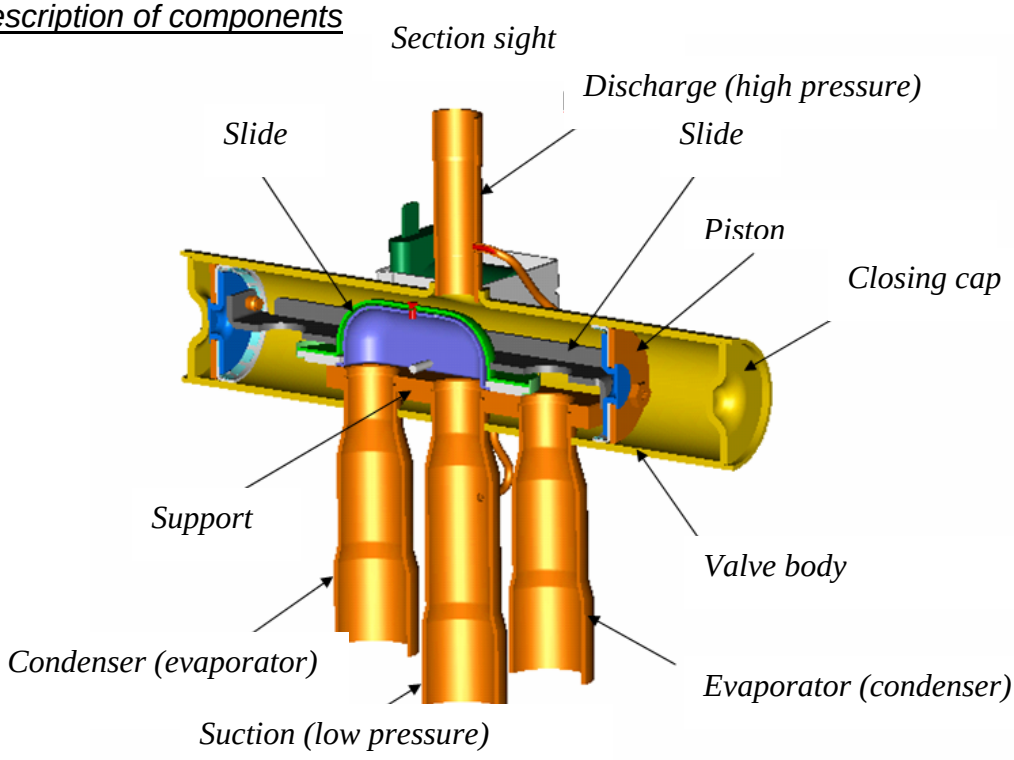
Technical Support
Bulletin Nr. 19 – Reversing Valves

Contents

- *Description of components*
- *Functional operation*
- *Selection criteria and pressure drop diagrams*
- *Interpreting diagrams*
- *Parallel valves*
- *General installation - removal procedures*
- *Replacing the valve unit - a few notes*
- *Troubleshooting*
- *Test mode*

Description of components



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- *Functional operation*

System tubing can be connected to the reversing valve depending on the system mode (heater or chiller) to be run should the solenoid coil fail. Refer to Figures 1(A) and 2(A), where the two heat exchangers, A and B, are shown. To simplify things, let's call heat exchanger "INSIDE-A" the internal one, i.e. the one that produces hot or cold in the environment to be climatized.

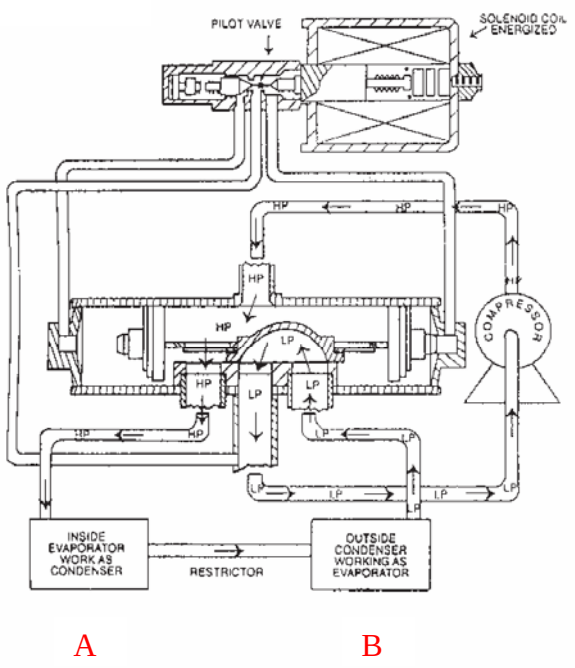
Fig. 1A: When the coil is energized, the valve makes heat exchanger A work as a condenser, allowing "heat" to be generated in the associated environment.

Fig. 1B: When the coil is not energized, the valve makes exchanger A work as an evaporator, allowing the associated environment to be "cooled". When it is not energized, the coil is in the same position as when it is faulty. Consequently, by way of this connection, the "chiller" mode is assured even when the coil fails.

Fig. 2A: When the coil is energized, the valve makes exchanger A work as an evaporator, allowing the associated environment to be "cooled".

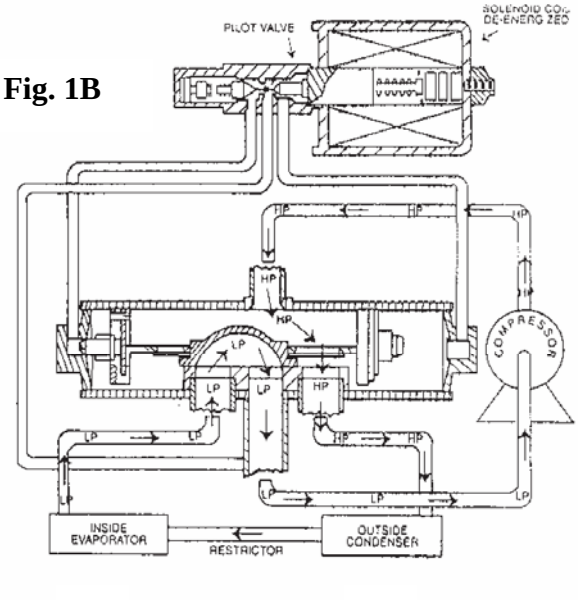
Fig. 2B: When the coil is not energized, the valve makes heat exchanger A work as a condenser, allowing "heat" to be generated in the associated environment. When it is not energized, the coil is in the same position as when it is faulty. Consequently, by way of this connection, the "heater" mode is assured even when the coil fails.

Fig. 1A



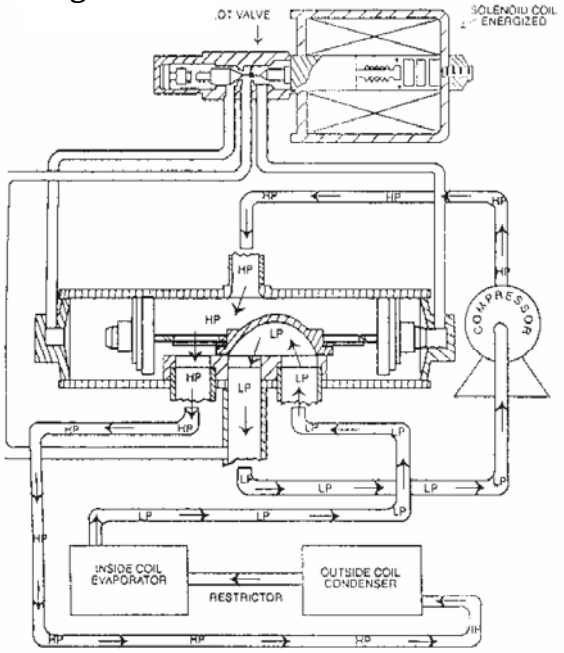
A B

Fig. 1B



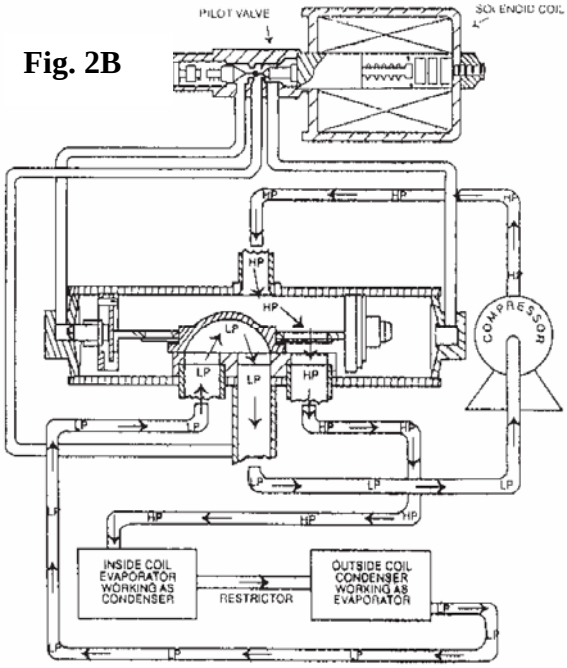
A B

Fig. 2A



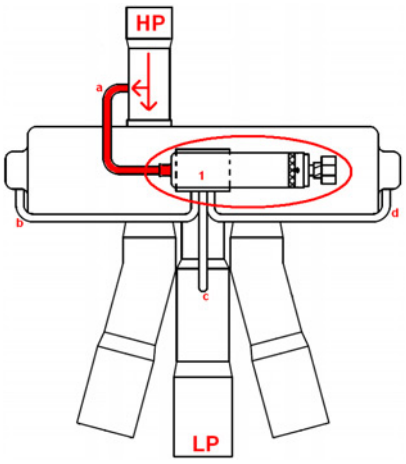
A B

Fig. 2B



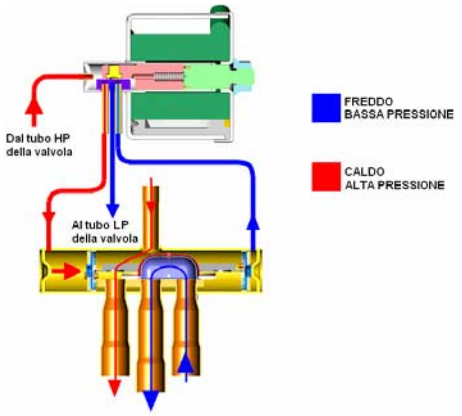
A B

Switching from heater to chiller and viceversa is done via movement of the slide, the position of which forces the refrigerant to flow in one direction or the other (see figures indicated above). This movement is controlled by the capillary tubes, as described below:



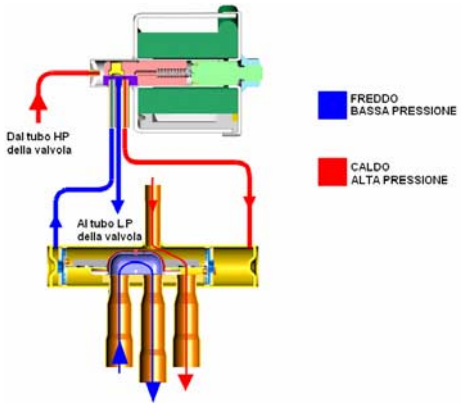
The red arrow indicates the direction of refrigerant flow. Part of this passes through capillary tube "a", shown in red, to get to point 1.

Here a selector switch allows the refrigerant to flow through capillary tubes c-b, or c-d. The position of this switch is determined by the coil (energized or not). You will be able to see now from this point that the coil indirectly activates movement of the slide.



Take the switch for example (piloted by the coil) that allows refrigerant to flow through c-b, indicated in red. While a part of the refrigerant is returned to the circuit through "c", another part is deviated by "b".

The refrigerant flowing through capillary tube "b" pushes the slide from left to right. The slide allows refrigerant to flow in the circuit through tube LP and the tube on the right.



Clearly, the switch in position c-d means pushing the slide from right to left. Consequently, refrigerant can flow through LP and the tube on the left.

Each position corresponds to a function mode, i.e. heater or chiller.

Freddo bassa pressione	*Cold low pression*
Caldo alta pressione	*Hot high pressure*
Dal tubo HP della valvola	*From HP valve tube*
Al tubo LP della valvola	A *To LP valve tube*

To guarantee movement of the slide, a minimum pressure differential ΔP is required between HP and LP (varies depending on V-N and VH range valves - see figures provided on relative drawings). If this differential is not achieved, the slide may only move partially or not at all, with the associated consequences.

- *Selection criteria and pressure drop diagrams*

To select the right valve, the following information is essential:

1. Evaporating Temperature, in °C or °F
2. Condensing temperature, in °C or °F
3. Sub Cooling, in °C or °F
4. Superheat, in °C or °F
5. Type of refrigerant
6. Maximum refrigeration capacity

N.B.: the Chiller and Heat Pump modes have different operating conditions. In this particular case, let's look at chiller mode conditions. Example:

Heat pump	Chiller
Sub Cooling=Overheating=5°C	Sub Cooling=Overheating=5°C
Evaporating Temperature=-7.5 °C	Evaporating Temperature=13.5 °C
Condensing Temperature=35.0 °C	Condensing Temperature=52.0 °C
refrigeration capacity=11.5KW	refrigeration capacity=13.0KW

In this case, the values to be considered for sizing purposes are:
Evaporating Temperature =-7.5 °C (Heat Pump)
Condensing Temperature =52.0°C (Chiller)
Refrigeration capacity =13.0KW (Chiller)

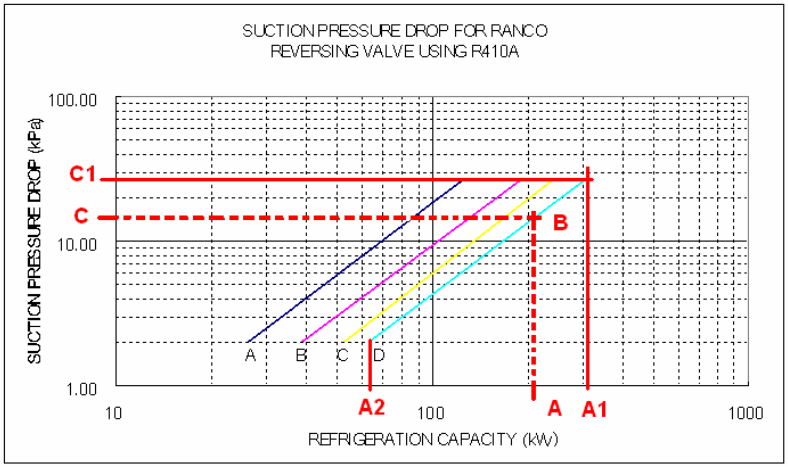
Select the right valve for ARI standard operating conditions using the figures listed in the table and in Eliwell documentation:

1. Evaporating temperature: 7.2°C
2. Condensing Temperature: 54.4°C
3. Sub Cooling: 5.0°C
4. Superheat: 5.0°C

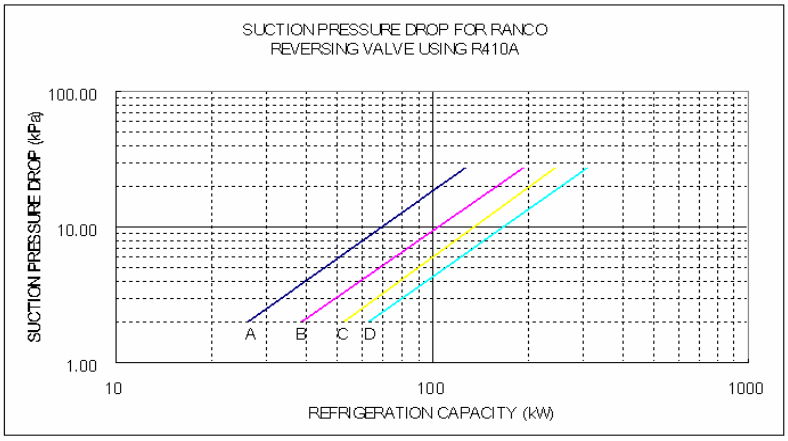
In these conditions and at the nominal refrigeration capacity, the selected valve creates a maximum drop in pressure of 0.014MPa in the refrigeration circuit. If the valve works with a refrigeration capacity that is higher than the nominal one, drops in pressure increase. See the section entitled “Pressure drop diagram”.

Part Number	R407C kW min/max (US ton min/max)	R410A kW min/max (US ton min/max)	R134A kW min/max (US ton min/max)	C.T.S.				Style	Mass (W/O coil)	Qty/box	Coil
				S.E.C.		Discharge					
				mm	Inch	mm	Inch				
V0-406050100	1,34 / 3,02 (0,38 / 0,86)	1,55 / 3,83 (0,44 / 1,09)	1,16 / 2,36 (0,33 / 0,67)	9,64	3/8	8,12	5/12	B	210	36	LDL/LDK
V1-408050100	1,41 / 4,57 (0,4 / 1,3)	1,76 / 5,98 (0,50 / 1,70)	1,41 / 3,87 (0,4 / 1,1)	12,84	1/2	8,01	5/16	A	285	36	LDL/LDK
V1-408060100	1,41 / 4,57 (0,4 / 1,3)	1,76 / 5,98 (0,50 / 1,70)	1,41 / 3,87 (0,4 / 1,1)	12,84	1/2	9,67	3/8	A	285	36	LDL/LDK
V1-406060100	1,41 / 4,57 (0,4 / 1,3)	1,76 / 5,98 (0,50 / 1,70)	1,41 / 3,87 (0,4 / 1,1)	9,64	3/8	9,67	3/8	A	285	36	LDL/LDK
V1-406050100	1,41 / 4,57 (0,4 / 1,3)	1,76 / 5,98 (0,50 / 1,70)	1,41 / 3,87 (0,4 / 1,1)	9,64	3/8	8,01	5/16	A	285	36	LDL/LDK

Based on the above table, we need to select a valve for a refrigeration capacity of 4KW, R410A, in standard operating conditions. We would choose V0-406050100 to run a minimum refrigeration capacity from F 1.55KW up to a maximum of 3.83KW.



In a refrigeration circuit, each component introduces a drop in pressure, i.e. reducing ideal performance. In an ideal system, the refrigeration capacity absorbed is transformed into equal amounts of refrigeration capacity delivered, although of a different nature: for example, 100KW of electricity is transformed into 100KW of refrigeration capacity. In a real system, friction in tubing, heat exchangers, bends in tubing, and reversing valves cause a loss of power. Hence, 100KW of electricity actually corresponds to 98KW of refrigeration capacity with 2KW of power dispersed. Clearly this dispersal of power must be kept to a minimum to get the maximum output. Reversing valves create a maximum drop in pressure in the system (at nominal refrigeration capacity) of 0.014MPa. Note the initial pressure then, as the final pressure may be just 0.014MPa less due to the valve, but this must be added to other losses caused by the other components. Guidelines on how to read the various diagrams are provided below.



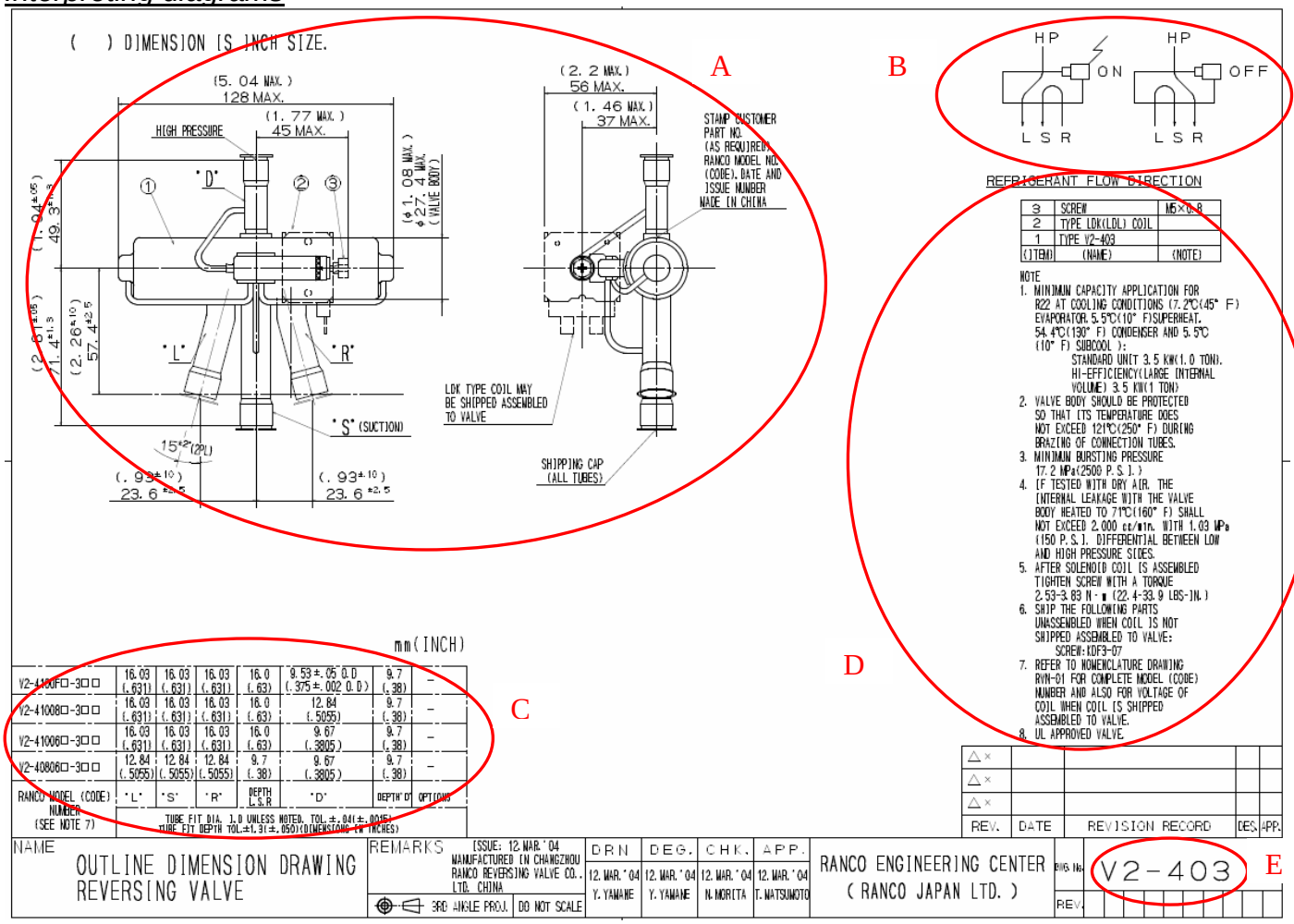
Lines A, B, C and D represent valves N20, N30, N40 and N50 respectively. They are R410A gas lines. Under normal conditions, valve N50 can operate with R410A at refrigeration capacities of up to 204KW.

Intersecting A (nominal refrigeration capacity_) with line D will give point C, i.e. the drop in pressure at nominal refrigeration capacity_: this value equals approx. 14KPa (=0.014MPa). You will see that line D does not stop at the nominal refrigeration capacity point, running on instead. When you intersect the extreme value, you get value A1 (slightly above 300KW). This value corresponds to pressure drop C1, equal to 30KPa. This means that if the valve is used at a refrigeration Fcapacity that is greater than the maximum value indicated, pressure drops increase. We recommend not to exceed limit A1 (or maximum refrigeration Fcapacity) so as not to increase pressure drops too much and compromise system efficiency.

Limit A2 on the other hand represents the minimum refrigeration capacity that can be run. Let's now go back to the same table as before, and take valve V0-406050100. With this valve, power outputs from 1.55KW (A2) to 3.83KW (A1) can be managed. If the valve was mounted on a machine with a refrigeration capacity, say, of 1.00KW, we would have oversized. The actual refrigeration capacity and flow rates are less than what the valve was designed for, and the system would fail to achieve the conditions required to move the slide mechanically.

The minimum refrigeration capacity is therefore a key factor in selecting a valve.

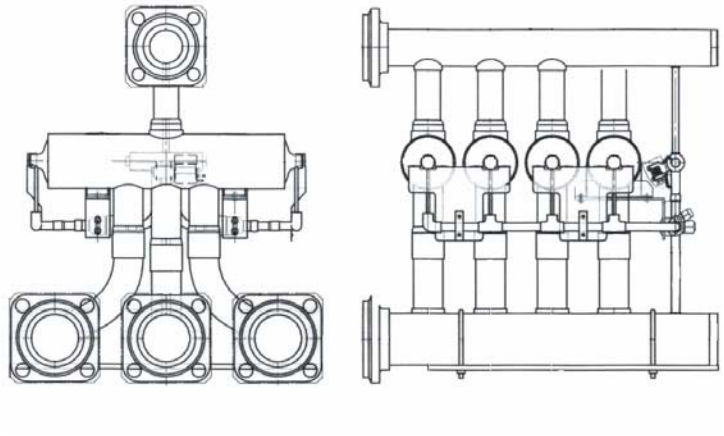
Interpreting diagrams



A Mechanical dimensions and space required
B Slide position with coil energized-deenergized
C Family models and tube dimension table. All measurements refer to internal dimensions.
D Technical data (refrigeration capacity , min/max. temp.)
E Drawing code

Parallel valves

This is an effective solution to adopt when the total power output is too much for a single valve. Let's take a look at an example. When the valves are mounted in parallel by the customer, care must be taken with the following aspects:



1. The number of valves to be connected in parallel: the lowest possible number. Example: to reach 400KW, it would be better to use 2 x 200KW valves rather than 4 x 100KW.
2. Distance between the valves: the smallest possible distance.
3. Parallel connection of pilot capillary tubes: they must be as close in length as possible.
4. In addition, before starting up the machine, make sure the valve slides are all in the same position.
5. Once they have been assembled in parallel, clean the capillary tubes and pipes before starting up the machine.

- *General installation - removal procedures*

When mounting the valves, the valve body must be horizontal and the connecting pipes vertical.

See the drawing referred to above for Suction, Delivery, Evaporator and Condenser connections.

• Use only an oxy-acetylene torch to unsolder connections. Other types of torches may not have the heat capacity to do the job in the time and at the temperature required.

• Protect the valve from excessive heat. Temperatures above 110°C may damage internal components. Wrapping a wet rag around the valve body while using the torch will help to dissipate heat.

• Inadequate heat is also a problem. Not only will the soldered joints be difficult to separate, but also the build up of heat over the longer period of time required will transfer to the valve body and possibly damage its internal
parts.

• The joint should separate in seconds, not minutes. Use enough heat to accomplish this, while using the wet rag to protect the valve body. Also remember that the remelt temperature of any solder alloy is much higher than the initial soldering temperature.

• After removing the valve, inspect the lines to make sure they are round and do not have any large solder blobs, which will interfere with the mechanical fit of the new joints.

• Be very careful when handling the new valve during installation. In particular, the use of vise-type pliers is recommended to manoeuvre the valve body during installation.

IMPORTANT: Protect tubes so that foreign matter such as moisture, metal filings, dust or dirt cannot enter. It only takes a tiny bit of scale, flux, threads or similar materials to clog a pilot valve.
• Use wet rags around the valve body and adjoining tubing to prevent overheating. Direct the flame of the torch away from the valve body. Heat in excess of 110°C may distort internal parts.
• Use a low temperature brazing rod as prescribed in local regulations, and use an inert gas to prevent oxide scale on the inside of the tubing.
• A phosphorus-bearing silver solder which requires no external flux is preferable. The entry of even a tiny bit of flux may be enough to
damage a new valve.
• If you must use silver solder with externally applied flux, make sure the sections to be joined are clean and polished, and that the flux is used sparingly. Given the intricacy of the job and the skill and attention required, the majority of valve manufacturers advise against using this method.

- *Replacing the valve unit - a few notes*

SYSTEM REPAIR - Follow the original equipment manufacturer's recommendations when replacing refrigerant components.
SYSTEM EVACUATION - Follow the original equipment manufacturer's recommendations and/or RSES SAM, Section 83 (630-46).
COMPRESSOR MOTOR BURNOUT - Follow the original equipment manufacturer's recommendations and/or RSES SAM Section 91.
WARNING: To prevent electrical shock or damage to equipment, disconnect the unit from the electricity supply before and during installation. DO NOT restore electrical power to the unit until the device has been properly installed.
Troubleshooting
If the valve does not work, follow the steps outlined below:

1. Remove the coil and replace it with a new, compatible one.
    - If the valve now works, it can be considered to be in working order and the problem must have been the coil; go to point 3.
    - If the valve is still not working, there must be mechanical damage and it should be replaced; go to point 2.
2. Check the capillary tubes: they must not be twisted, solders connecting them to the valve must be intact; there should be no holes or tears in capillary tubes;
3. check that the coil has been connected at the right voltage. Check also that the coil installed is compatible with the valve. For example, valve V0-406050100 needs an LDL/LDK coil whilst an LB6 will not work!

Test mode

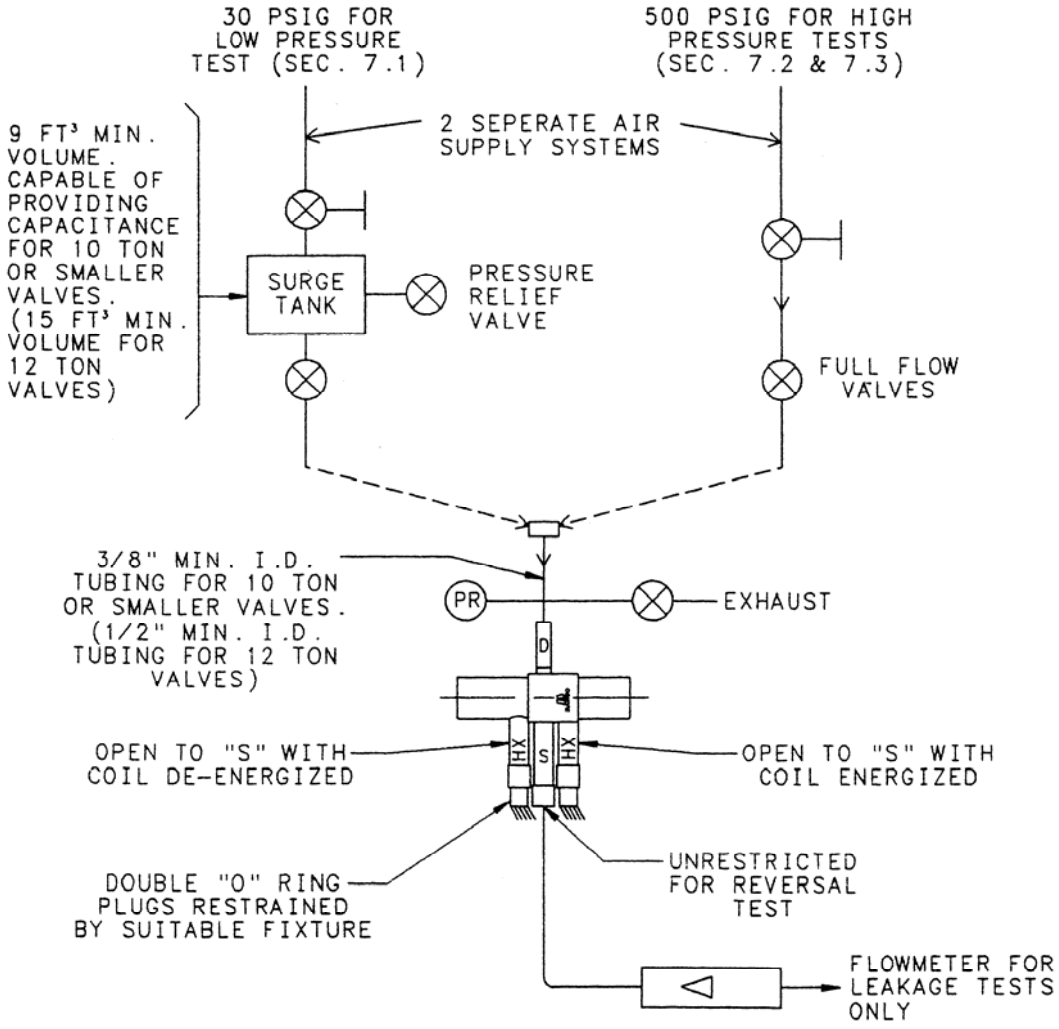
ACCEPTANCE CRITERIA/FUNCTIONAL VALIDATION OF REVERSING VALVES

The functional trials described below are carried out on the final groups of reversing valves. Air flow rates required for functional trials are listed in Figure 1.

1. Reversal at minimum pressure differential: Feed dry air at a maximum pressure of 0.15 MPa (+0MPa, -0.05MPa) into tube "D" (Figure 1) at "full flow rate". Block tubes HX, energize and deenergize the valve coil by applying 85% of the nominal voltage. Check that the valve reverses correctly within 2 seconds. To determine the minimum pressure differential required for reversal, reduce the pressure until no form of reversal at all occurs.
2. Reversal at maximum pressure differential: Apply the nominal voltage and wait for the EMA temperature to stabilize. Reduce the voltage to 85% of the nominal value and select the frequency (within the permitted time interval) that equates to minimum output (in Watts) of the coil. The valve must be able to reverse in the energized position when dry air at a minimum pressure of 3.04MPa is applied to tube "D". Subsequently, the valve must be able to return to the deenergized position when a minimum pressure differential of 3.04MPa is applied.
3. Combined internal leakage: Heat the valve to 70°C (simulating the temperature of the valve body during refrigeration) and inject air at room temperature inside it. Apply dry air at a pressure of 1.0MPa to tube "D" (Figure 1) after connecting tubes "HX" together and an adjustable flow meter has been installed on tube "S" (Figure 1). Measure the rate of internal leaks with the valve in the energized position first then in the deenergized position. Check that the leaks measured are below the values listed in Table 1.
4. External leaks: Block the two HX tubes. Introduce pressure into the valve in two steps using the "S & D" tubes (Figure 1). Inject oil then refrigerant gas at a pressure of 0.69MPa, then dry air at a pressure of 4.15 MPa. Measure the DUT leak rate using an electronic leak gauge or similar instrument. Total flow rate for external leaks equals 10^{-5} CC/second.

Figure 1.

Configuration to run air tests on reversing valves.



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