hazard with a high level of risk, which if not avoided, will result in death or serious injury if instructions, including recommended precautions, are not followed.

WARNING

This indicates a hazard with a medium level of risk, which if not avoided, will result in death or serious injury if instructions, including recommended precautions, are not followed. In addition, there is a high risk of damage to the component, product or process.

CAUTION

This indicates a hazard with a low level of risk, which if not avoided, will result in minor or moderate injury if instructions, including recommended precautions, are not followed. In addition, there is a potential risk of damage to the component, product or process.

NOTE: Draws attention to important additional information.

1.2. Units of Measurement

Quantities are expressed in SI units or SI derived units; refer to J & E Hall International Standard JEH-ES-02 Guide to the International System of Units (SI).

1.3. Terminology

Terminology, abbreviations and acronyms are those currently in use throughout the refrigeration and air conditioning industry; refer to J & E Hall International Standard JEH-ES-01 Definition of Terms and Acronyms Used in the Refrigeration Industry.

1.4. Additional Copies

Obtain additional copies of these instructions from J & E Hall International; go to www.jehall.com.

2. Application

PM 1 and PM 3 are servo-controlled main valves whose function is determined by the type and number of pilot valves fitted. The main valve function is open, closed or some intermediate position (modulated flow) according to the condition of the pilot valve (or valves).

This publication describes the main valve's operation and installation; the individual pilot valves are covered in their own instruction publication in Section 4 of this manual.

The location of the PM main valve, and the type and number of pilot valves fitted, can be found from the system schematic flow diagram and in Part A : Specification in Section 1 of the plant instruction manual.

PMC 1 and PMC 3 main valves, identical in operation and very similar in construction to PM 1 and PM 3, are specifically designed for use in hot gas bypass applications; refer to 4.2. and 4.4.

PM 1

PM3

Fig 1 PM 1 and PM 3 Main Valves

3. Technical Data

Parameter	Details
Refrigerants	All common refrigerants including R717 (ammonia) and R744 (CO_2) and non-corrosive gases/liquids. Not recommended for use with flammable hydrocarbons.
Maximum pressures	Working pressure 28 bar g
	Test pressure 42 bar g
Temperature range	-60 °C to +120 °C
Opening differential pressure	Fully open: 0.2 bar g minimum. Maximum operating differential pressure for pilot solenoid valves: 10 W ac (NC)/12 W ac (NO) or 20 W dc: 21 bar g

Table 1 Technical Data

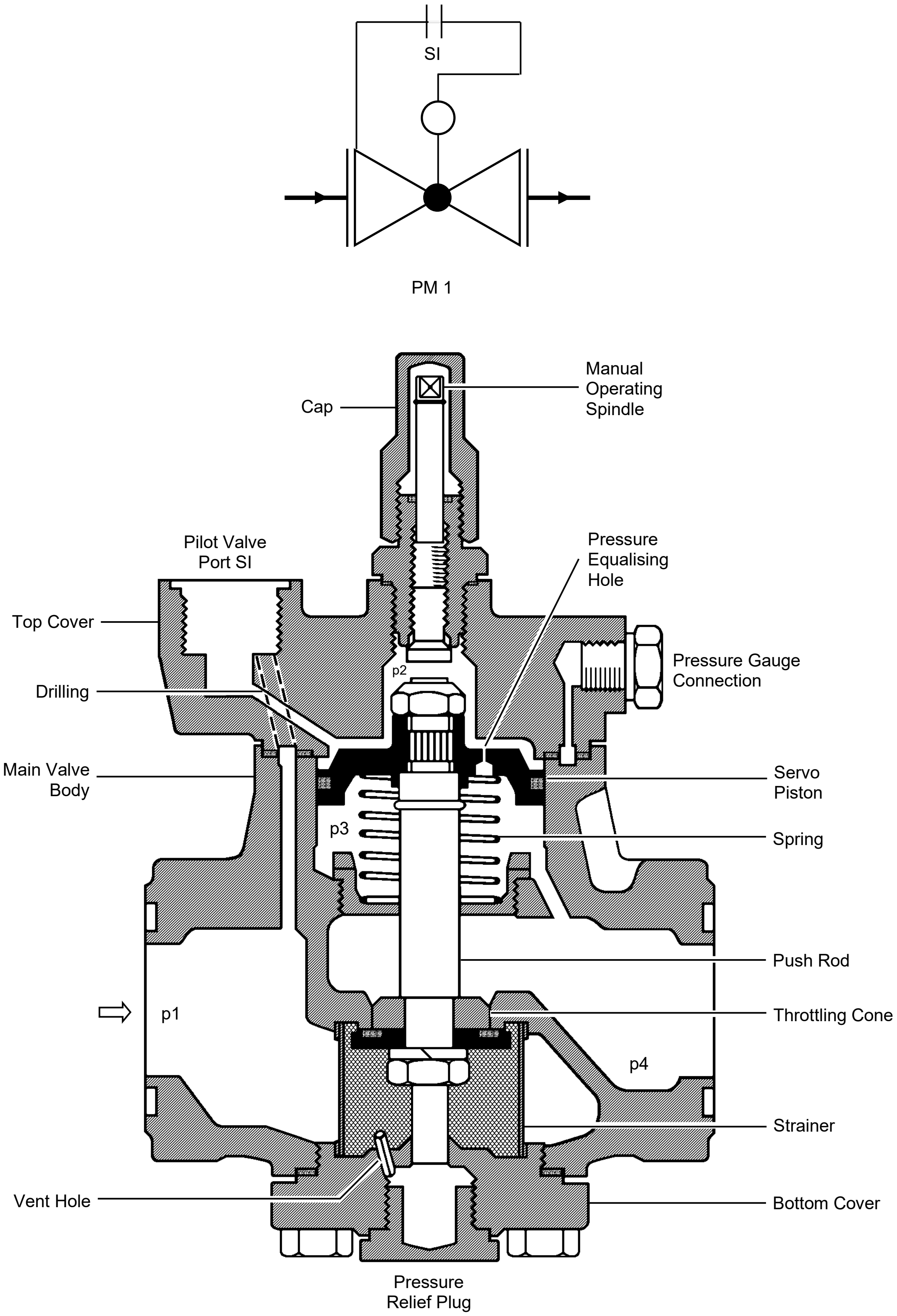
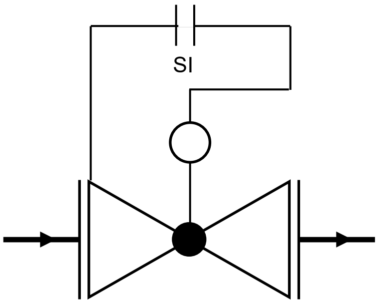


Fig 2 PM 1-5 to 65 Main Valves



PMC 1

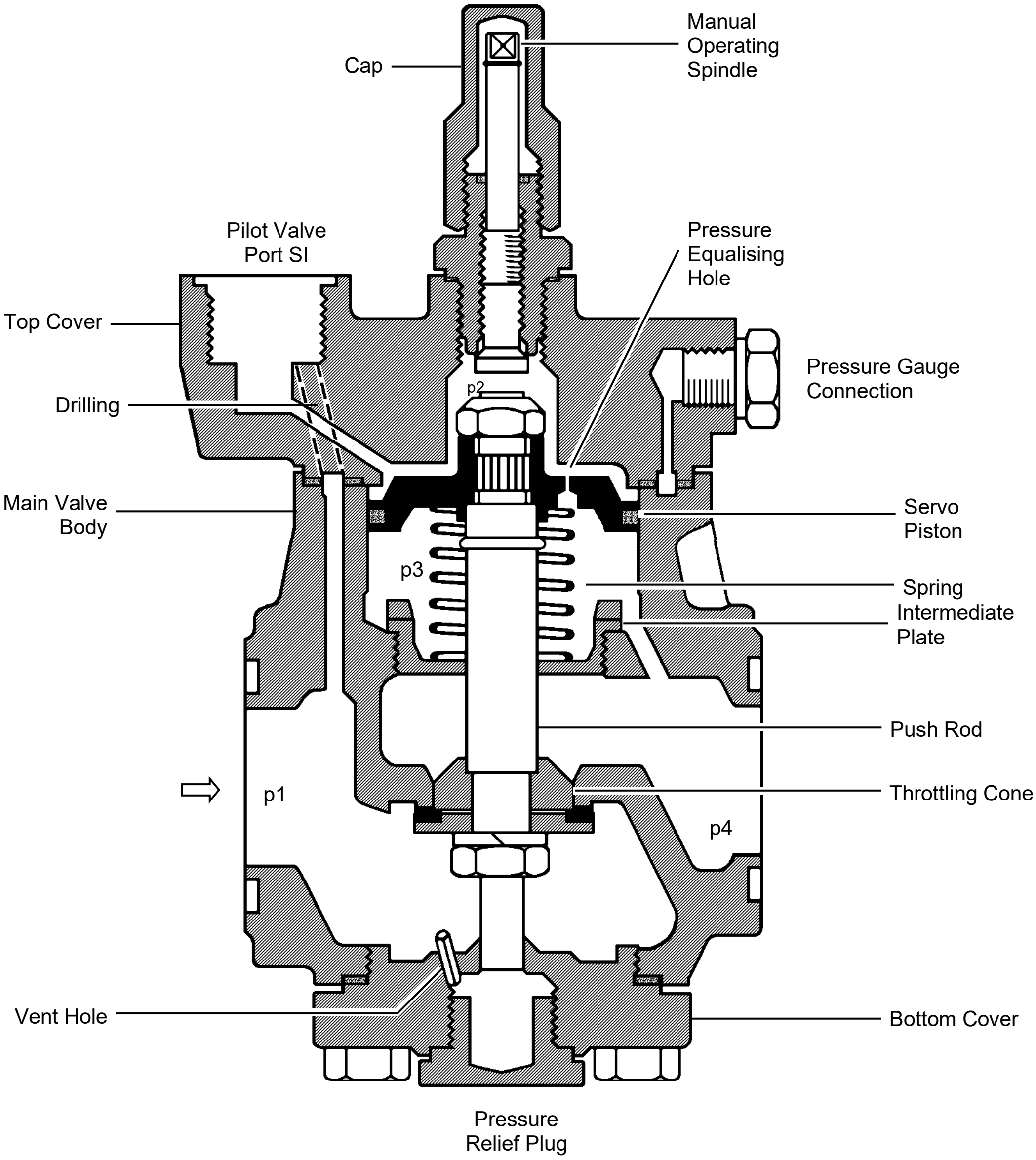


Fig 3 PMC 1-5 to 20 Main Valve

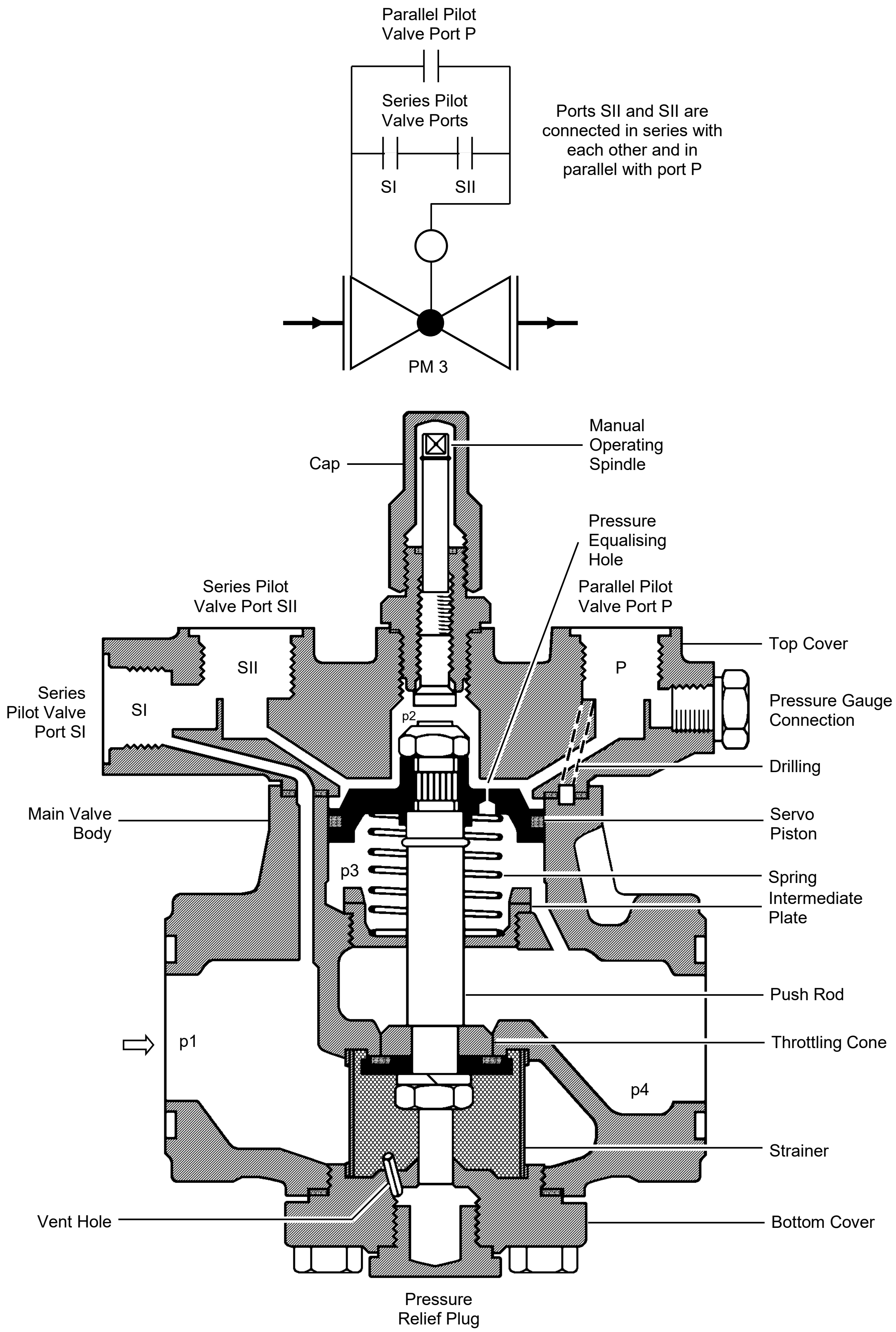


Fig 4 PM 3-5 to 65 Main Valves

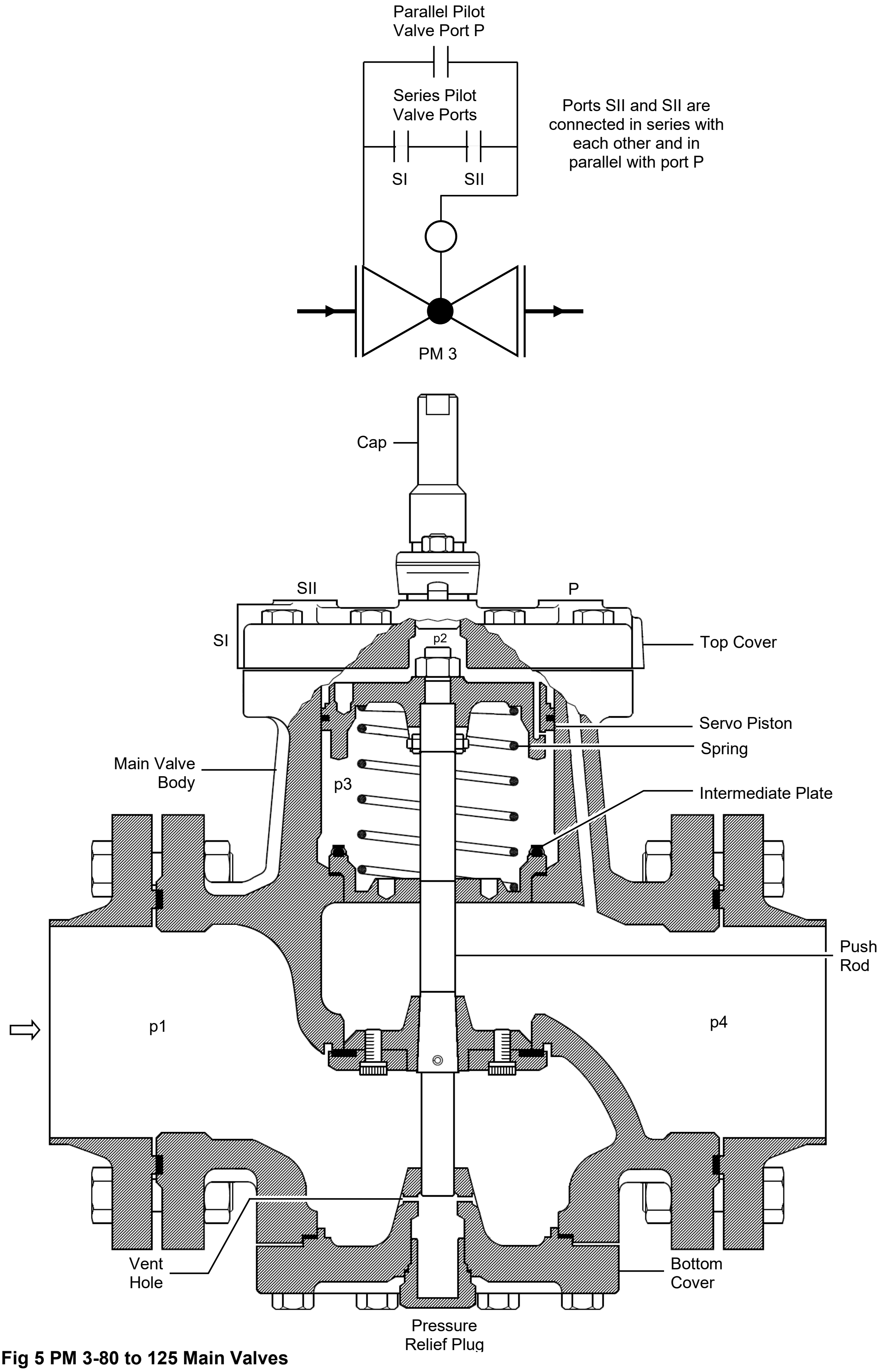


Fig 5 PM 3-80 to 125 Main Valves

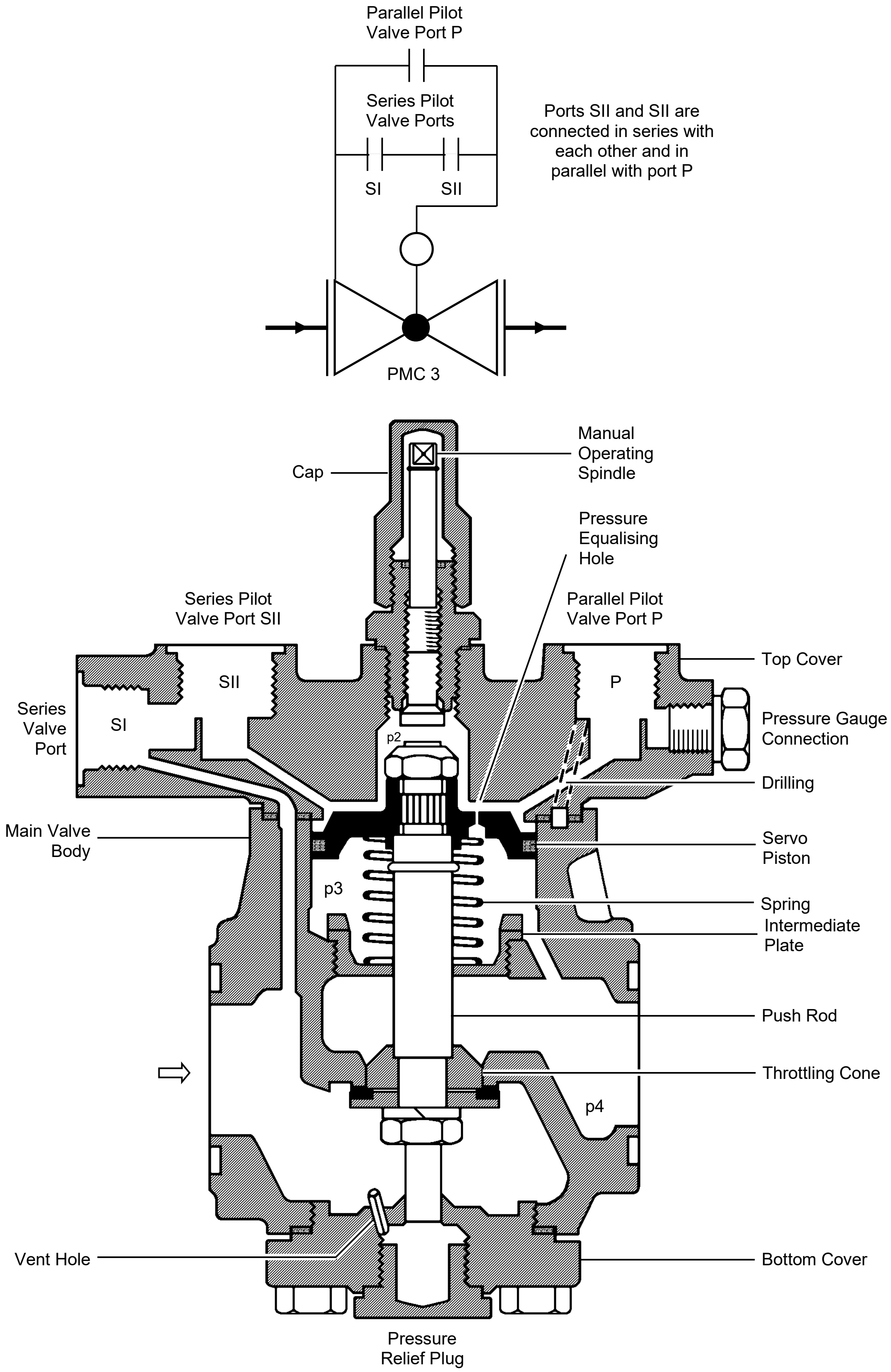
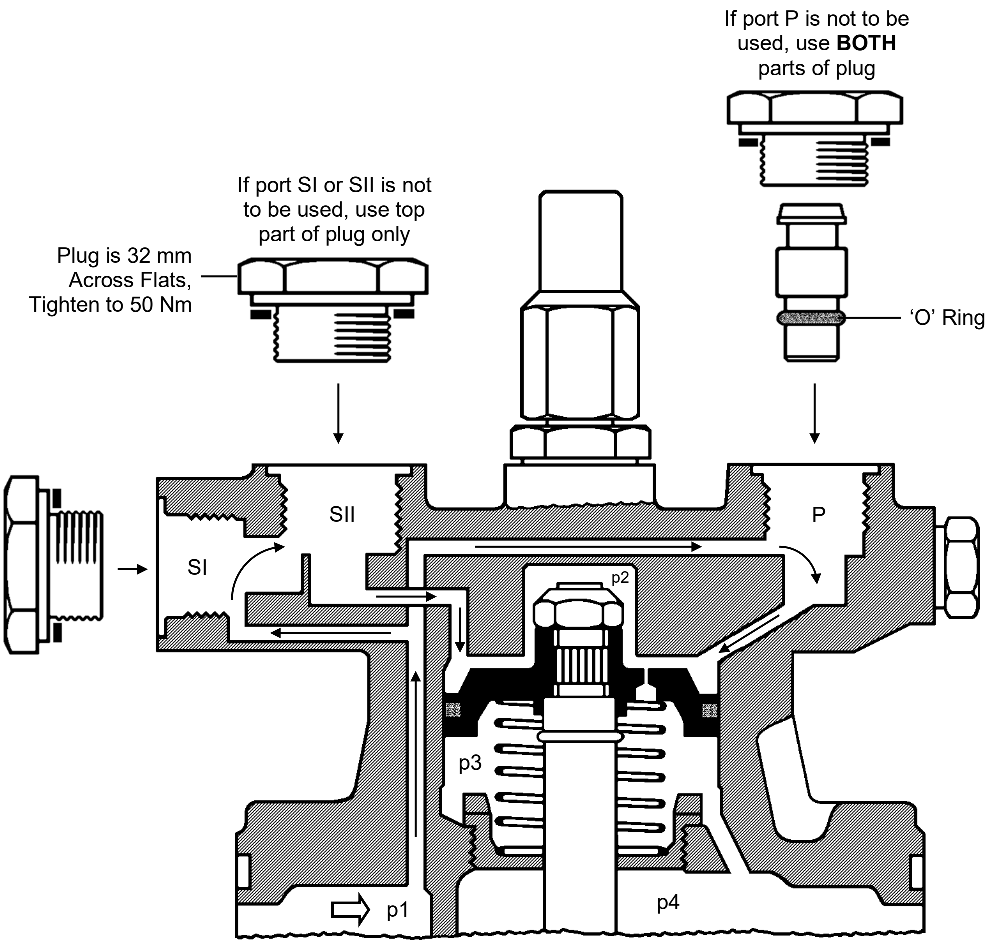


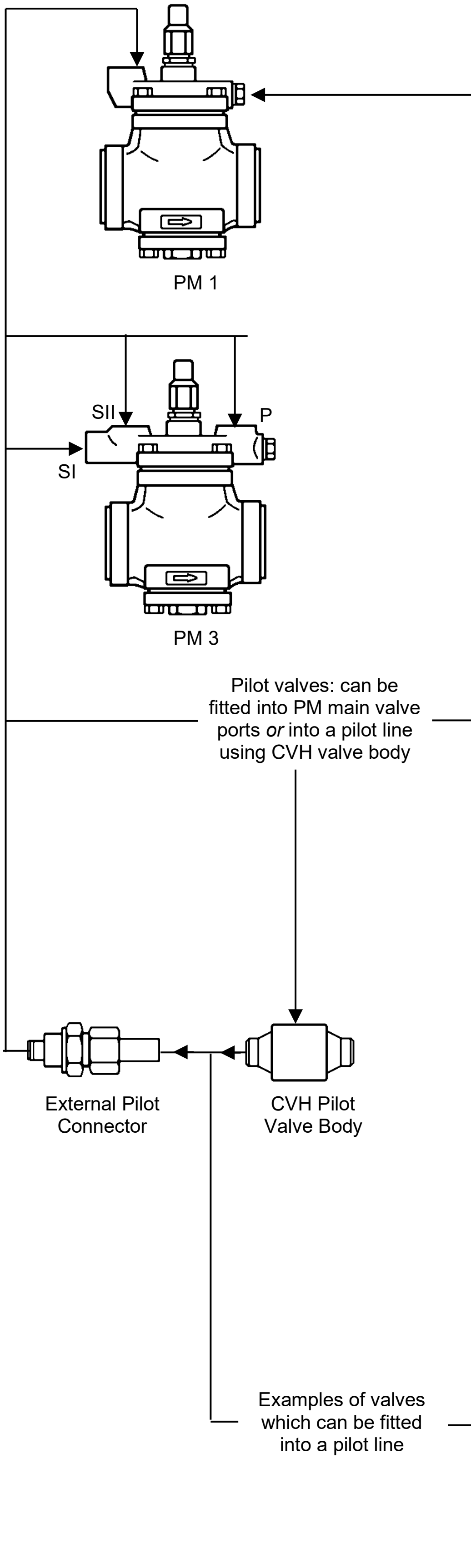
Fig 6 PMC 3-5 to 65 Main Valves

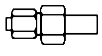
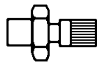


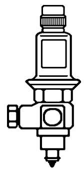
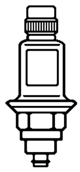
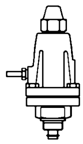
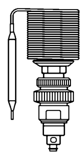
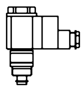
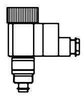
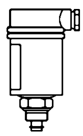
Gas flow through PM 3 main valve show in schematic

Pilot Valve Operation: Open or Closed			PM 3 Main Valve
In Port SI	**In Port SII**	**In Port P**	
Open	Open	Closed	Open
		Open	
	Closed	Closed	Closed
		Open	Open
Closed	Open	Closed	Closed
		Open	Open
	Closed	Closed	Closed
		Open	Open

Fig 7 PM 3 Pilot Valve Operation, Use of Blank Plug



	6.5 mm dia/10 mm dia solder/weld	**Pressure Gauge Connection**
	¼" flare (self-closing) Schrader valve	

Pilot Valves		**Instruction Publication for Further Information**
Symbol	**Type**	
	CVC pressure controlled pilot valve with signal connection	4-101
	CVP and CVP(HP) pressure controlled pilot valves	
	CVPP and CVPP(HP) differential pressure controlled pilot valves	
	CVT and CVTO temperature controlled pilot valves	4-102
	EVM(NC) solenoid operated pilot valve	4-08
	EVM(NO) solenoid operated pilot valve	
	CVQ electric pilot valve	4-106

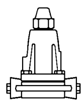
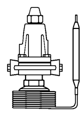
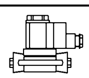
	CVM, CVML, CVMH, CVMP and CVMO constant pressure regulators	4-104
	CVMT constant temperature regulator	4-105
	EVR or EVRA solenoid valve	4-08

Fig 8 Pilot Valve Options

4. Operation

PM main valves are illustrated in Fig 2 to Fig 6.

In the following description:

p1 = inlet pressure.
p2 = pressure acting above the servo piston.
p3 = pressure acting below the servo piston
p4 = outlet pressure.

PM main valves open in response to the pressure difference (differential) between pressure p2 acting above the servo piston and pressure p3 acting on the piston's underside.

If the differential pressure (p2 - p3) across the servo piston is zero, the PM main valve will be completely closed. If the differential pressure exceeds 0.2 bar, the main valve will be completely open. A differential pressure between 0.07 bar and 0.2 bar opens the main valve in proportion.

PM main valve operation can be summarised as follows:

p2 = p4	PM main valve completely closed.
p2 = p4 + 0.2 bar	PM main valve completely open.
$p4 \leq p2 \leq p4 + 0.2$ bar	Proportional degree of opening.

The pressure p2 acting above the servo piston normally corresponds to inlet pressure p1. Pressure p1 is communicated to the space above the servo piston through drillings in the PM main valve body and top cover. These drillings communicate with spaces in the cover into which the pilot valves are screwed: one pilot valve for the PM 1 main valve, up to three pilot valves for the PM 3 main valve (two connected in series with each other and one connected in parallel with the two series pilot valves). A drilling in the main valve body communicates outlet pressure to the underside of the servo piston.

How far the individual pilot valves open determines the size of pressure p2 and thus how far the PM main valve opens. The equalisation hole in the servo piston ensures that pressure p2 is balanced according to how far the pilot valve opens.

PM main valves are fitted with a manual operating spindle, which can be used to open the main valve even if the pilot valve(s) are in the 'closed' condition. Turning the spindle in a clockwise direction forces the throttling cone of its seat and opens the main valve to flow.

4.1. PM 1 Main Valve

PM 1 is fitted with one pilot valve. The main valve is completely closed when the pilot valve is completely closed, and completely open when the pilot valve is completely open, or opens in proportion to the degree of opening of the pilot valve.

4.2. PMC 1 Hot Gas Bypass Valve

The PMC 1, a variant of the PM 1 main valve, is used as a hot gas bypass valve. The CVC pressure operated pilot valve is fitted with an external pilot line sensing suction (evaporating) pressure. The CVC opens the PMC 1 main valve when pilot pressure falls to the valve setting.

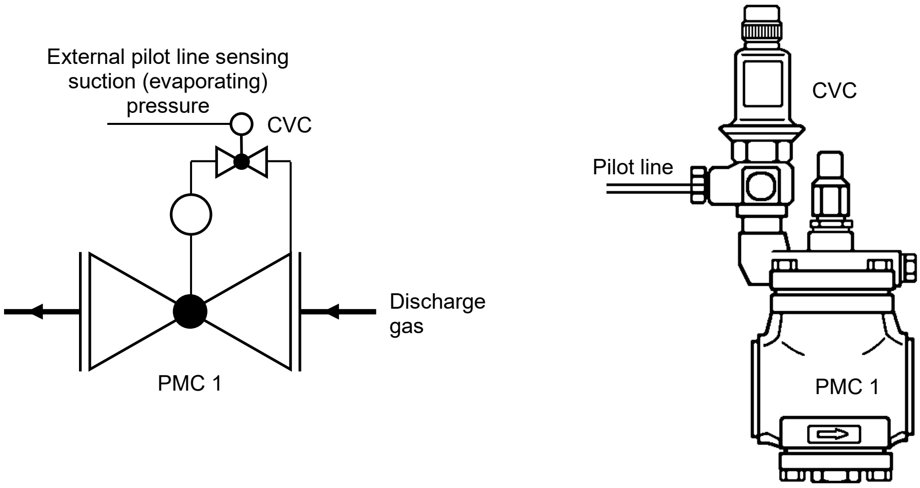


Fig 9 PMC 1 + CVC Hot Gas Bypass Valve Arrangement

4.3. PM 3 Main Valve

PM 3 has three pilot valve ports SI, SII and P: SI and SII are connected in series with each other and in parallel with port P. Pilot valves can be fitted into either one, two or all three ports; their relationship is as follows, refer to Fig 4 and Fig 7.

4.3.1. Ports SI and SII Connected in Series

Assuming pilot valves are fitted into both ports, the PM 3 main valve will be completely closed if one of the series-connected pilot valves in ports SI and SII is completely closed. The main valve can only open completely provided both series connected pilot valves are completely open at the same time.

4.3.2. Port P Connected in Parallel with Ports SI and SII

The pilot valve fitted into this port can be used to override the control action of the pilot valves fitted into the series ports.

The PM 3 main valve will be completely open if a pilot valve fitted into port P is completely open, irrespective of the degree of opening of the SI or SII pilot valves. The main valve will be completely closed if the pilot valve in port P is completely closed and at least one of the pilot valves in SI or SII is also completely closed at the same time.

4.4. PMC 3 Hot Gas Bypass Valves

The PMC 3, a variant of the PM 3 main valve, is used as a hot gas bypass valve. The CVC pressure operated pilot valve in port SII is fitted with an external pilot line sensing suction (evaporating) pressure. The EVM pilot solenoid valve in port SI provides on/off control.

When the compressor unloads to minimum, the EVM solenoid valve energises (opens) to enable the CVC pilot valve. The CVC opens the PMC 3 main valve when pilot pressure falls to the valve setting.

4.5. Pilot Valves

PM main valves can be fitted with several different types of pilot valve depending on whether it is required to control on temperature, pressure or an electrical signal; the various options available are illustrated in Fig 8.

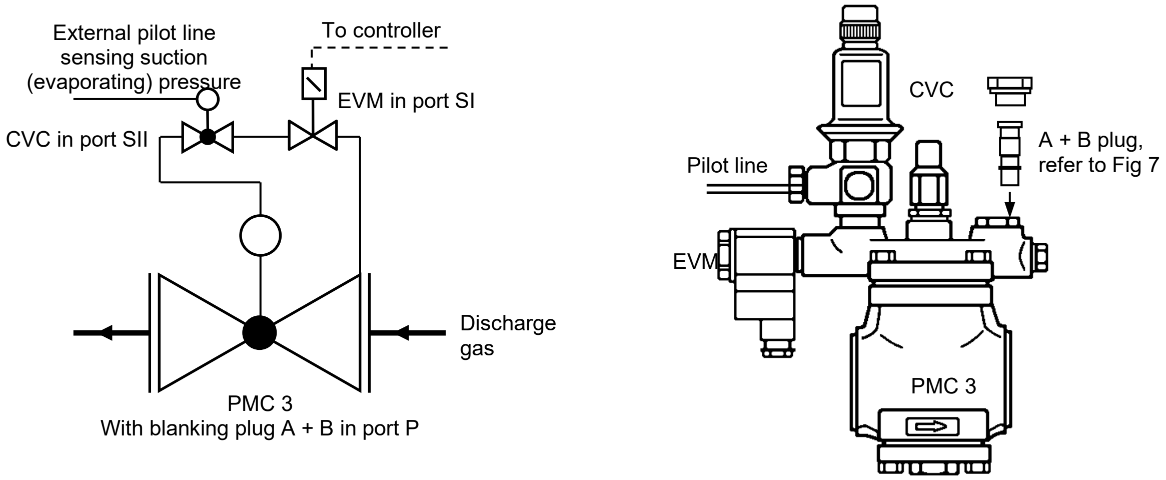


Fig 10 PMC 3 + CVC + EVM Hot Gas Bypass Valve Arrangement

If PM main valve operation is not to be a function of inlet pressure, or in the case of the PM 3 main valve, if more than three regulating functions are required, any pilot valve port can be connected to an external pilot pressure using the external pilot connector illustrated in Fig 8. The external connector also cuts off main valve inlet pressure p1 to the port to which it is fitted. So the pressure p2 acting above the servo piston is now determined by the pressure source to which the external pilot line is connected, and the main valve function (open, closed or some intermediate position) by the pilot valve (or valves) fitted in the pilot line.

Any of the pilot valve ports on the PM 3 main valve that are not to be used must be sealed with a blank plug; refer to Fig 7.

5. Installation

Dirt and other foreign matter is prevented from entering the PM main valve and pilot valve(s) by protective covers fitted to the various connections. These covers should remain in place until immediately before the main valve is installed.

5.1. PM Main Valve

Install the PM main valve in a horizontal pipeline with the top cover positioned uppermost and the manual operating spindle vertical. The top cover can be turned through 4 x 90° relative to the valve body.

Tack-weld the companion flanges, then dismantle the PM main valve from between the flanges before completing the welding/brazing operation. Remove any dirt, scale or weld from the line; this is an essential precaution to prevent these contaminants entering the system.

Reassemble checking that the PM main valve is correctly seated between the flanges; the arrow embossed on the side of the valve body must point in the direction of flow. Tighten the flange nuts evenly to ensure the flanges and gaskets seat square. Do not attempt to align the pipework by tightening the nuts excessively. If the studs bind in their holes or the flanges spring out of line when the studs are removed, obviously there is a misalignment which must be corrected. Refer to Table 2 for recommended tightening torques for the flange bolts.

Screw the pilot valve(s) into the appropriate ports; refer to 5.2. Connect the pilot line (if fitted), refer to 5.3.

After installation, check the main valve, pilot valve(s) and flange joints for leaks.

5.2. Pilot Valves

Fit the pilot valve(s) referring to the relevant instruction publication; publication numbers can be found from Fig 8. In the case of the PM 3 main valve, make sure the pilot valves are fitted to the correct ports; refer to the system schematic flow diagram.

If any of the PM 3 main valve ports are not to be fitted with pilot valves or a pilot line, the unused ports must be blanked off using the special plug provided. Fig 7 shows how to use the plug.

Pilot valve arrangements for PMC 1 and PMC 3 hot gas bypass valves are illustrated in Fig 9 and Fig 10.

5.3. Pilot Line

If a pilot line is to be connected to the main valve, route the line so that any dirt or oil from the plant will not find its way into the main valve via the line.

6. Adjustment

The precise method of adjusting the PM main valve depends on the type and number of pilot valves fitted, these are adjusted to open and close at the correct pressure, temperature or electrical signal. To assist in obtaining an accurate setting, a pressure gauge can be fitted to the connection provided in the top cover of the main valve.

After adjusting the pilot valve (or valves in the case of the PM 3 main valve), check that the main valve opens and closes at the correct pressure or temperature, or in response to an electrical signal.

7. Maintenance

PM 1 and PM 3 main valves are fitted with a stainless steel gauze strainer. Clean the strainer after the first 200 hours operation, then annually, or at intervals of 5,000 operating hours, whichever is the sooner. Experience of running the plant may suggest that more frequent cleaning is necessary.

8. Servicing

Spare parts are available from the address at the end of this publication. It is important to use spares obtained from J & E Hall International. Gaskets must be compatible with the system refrigerant and lubricating oil.

⚠ WARNING

The PM main valve and pilot valve(s) are in direct contact with the system environment. DO NOT attempt to dismantle the main valve or remove it from the line until it has been isolated and that part of the system cleared of oil/refrigerant. Suitable clothing must be worn; this should include goggles, gloves etc., and, on a system using ammonia refrigerant, a suitable respirator.

(a) Clear the part of the system containing the PM main valve by pumping over refrigerant charge. Close isolating stop valves.

- For systems charged with hydrochlorofluorocarbon or hydrofluorocarbon refrigerant, use a pump-out unit to remove the rest of the refrigerant.
- For systems charged with R717 (ammonia) refrigerant, purge off the remaining refrigerant using the apparatus and method illustrated and described under Apparatus for Purging Ammonia Vapour and Draining Oil in publication 5-20 in Section 5 of the plant instruction manual.

(b) Dismantle the PM main valve; refer to Fig 2 to Fig 6.

(c) Clean parts with a suitable solvent, preferably by applying and then blowing-off with compressed air; abrasives must **NOT** be used for this purpose. Examine parts for damage or wear: scoring or chatter-marks for example, fit new parts as required.

(d) Reassemble the valve using new gaskets and ‘O’ rings

Reassemble is a reversal of dismantling, however, note the following points:

- Use fresh refrigerant oil to lubricate ‘O’ rings before assembly.
- Hold the valve plate as shown in Fig 11 when tightening the valve plate securing nut.
- Tighten fastenings to the torques shown in Table 2.

(e) Evacuate that part of the system opened up to atmosphere. The procedure to adopt is described in Part E : Evacuation and Dehydration in Section 1 of the plant instruction manual.

(f) Open stop valves to reunite the system. Check for leaks.

8.1. Fitting a New Manual Operating Spindle Assembly

Isolate and clear the PM main valve of refrigerant as described in 8. Servicing.

(a) Unscrew the operating spindle assembly, remove and discard the old aluminium gasket.

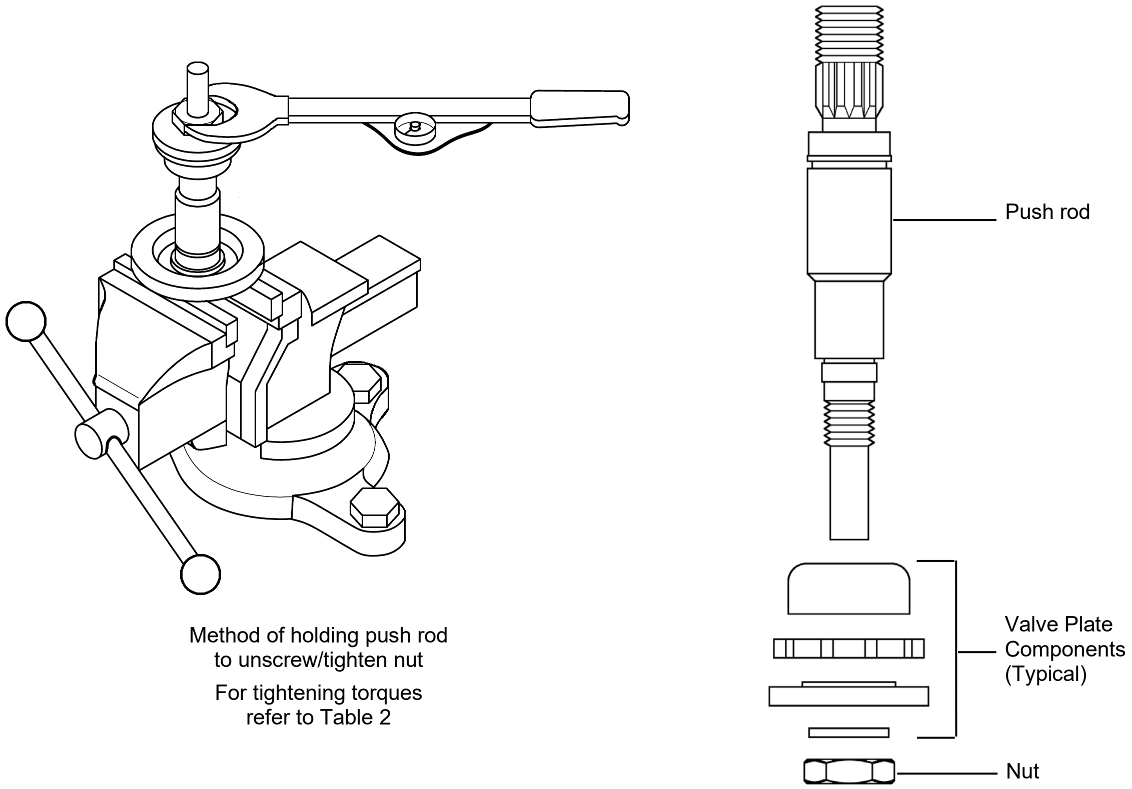
(b) Locate a new aluminium gasket into position. Mount the new operating spindle assembly and tighten clockwise to 80 Nm.

(c) Unscrew and remove the cap.
Tighten the spindle anti-clockwise to 8 Nm.

(d) Refit the cap and tighten clockwise to 8 Nm.

<table>
<tr><th>Application</th><th>PM 32</th><th>PM 40</th><th>PM 50</th><th>PM 65</th><th>PM 80</th><th>PM 100</th><th>PM 125</th></tr>
<tr><td>Top and bottom cover screws to valve body</td><td>45 Nm</td><td colspan="2">60 Nm</td><td>80 Nm</td><td>75 Nm</td><td>80 Nm</td><td>125 Nm</td></tr>
<tr><td>Connecting flange screws to valve body</td><td colspan="2">60 Nm</td><td colspan="4">80 Nm</td><td>125 Nm</td></tr>
<tr><td>Push rod nut (top) – secures servo piston</td><td colspan="4">30 Nm</td><td>45 Nm</td><td>60 Nm</td><td>90 Nm</td></tr>
<tr><td>Push rod nut (bottom - secures valve plate)</td><td colspan="2">55 Nm</td><td>60 Nm</td><td>65 Nm</td><td colspan="3">25 N m</td></tr>
<tr><td>Intermediate plate to valve body</td><td colspan="3">60 Nm</td><td>100 Nm</td><td>150 Nm</td><td>220 Nm</td><td>310 Nm</td></tr>
<tr><td>Screws (8 off) – clamping plate to throttling cone</td><td colspan="4">-</td><td>25 Nm</td><td>40 Nm</td><td>60 Nm</td></tr>
</table>

Table 2 Tightening Torques for Fastenings



Method of holding push rod to unscrew/tighten nut

For tightening torques refer to Table 2

Fig 11 PM Valve Plate Assembly

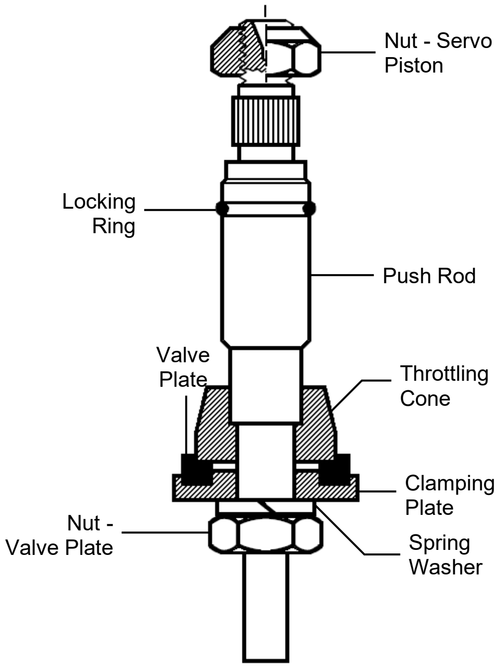
9. Spares and Accessories

Obtain spare parts from the address below:

J & E Hall International
Hansard Gate,
West Meadows,
Derby,
DE21 6JN
England

Telephone: +44 (0) 1332-253400
Fax: +44 (0) 1332-371061
Email: spares@jehall.co.uk
Website: www.jehall.com

When ordering spares always quote the J & E Hall International contract number and the component serial number (if available).

Push Rod Assembly	PMC 5	PMC 8	PMC 12	PMC 20
	027F0160	027F0161	027F0162	027F0163

Contents	Component	No off	PMC 5 to 20
Piston Assembly	Piston Piston ring	1 1	027F0400
Cover Gasket Kit	Gasket – top cover Gasket – bottom cover	1 1	027F2170
Manual Operating Spindle	Aluminium gasket Manual spindle body	1 1	027F2130
Spring		1	027F0910
Valve Plate		1	027F0683
Piston Ring		1	027F0649
Seal Kit (all gaskets and ‘O’ rings)		1	027F0086
Flange Gaskets		2	027F2175
Seal Kit for External Pilot Line Connection		1	027F1004

Table 3 Spare Parts for PMC 5 to 20 Valves

Kit A		Kit B		Kit C	
Contents	**No Off**	**Contents**	**No Off**	**Contents**	**No Off**
Gasket – top cover Gasket – bottom cover Flange gaskets Set of ‘O’ rings (027F1004) for pilot valves not included	1 1 2	Gasket – top cover Gasket – bottom cover Flange gaskets Piston ring Valve plate Set of ‘O’ rings (027F1004) for pilot valves not included	1 1 2 1 1	Gasket – top cover Gasket – bottom cover Flange gaskets Piston Piston ring Push-rod Valve seat Valve plate Cone Strainer Spring Intermediate plate Gaskets and ‘O’ rings for pilot valves	1 1 2 1 1 1 1 1 1 1 1 1 3 sets

<table>
<tr><th rowspan="2">PM 1/PM 3 Valve</th><th>Kit A</th><th>Kit B</th><th colspan="2">Kit C</th></tr>
<tr><th>Standard and V-cone</th><th>Standard and V-cone</th><th>Standard Cone</th><th>V-cone</th></tr>
<tr><td>5</td><td rowspan="5">027F3241</td><td rowspan="5">027F3250</td><td rowspan="3"></td><td>027F3259</td></tr>
<tr><td>10</td><td>027F3260</td></tr>
<tr><td>15</td><td>027F3261</td></tr>
<tr><td>20</td><td>027F3262</td><td rowspan="2"></td></tr>
<tr><td>25</td><td>027F3263</td></tr>
<tr><td>32</td><td>027F3242</td><td>027F3251</td><td>027F3264</td><td>027F3271</td></tr>
<tr><td>40</td><td>027F3243</td><td>027F3252</td><td>027F3265</td><td>027F3272</td></tr>
<tr><td>50</td><td>027F3244</td><td>027F3253</td><td>027F3266</td><td>027F3273</td></tr>
<tr><td>65</td><td>027F3245</td><td>027F3254</td><td>027F3267</td><td>027F3274</td></tr>
<tr><td>80</td><td>027F3246</td><td>027F3255</td><td>027F3268</td><td>027F3275</td></tr>
<tr><td>100</td><td>027F3247</td><td>027F3256</td><td>027F3269</td><td>027F3276</td></tr>
<tr><td>125</td><td>027F3248</td><td>027F3257</td><td>027F3270</td><td>027F3277</td></tr>
</table>

Table 4 Spare Parts for PM 1 and 3 Valves

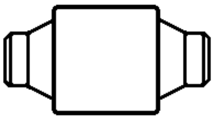
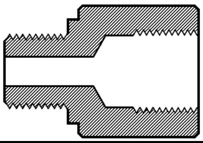
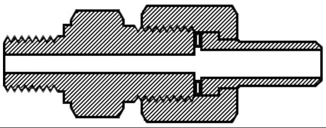
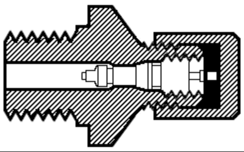
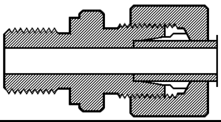
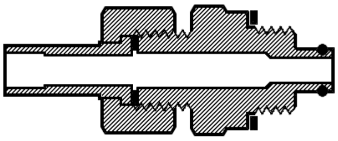
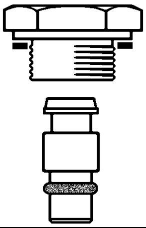
Part	Description		Part Number
	CVH pilot valve body (for installing pilot valve into pilot lines)	Weld 12.7 mm ID /18 mm OD	027F1047
		G ¼ (ISO 228-1)	027F1160
		G ¼ (USA B2.1-1960)	027F1159
	Pressure gauge connection ¼" FPT		027B2062
	Pressure gauge connection (weld/solder) 6.5 mm dia/10 mm dia		027B2035
	Pressure gauge connection ¼" flare (self-closing) **NOTE: must NOT be used with R717 (ammonia)**		027B2041
	Pressure gauge connection (cutting ring)	6 mm	027B2063
		10 mm	027B2064
	External pilot connection (including damping orifice) 1.0 mm OD pipe	ICS 25 to ICS 80	027F1048
	External pilot connection (including damping orifice) 1.8 mm OD pipe	ICS 100 to ICS 150	027F1049
	Accessory bag with seal and 'O' ring for pilot valve	ICS 25 to ICS 150	027F0666
 A B	Two part blanking plug (A + B) for unused ports in PM 3/PMC 3 main valve cover (refer to Fig 7)		027F1046
	'Strong' spring for PM 1 and 3 sizes 5 to 25, approximately 45 % more closing force		027F0662

Table 5 Accessories For PM Valves